Countermeasures That Work:

A Highway Safety Countermeasure Guide For State Highway Safety Offices Ninth Edition, 2017

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16. Abstract
The guide is a basic reference to assist State Highway Safety Offices (SHSOs) in selecting effective, evidence-based countermeasures for traffic safety problem areas. These areas include:

- Alcohol- and Drug-Impaired Driving;
- Seat Belts and Child Restraints;
- Speeding and Speed Management;
- Distracted and Drowsy Driving;
- Motorcycle Safety;
- Young Drivers;
- Older Drivers;
- Pedestrian Safety; and
- Bicycle Safety.

The guide:

- describes major strategies and countermeasures that are relevant to SHSOs;
- summarizes strategy/countermeasure use, effectiveness, costs, and implementation time; and
- provides references to the most important research summaries and individual studies.

17. Key Words
Alcohol-Impaired Driving, Drug-Impaired Driving, Seat Belts, Child Restraints, Speeding, Distracted Driving, Drowsy Driving, Motorcycle Safety, Young Drivers, Older Drivers, Pedestrians, Bicycles, Unsafe Driving

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Note: Asterisks next to topics indicate one- and two-star countermeasures. These countermeasures are summarized in the main document, with full write-ups provided in the appendices.

Preface to the Ninth Edition, 2017

This edition of *Countermeasures That Work* was prepared by Battelle Memorial Institute. Researchers who contributed to this edition include Christian M. Richard, Kelly Magee, Paige Bacon-Abdelmoteleb, and James L. Brown. The original *Countermeasures That Work* was prepared in 2005 by James H. Hedlund, Ph.D., of Highway Safety North, with the assistance of Barbara Harsha, executive director of the Governors Highway Safety Association. The chapters on pedestrian and bicycle safety were added in the Second Edition by William A. Leaf of Preusser Research Group.

All chapters have been revised and updated for this edition. Information and research studies through May 31, 2016, have been reviewed and included as appropriate. Data has been updated to include information from 2015 FARS (Fatality Analysis Reporting System).

A significant change in the 9th Edition is that the detailed descriptions of one- and two-star countermeasures were moved to an appendix section in the guide. The main part of the guide retains brief summaries for the one- and two-star countermeasures to facilitate navigation of the topics and to maintain continuity with previous editions.

User Suggestions and Future Editions

NHTSA will update this guide biennially and may expand it with additional problem areas and countermeasures as appropriate. Users are invited to provide their suggestions and recommendations for the guide.

- How can it be improved, in form and content?
- Specific comments on information in the guide.
- Additional problem areas to include.
- Additional countermeasures to include for the current problem areas.
- Additional key references to include.

Please send your suggestions and recommendations to:

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Introduction

Purpose of the Guide

This guide is a basic reference to assist State Highway Safety Offices (SHSOs) in selecting effective, science-based traffic safety countermeasures for major highway safety problem areas. The guide

- describes major strategies and countermeasures that are relevant to SHSOs;
- summarizes their use, effectiveness, costs, and implementation time; and
- provides references to the most important research summaries and individual studies.

The guide is not intended to be a comprehensive list of countermeasures available for State use or a list of expectations for SHSO implementation. For a description of an optimal State countermeasure program, SHSOs should refer to the *Highway Safety Program Guidelines*, which delineate the principal components of each of the major program areas.

States should identify problem areas through systematic data collection and analysis and are encouraged to continue to apply innovation in developing appropriate countermeasures. The evaluations summarized in this guide allow SHSOs to benefit from the experience and knowledge gained by others and to select countermeasure strategies that either have proven to be effective or that have shown promise. States choosing to use innovative programs can contribute to the collective knowledge pool by carefully evaluating the effectiveness of their efforts and publishing the findings for the benefit of others.

How to Use the Guide

What's included: The guide contains a chapter for each problem area. Each chapter begins with a brief overview of the problem area's size and characteristics, the main countermeasure strategies, a glossary of key terms, and a few general references. Next, a table lists specific countermeasures and summarizes their effectiveness, costs, use, and implementation time. Each countermeasure is then discussed in approximately one page.

The guide provides an overview and starting point for readers to become familiar with the behavioral strategies and countermeasures in each program area. It has attempted to include countermeasures that have the most evidence of effectiveness as well as those that are used most regularly by SHSOs. Only those countermeasures that could be supported by traditional highway safety grant programs have been considered. In addition, updates to the guide are based only on published research. Unpublished programs and efforts are not included in this edition.

Some countermeasure areas are covered in more depth than others due to the availability of published research. For example, impaired driving has a long and rich research history while other topics, such as driver distraction and drowsiness, have received less attention. This difference in the availability of published research findings is due to a number of factors, including the relative scale of the problem areas, the availability of reliable data on the frequency and characteristics of some safety problems, and the challenge of conducting scientifically valid studies in certain behavioral areas.

References are provided for each countermeasure. When possible, summaries of available research are cited, with web links where available, so users can find most of the evaluation information in one place. If no summaries are available, one or two key studies are cited. There has been no attempt to list all research, current studies, or program information available on any countermeasure. Readers interested in any problem area or in specific countermeasures are urged to consult the references. Although all web links in this guide were accurate at the time of publication, please note that web links may change periodically. For broken links to NHTSA documents, we recommend searching NHTSA's behavioral safety research reports (ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm). For broken links to other reports or documents, refer to the website for the agency that produced the report.

What's not included: Since the guide is intended as a tool for SHSO use, it does not include countermeasures for which SHSOs have little or no authority or responsibility, or that cannot be supported under typical highway safety grant programs. For example, the guide does not include vehicle- or roadway-based solutions. Also, it does not include countermeasures that already are in place in every State, such as .08 grams per deciliter blood alcohol concentration laws. Finally, the guide does not include administrative or management topics such as traffic safety data systems and analyses, program planning and assessments, State and community task forces, or comprehensive community traffic safety programs.

What the effectiveness data mean: The effectiveness of any countermeasure can vary immensely from State to State or community to community. *What* is done is often less important than *how* it is done. The best countermeasure may have little effect if it is not implemented vigorously, publicized extensively, and funded satisfactorily. Evaluation studies generally examine and report on high-quality implementation because there is little interest in evaluating poor implementation. Also, the fact that a countermeasure is being evaluated usually gets the attention of those implementing it, so that it is likely to be done well. *The countermeasure effectiveness data presented in this guide probably shows the maximum effect that can be realized with high-quality implementation*. Many countermeasures have not been evaluated well, or at all, as noted in the effectiveness data. Effectiveness ratings are based primarily on demonstrated reductions in crashes; however, changes in behavior and knowledge are taken into account in the ratings when crash information is not available.

NCHRP Guides: The National Cooperative Highway Research Program is developing a series of guides for State Departments of Transportation to use in implementing the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan. This guide draws heavily on the published NCHRP guides and on several draft guides. It differs from the NCHRP guides because it is written for SHSOs, contains only behavioral countermeasures, and is considerably more concise. Readers are urged to consult the NCHRP guides relevant to their interests. They are available at http://safety.transportation.org/guides.aspx.

NCHRP has also developed a framework for estimating the costs and benefits associated with behavioral countermeasures. Each of the countermeasures included in *Countermeasures That*

Work was reviewed, and the potential savings of the countermeasures were projected. The subsequent report was designed to help States in selecting countermeasures that will result in the greatest reduction in crashes, injuries, and fatalities. Readers can find a copy of the report at www.cmfclearinghouse.org/collateral/NCHRP_Report_622.pdf.

Cochrane Reviews: In several of the chapters, Cochrane Reviews are cited. The Cochrane Collaboration is a nonprofit organization that produces and disseminates systematic reviews of the effects of healthcare interventions. The database of reviews is published quarterly as part of the Cochrane Library. More information about Cochrane Reviews can be found at www.cochrane.org/.

Disclaimers: As with any attempt to summarize a large amount of sometimes-conflicting information, this guide is highly subjective. All statements, judgments, omissions, and errors are solely the responsibility of the authors and do not necessarily represent the views of NHTSA. Users who disagree with any statement or who wish to add information or key references are invited to send their comments and suggestions for future editions (see bottom of page vii for details).

New traffic safety programs and research appear almost weekly and sometimes daily. Websites change frequently. This means that this guide was out-of-date even before it was published. Readers interested in a specific problem area or countermeasures are urged to contact NHTSA for up-to-date information.

Abbreviations, Acronyms, and Initialisms Used

- AAA: was the American Automobile Association but now the organization uses only the initials
- AAAFTS: AAA Foundation for Traffic Safety
- AAMVA: American Association of Motor Vehicle Administrators
- AARP: was the American Association of Retired Persons but now the organization uses only the initials
- AASHTO: American Association of State Highway and Transportation Officials
- ADTSEA: American Driver and Traffic Safety Education Association
- ALR: administrative license revocation
- ALS: administrative license suspension
- AMA: American Medical Association
- ASA: American Society on Aging
- BAC: blood alcohol concentration, measured in grams per deciliter (g/dL)
- BrAC: breath alcohol concentration, measured in grams per 210 liters of breath (g/210L)
- CDC: Centers for Disease Control and Prevention
- CPSC: Consumer Product Safety Commission
- CTIA: Cellular Telecommunications and Internet Association
- DOT: Department of Transportation (Federal or State)
- DWI: driving while impaired or intoxicated, and also often includes DUI, driving under the influence

- DWS: driving while [driver's license is] suspended
- FHWA: Federal Highway Administration
- FMCSA: Federal Motor Carrier Safety Administration
- GDL: graduated driver licensing
- GHSA: Governors Highway Safety Association
- HOS: hours of service
- IIHS: Insurance Institute for Highway Safety
- ITS: Intelligent Transportation Systems
- MAB: medical advisory board
- MSF: Motorcycle Safety Foundation
- NCHRP: National Cooperative Highway Research Program
- NCSDR: National Center for Sleep Disorders Research
- NCUTLO: National Committee on Uniform Traffic Laws and Ordinances [disbanded]
- NHTSA: National Highway Traffic Safety Administration
- NIAAA: National Institute on Alcohol Abuse and Alcoholism (a branch of NIH)
- NIH: National Institutes of Health
- NMSL: National Maximum Speed Limit
- NSC: National Safety Council
- NSF: National Sleep Foundation
- NTSB: National Transportation Safety Board
- SFST: Standardized Field Sobriety Tests
- SHSO: State Highway Safety Office
- SMSA: National Association of State Motorcycle Safety Administrators
- STEP: selective traffic enforcement program
- TIRF: Traffic Injury Research Foundation
- TRB: Transportation Research Board
- UVC: Uniform Vehicle Code

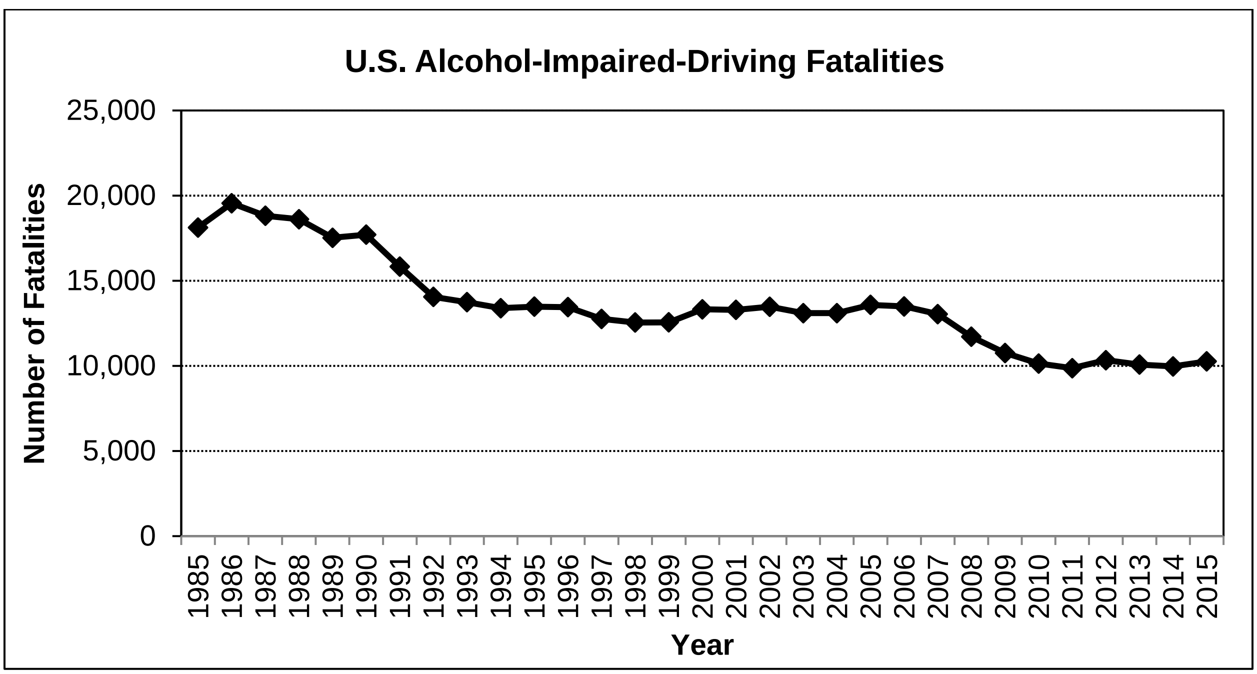
1. Alcohol- and Drug-Impaired Driving

Overview

In 2015 there were 10,265 people killed in crashes involving alcohol-impaired drivers (defined as drivers or motorcycle riders with blood alcohol concentrations (BACs) of ≥.08 g/dL). This is an increase of 3.2% from the 9,943 fatalities in 2014 (National Center for Statistics and Analysis, 2016a). Fatalities in crashes involving alcohol-impaired drivers continue to represent almost one-third (29%) of the total motor vehicle fatalities in the United States (NCSA, 2016a). See NHTSA's most recent *Traffic Safety Facts* (NCSA, 2016b) for the latest national and State data.

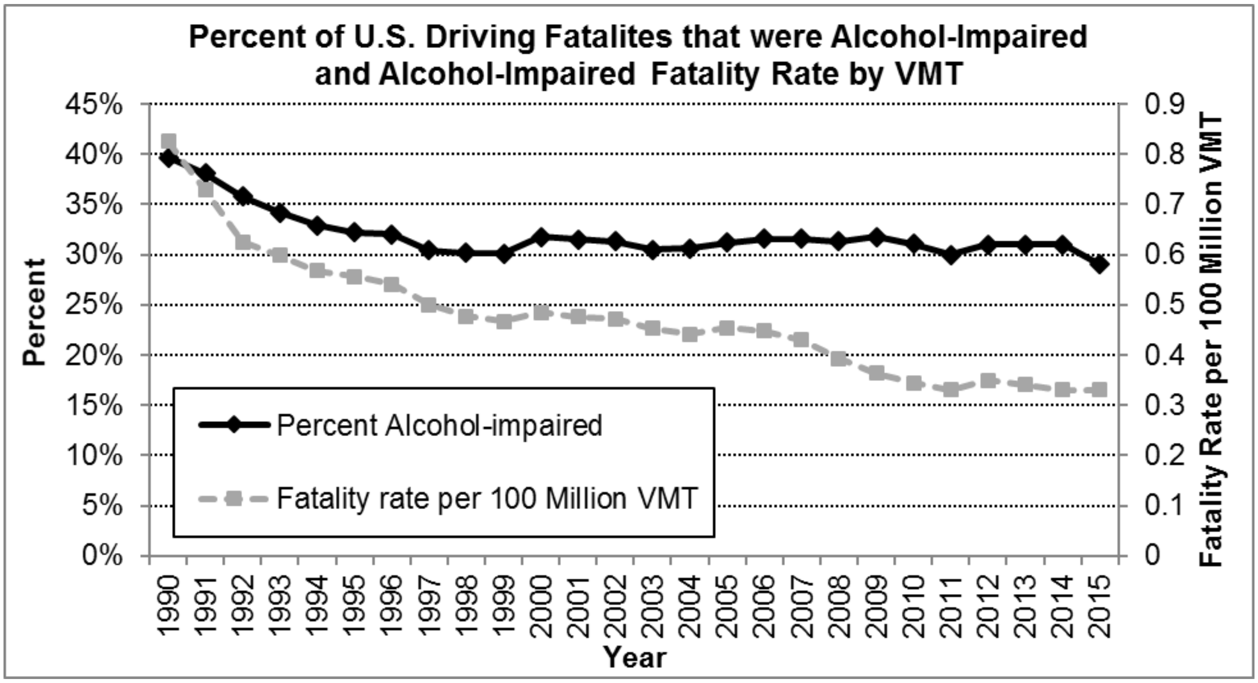
Trends. Alcohol-impaired driving dropped steadily from 1982 to the mid-1990s. A study showed that much of this decrease could be attributed to alcohol-related legislation (e.g., .08 BAC, administrative license revocation, and minimum drinking age laws) and to demographic trends (e.g., the aging of the population and the increased proportion of female drivers; Dang, 2008). However, during this period there also was substantial public attention to the issue of alcohol-impaired driving, including the growth of grassroots organizations such as Mothers Against Drunk Driving and Remove Intoxicated Drivers, increased Federal programs and funding, State task forces, and increased enforcement and intensive publicity, all of which combined to help address this critical traffic safety problem.

As the chart shows, alcohol-impaired-driving fatalities changed very little from 1992 to 2007, but then began declining again in 2008. This decrease likely reflects, in part, the economic recession during that period. Alcohol-impaired-driving fatalities dropped 24% from 2006 to 2015 (NCSA, 2016a).



Source: NCSA (2016b)

As shown in the next chart, the *rate* of alcohol-impaired-driving fatalities, based on vehicle miles traveled (VMT), has also declined noticeably in recent years. However, the percentage of fatalities in the United States that involve alcohol-impaired driving has remained essentially unchanged during this time (NCSA, 2015).



Source: NCSA (2016a)

One age group has shown an especially sizeable decrease in alcohol-related traffic fatalities. From 2006 to 2015, the percentage of fatally injured drivers 16 to 18 years old with positive BACs (.01 g/dL or higher) decreased by 61% (FARS data). Self-reported drinking and driving among high school students has also declined. In 1991, 22% of high school students reported drinking and driving in the past 30 days, compared to just 10% of high school students in 2011 (CDC, 2012). It should be noted that most States implemented graduated driver licensing systems (GDL) during this time period. GDL systems have had a substantial impact on reducing the crash risk of young, beginning drivers. (For more information on young drivers and GDL, see Chapter 6.)

Drinking and driving characteristics. According to the CDC, half (52%) of U.S. adults can be considered "regular" drinkers; that is, they have consumed at least 12 drinks during the past year (CDC, 2014). An estimated 112 million trips are made annually by drivers with BACs of .08 or higher (CDC, 2011). Studies show drivers are arrested once for every 80 trips they make with BACs over .08 (Ferguson, 2012). The 2013-2014 National Roadside Survey estimated that 8.3% of drivers on weekend nights have positive BACs, while 1.5% have BACs of .08 or higher (Berning, Compton, & Wochinger, 2015). This represents a significant reduction from 2007, when 12.4% of drivers had positive BACs and 2.2% had BACs of .08 or higher. The percentage of drivers drinking on weekend nights has fallen dramatically since the first National Roadside

Survey in 1973, which found that 35.9% of drivers had positive BACs and 7.5% of drivers had BACs of .08 or higher (Berning, Compton, & Wochinger, 2015).

NHTSA surveyed approximately 7,000 people in 2008 and asked about a variety of attitudes and behaviors related to drinking and driving (Moulton, Peterson, Haddix, & Drew, 2010). Twenty percent reported they had driven within two hours of drinking alcohol in the past year. Males, college graduates, and unmarried people were more likely than their respective counterparts to report driving after drinking too much. Similarly, an AAA Foundation survey of 3,103 U.S. residents conducted in 2013 found that 96% believe it is unacceptable to drink and drive. Nonetheless, 13% reported having driven when they may have been close to, or above, the illegal limit within the past 12 months (AAA Foundation, 2014).

Alcohol-impaired drivers include both occasional drinkers who may drive after drinking too much, as well as persistent offenders who regularly drive while impaired. Impaired drivers may be considered “high risk” if they have high BACs, prior convictions, or alcohol abuse problems. For example, among drivers involved in fatal crashes during 2015 with positive BACs (.01 or higher), 55% had BACs at or above .15 g/dL (NCSA, 2016a). Additionally, one-quarter of all drivers arrested for impaired driving and 30% of drivers convicted of impaired driving each have a prior DWI conviction (Warren-Kigenyi & Coleman, 2014). In 2015, 9% of drivers involved in fatal motor vehicle crashes with BACs of .08 g/dL or above had been convicted of a DWI in the past 3 years, compared to 2% of sober drivers (NCSA, 2016a).

Alcohol-impaired-driving fatalities are affected by several external factors including geography, urbanization, road structure and conditions, and economic activity, as well as by a State’s laws and programs. For these reasons, both the current level of alcohol-impaired driving and the progress in reducing alcohol-impaired driving vary greatly from State to State. For example, comparing all 50 States and the District of Columbia, the proportion of traffic fatalities that involve a driver with a BAC of .08 or higher in 2015 ranged from 16% in the lowest State to 43% in the highest (NCSA, 2016a).

Drug-impaired-driving characteristics. There is considerably less research on drug-impaired driving than alcohol-impaired driving. However, three roadside surveys suggest some drivers have detectable levels of one or more drugs in their systems. In a 2013-2014 study for NHTSA, voluntary and anonymous oral fluid samples were collected from 7,881 drivers, and blood samples from 4,686 drivers across the United States (Berning, Compton, & Wochinger, 2015). Among weekend nighttime drivers who provided oral fluid and/or blood samples:

- 15.2% tested positive for the presence of an illegal drug;
- 7.3% tested positive for the presence of a medication (i.e., a prescription or over-the-counter drug); and
- 12.6% tested positive for THC, a 48% increase from the 2007 NRS (though testing positive for THC does not necessarily imply impairment, since THC can be detected in the blood weeks after psychoactive effects have ended).

In another NHTSA study, the prevalence of drivers testing positive for THC and other drugs was examined in Washington State in an anonymous roadside survey that collected voluntary breath, oral fluid, and blood samples from 2,400 drivers (Ramirez et al., 2016). The survey was conducted before and after legalization of the sale of marijuana in Washington State. It involved three data collection waves that occurred 1-month prior, 5 months after, and 11 months after the implementation of legal sales. Positive THC measurements were recorded in 14.6%, 19.4%, and 21.4% of drivers in Waves 1, 2, and 3, respectively. This increasing trend was not statistically significant across waves. However, there was a statistically significant increase in daytime prevalence of THC-positive drivers between Wave 1 (7.8%) and Wave 2 (18.4%), and also between Wave 1 and Wave 3 (18.9%). This contrasts with findings for nighttime driving, where the percentage of THC-positive nighttime drivers increased with each successive wave, but these increases were not statistically significant.

Another study, conducted in Virginia Beach, Virginia, estimated the relative crash risk of alcohol- and drug-positive driving (Compton & Berning, 2015). Breath alcohol concentrations (BrACs) were obtained from 10,221 drivers, oral fluid samples from 9,285 drivers, and blood samples from 1,764 drivers. A statistically significant increase in <u>unadjusted</u> crash risk was found for drivers who tested positive for use of illegal drugs (1.21 times), and THC specifically (1.25 times). However, <u>after adjusting</u> for factors that are known to be associated with crash risk, including age, gender, ethnicity, and alcohol concentration level, there were no longer statistical evidence of increased crash risk associated with any drugs, including illegal drugs and THC. This finding indicates that these other variables (age, gender, ethnicity, and alcohol use) account for much of the increased risk associated with the use of illegal drugs and with THC. In contrast, this study found large, statistically significant associations between driver alcohol level and crash risk both before and after adjustment for demographic factors.

In a roadside survey in Canada, researchers collected oral fluid samples from approximately 1,200 nighttime drivers (Beirness & Beasley, 2010). Similar to the U.S. study, 10% of drivers tested positive for drug use. This was slightly higher than the percentage of drivers who tested positive for alcohol use (8%). Of the drug positive cases, most (88%) involved a single drug, the most common being marijuana or cocaine. Male drivers were more likely than female drivers to test positive for drugs (Beirness & Beasley, 2010).

In both the U.S. and Canadian studies, it is important to keep in mind that a positive drug test does not necessarily indicate "impairment." The level of drugs detected may have been too low to be impairing. Moreover, many drugs can be detected in oral or blood tests long after their effects have diminished. For example, marijuana can be detected for 30 days or longer among heavy users.

Although some countries such as Sweden and Finland have carefully tracked the prevalence of drug-impaired driving (Ojaniemi et al., 2009), little is known about trends in drug-impaired driving in the United States. One study from Washington State found a significant increase in methamphetamine use among fatally injured drivers from 1992 to 2002 (Schwilke, Sampaio dos Santos, & Logan, 2006). In part, this likely reflects larger trends in the drug's popularity.

Data regarding drug use and crashes are limited, and there are important shortcomings in FARS data used to track drug-related driving fatalities. Specifically, a recent NHTSA Research Note described the key methodological and data limitations of FARS drug test information and reporting (Berning & Smither, 2014; see also Compton, Vegega, & Smither, 2009). These limitations include:

- Only a minority of drivers are tested for drugs (e.g., only 42% of drivers involved in fatal crashes were tested in 2014; FARS data file);
- Testing rates are higher for drivers who died in crashes (65% in 2014) compared to surviving drivers (22% in 2014);
- In addition to those tested for drugs and not tested for drugs, there are a small (6% in 2015), but significant number of drivers for which it is unknown if they were tested for drugs;
- Testing positive for a drug indicates the presence of the drug in the driver's system, but it does not necessarily indicate that the driver was impaired at the time of the crash;
- There is no consistent set of policies or procedures for drug testing across States, which leads to variation in the drivers and drugs tested, in addition to the types of tests, cut-off levels, and equipment used;
- Decreases in the cost of drug testing may have led to an increase in the number of people tested, as well as the range of drug types tested;
- The more drivers tested, the more drugs will be detected.

Although drugs are often detected among drivers involved in crashes, this does not necessarily imply that drug impairment played a causal role in the crash. Moreover, not all testing is comprehensive in that some drugs may not be detected despite evidence of being present. Currently, the evidence is mixed on whether cannabis and benzodiazepines increase crash risk, and fewer studies have examined the risks associated with stimulants, opioids, and other drugs (Stewart, 2006; Elvik, 2013).

Strategies to Reduce Impaired Driving

Four basic strategies are used to reduce impaired crashes and driving under the influence:

- Deterrence: enact, publicize, enforce, and adjudicate laws prohibiting impaired driving so that people choose not to drive impaired;
- Prevention: reduce drinking and drug use and keep impaired drivers from driving;
- Communications and outreach: inform the public of the dangers of impaired driving and establish positive social norms that make driving while impaired unacceptable; and
- Alcohol and drug treatment: reduce alcohol dependency or addiction among drivers.

In this chapter, impaired-driving deterrence countermeasures are divided into four sections: (1) laws, (2) enforcement, (3) prosecution and adjudication, and (4) offender treatment, monitoring, and control. Prevention, intervention, communications, and outreach countermeasures are combined in a single section. Finally, the Underage Drinking and Drinking and Driving section includes deterrence, prevention, and communications measures specific to this age group.

This chapter also briefly considers countermeasures to address drugs other than alcohol. Drugs pose quite different and difficult issues at every step, from estimating their prevalence and effect on driving, to developing effective laws and strategies for enforcement, prevention, and treatment. However, many of the countermeasures to address alcohol-impaired driving may also deter drug-impaired driving.

Many other traffic safety countermeasures help reduce alcohol-impaired and drug-impaired driving-related crashes and casualties, but are not discussed in this chapter. A number of vehicular strategies may be helpful in detecting or preventing impaired driving. For example, NHTSA has studied the feasibility of using vehicle-based sensors to detect alcohol-related impairment in drivers (Lee et al., 2010). The Driver Alcohol Detection System for Safety (DADSS, see www.dadss.org/) program is a collaborative research partnership between the Automotive Industry and NHTSA to assess and develop alcohol-detection technologies to prevent vehicles from being driven when a driver’s BAC exceeds the legal limit of .08 g/dL. There are also many environmental countermeasures such as improved vehicle structures and centerline rumble strips and barriers that may reduce the likelihood of crashes and/or injuries sustained by impaired drivers. However, vehicular and environmental countermeasures are not included in this chapter because State Highway Safety Offices have little or no authority or responsibility for them.

Resources

The agencies and organizations listed below can provide more information on impaired driving and links to numerous other resources.

- National Highway Traffic Safety Administration:
  - Drunk Driving – www.nhtsa.gov/risky-driving/drunk-driving
  - Drugged Driving – www.nhtsa.gov/risky-driving/drugged-driving
  - Impaired Driving – one.nhtsa.gov/Driving-Safety/Impaired-Driving
  - Behavioral Safety Research Reports – ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Centers for Disease Control and Prevention: www.cdc.gov/MotorVehicleSafety/Impaired_Driving/impaired-drv_factsheet.html
- Office of National Drug Control Policy: www.whitehouse.gov/ondcp/drugged-driving
- American Automobile Association: http://duijusticelink.aaa.com/for-the-public
- Governors Highway Safety Association: www.ghsa.org/html/issues/impaireddriving/index.html
- Insurance Institute for Highway Safety: www.iihs.org/iihs/topics/t/alcohol-impaired-driving/topicoverview
- Mothers Against Drunk Driving: www.madd.org
- National Conference of State Legislatures: www.ncsl.org/research/transportation/drunken-impaired-driving
- National Safety Council: www.nsc.org/safety_road/DriverSafety/Pages/ImpairedDriving.aspx
- National Institute on Alcohol Abuse and Alcoholism: www.niaaa.nih.gov
- National Institute on Drug Abuse: www.drugabuse.gov
- Traffic Injury Research Foundation: www.tirf.ca

For overviews of alcohol-impaired-driving prevalence, risks, legislation, research, and recommended strategies, see NHTSA's *Alcohol and Highway Safety: A Review of the State of Knowledge* (Voas & Lacey, 2011), *Alcohol and Highway Safety 2006: A Review of the State of Knowledge* (Voas & Lacey, 2011), *Compendium of Traffic Safety Research Projects 1985-2013* (Agimi, Warren-Kigenyi, Berning, & Wochinger, 2014) and *Digest of Impaired Driving and Selected Beverage Control Laws* (NHTSA, 2016a), NCHRP's *A Guide for Reducing Alcohol-Related Collisions* (Stutts, Knipling, Pfefer, Neuman, Slack, & Hardy, 2005), National Conference of State Legislatures's (NCSL) Alcohol Impaired and Drunken Driving webpage (NCSL, 2016), the e-Circular produced by TRB's Alcohol, Other Drugs, and Transportation Committee (TRB, 2013), and The Community Guide website developed by the CDC.

Key terms

- BAC: Blood alcohol concentration in the body, expressed in grams of alcohol per deciliter (g/dL) of blood, usually measured with a breath or blood test
- BrAC: Breath alcohol concentration (breath tests use a different measuring scale from blood tests, but are often "converted" to BAC terminology, such as ".08" or ".08 g/dL"
- DUID: Driving Under the Influence of Drugs
- DRE: Drug Recognition Expert, a law enforcement officer trained in identifying drivers who are drug-impaired
- DWI: the offense of driving while impaired by alcohol. In different States the offense may be called driving while intoxicated, driving under the influence (DUI), or other similar terms
- Ignition interlock: a breathalyzer installed into a vehicle that prevents the vehicle from being started if the driver's BrAC is above a specified limit
- MADD: Mothers Against Drunk Driving
- PAS: Passive alcohol sensor, a device to detect alcohol presence in the air near a driver's face, used to estimate whether the driver has been drinking
- PBT: Preliminary breath test device, a small hand-held alcohol sensor used to estimate or measure a driver's BrAC
- SFST: Standardized Field Sobriety Test, a battery of three tests (one-leg stand, walk-and-turn, and horizontal gaze nystagmus) used by law enforcement at the roadside to estimate whether a driver is at or above the illegal limit of .08 BAC
- Illegal per se law: A law that makes it an offense to operate a motor vehicle with a BAC at or above a specified level

Alcohol- and Drug-Impaired-Driving Countermeasures

The first six sections address alcohol-impaired driving and the last section deals specifically with drug-impaired driving. Countermeasures to reduce alcohol- and drug-impaired driving are listed in the table below. The table is intended to provide a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. Effectiveness is shown using a five-star rating system:

- Countermeasures that receive ★★★★ or ★★★★★ have been determined to be effective.
- Countermeasures that receive ★★★ are considered promising, and likely to be effective.
- Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States, communities and other organizations are encouraged to use ★★★ and especially ★★★★ or ★★★★★ countermeasures. They should use caution in selecting ☆ or ☆☆ countermeasures, as conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to evaluate the countermeasure.

Further details about the symbols and terms used are included after the table. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate.

Each countermeasure to reduce alcohol- and drug-impaired driving is discussed individually in this chapter. Full descriptions are included for ★★★, ★★★★, and ★★★★★ countermeasures. Brief descriptions are included for ☆ and ☆☆ countermeasures. Further details about the ☆ and ☆☆ countermeasures are included in Appendix A1 to this report.

1. Deterrence: Laws

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Administrative License Revocation or Suspension (ALR/ALS)	★★★★★	$$$	High	Medium
1.2 Open Container	★★★	$	High	Short
1.3 High-BAC Sanctions	★★★	$	Medium	Short
1.4 BAC Test Refusal Penalties	★★★	$	Unknown	Short
1.5 Alcohol-Impaired Driving Law Review	★★★	$$	Unknown	Medium

2. Deterrence: Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Publicized Sobriety Checkpoints	★★★★★	$$$	Medium	Short
2.2 High-Visibility Saturation Patrols	★★★★	$$	High	Short
2.3 Preliminary Breath Test Devices (PBTs)†	★★★★	$$	High	Short
2.4 Passive Alcohol Sensors††	★★★★	$$	Unknown	Short
2.5 Integrated Enforcement	★★★	$	Unknown	Short

† Proven for increasing arrests
†† Proven for detecting impaired drivers

3. Deterrence: Prosecution and Adjudication

Countermeasure	Effectiveness	Cost	Use	Time
3.1 DWI Courts†	★★★★	$$$	Low	Medium
3.2 Limits on Diversion & Plea Agreements††	★★★★	$	Medium	Short
3.3 Court Monitoring††	★★★	$	Low	Short
3.4 Sanctions	☆☆	Varies	Varies	Varies

† Proven for reducing recidivism
†† Proven for increasing conviction

4. Deterrence: DWI Offender Treatment, Monitoring, and Control

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Alcohol Problem Assessment and Treatment	★★★★★	Varies	High	Varies
4.2 Alcohol Ignition Interlocks†	★★★★★	$$	Medium	Medium
4.3 Vehicle and License Plate Sanctions†	★★★★	Varies	Medium	Medium
4.4 DWI Offender Monitoring†	★★★★	$$$	Unknown	Varies
4.5 Lower BAC Limit for Repeat Offenders	★★★★	$	Low	Short

† Proven for reducing recidivism

5. Prevention, Intervention, Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
5.1 Alcohol Screening and Brief intervention	★★★★★	$$	Medium	Short
5.2 Mass-Media Campaigns	★★★	$$$	High	Medium
5.3 Responsible Beverage Service	☆☆	$$	Medium	Medium
5.4 Alternative Transportation	☆☆	$$	Unknown	Short
5.5 Designated Drivers	☆☆	$	Medium	Short

6. Underage Drinking and Drinking and Driving

Countermeasure	Effectiveness	Cost	Use	Time
6.1 Minimum Drinking Age 21 Laws	★★★★★	$$$	High	Low
6.2 Zero-Tolerance Law Enforcement	★★★	$	Unknown	Short
6.3 Alcohol Vendor Compliance Checks†	★★★	$$	Unknown	Short
6.4 Other Minimum Legal Drinking Age 21 Law Enforcement	★★★	$$	Varies	Varies
6.5 Youth Programs	☆☆	Varies	High	Medium

† Proven for reducing sales to underage people

7. Drug-Impaired Driving

Countermeasure	Effectiveness	Cost	Use	Time
7.1 Enforcement of Drug-Impaired Driving	★★★	$$	Unknown	Short
7.2 Drug-Impaired-Driving Laws	☆	Unknown	Medium†	Short
7.3 Education Regarding Medication	☆	Unknown	Unknown	Long

† Use for drug per se laws

Effectiveness:

★★★★★ - Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★ - Demonstrated to be effective in certain situations

★★★ - Likely to be effective based on balance of evidence from high-quality evaluations or other sources

☆☆ - Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆ - Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment, facilities, and publicity

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: less than one-third of States or communities
Unknown: data not available

Time to implement:

Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies.

Deterrence

Deterrence means enacting laws that prohibit driving while impaired, publicizing and enforcing those laws, and punishing the offenders. Deterrence works by changing behavior through the fear of apprehension and punishment. If drivers believe that impaired driving is likely to be detected and that impaired drivers are likely to be arrested, convicted and punished, many will not drive while impaired by alcohol. This strategy, called *general deterrence*, influences the general driving public. An example of general deterrence would be well publicized and highly visible enforcement activities, such as sobriety checkpoints. In contrast, *specific deterrence* refers to efforts to influence drivers who have been arrested for impaired driving so they will not continue to drive while impaired by alcohol. An example of this approach would include ignition interlocks or vehicle sanctions for DWI offenders. Although most of the discussion in this section relates to alcohol-impaired driving, much of this information could be applied also to drug-impaired driving.

Deterrence works when consequences are swift, sure, and severe (with swift and sure being more important in affecting behavior than severe). All States have the basic laws in place to define impaired driving, set illegal per se limits at .08 BAC, and provide standard penalties.

Deterrence, however, is far from straightforward, and complexities can limit the success of deterrence measures. For instance:

- Detecting alcohol-impaired drivers is difficult. Law enforcement agencies have limited resources and (except at checkpoints) officers must observe some traffic violation or other aberrant behavior before they can stop a motorist.
- Conviction also may be difficult. DWI laws are extremely complicated (20 pages or more in some State codes); the evidence needed to define and demonstrate impairment is complex; judges and juries may not impose specified penalties if they believe the penalties are too severe.
- The DWI control system is complex. There are many opportunities for breakdowns in the system that allow impaired drivers to go unaddressed.

DWI control system operations and management. The DWI control system consists of a set of laws together with the enforcement, prosecution, adjudication, and offender monitoring policies and programs to support the laws. In this complicated system, the operations of each component affect all the other components. Each new policy, law, or program affects operations throughout the system, often in ways that are not anticipated.

This guide documents 19 specific impaired-driving countermeasures in the deterrence section, in four groups: (1) laws, (2) enforcement, (3) prosecution and adjudication, and (4) offender treatment, monitoring, and supervision. But the overall DWI control system, including its management and leadership, is more important than any individual countermeasure.

Studies have highlighted the key characteristics of an efficient and effective DWI control system (Hedlund & McCartt, 2002; Robertson & Simpson, 2003):

- training and education for law enforcement, prosecutors, judges, and probation officers;
- record systems that are accurate, up-to-date, easily accessible, and able to track each DWI

offender from arrest through the completion of all sentence requirements;
- adequate resources for staff, facilities, training, equipment, and new technology; and
- coordination and cooperation within and across all components.

A few of the countermeasures discussed in this chapter, such as BAC Test Refusal Penalties (Chapter 1, Section 1.4), Alcohol-Impaired-Driving Law Review (Section 1.5), and DWI courts (Section 3.1), are directed at improving DWI system operations. In some instances, the most important action that SHSOs can take to reduce alcohol-impaired driving is to review and improve DWI control system operations, perhaps using a State DWI task force and/or a State impaired-driving program assessment.

Ulmer, Hedlund, and Preusser (1999) investigated why some States reduced alcohol-related traffic fatalities more than others. They concluded that there is no “silver bullet,” no single critical law, enforcement practice, or communications strategy. Once a State has effective laws, high-visibility enforcement, and substantial communications and outreach to support them, the critical factors are strong leadership, commitment to reducing impaired driving, and adequate funding. Although 17 years have passed, the basic findings of Ulmer, Hedlund, and Presser are still applicable. SHSOs should keep this in mind as they consider the specific countermeasures in this chapter.

1. Deterrence: Laws

1.1 Administrative License Revocation or Suspension (ALR or ALS)

Effectiveness: ★★★★★	Cost: $$$	Use: High	Time: Medium

Administrative license suspension (ALS) laws allow law enforcement and driver licensing authorities to suspend a driver's license if the driver fails or refuses to take a BAC test. Administrative license revocation (ALR) laws are similar, except the offender must re-apply for a license once the suspension period ends. Usually the arresting officer takes the license at the time that a BAC test is failed or refused. The driver typically receives a temporary license that allows the driver time to make other transportation arrangements and to request and receive an administrative hearing or review. In most jurisdictions, offenders may obtain an occupational or hardship license during part or all of the revocation or suspension period (NHTSA, 2008a). NHTSA recommends that ALR laws include a minimum license suspension of 90 days (NHTSA, 2006a). A model ALR law is provided by the National Committee on Uniform Traffic Laws and Ordinances (NCUTLO, 2000).

ALR and ALS laws provide for swift and certain penalties for DWI, rather than the lengthy and uncertain outcomes of criminal courts. They also protect the driving public by removing some DWI offenders from the road (but see the discussion of driving with a suspended license, under “other issues,” below). More information about ALR laws can be found in the NCHRP Report 500 guide on reducing impaired-driving (Goodwin et al., 2005, Strategy C1) and NHTSA’s *Traffic Safety Facts* on ALR (NHTSA, 2008a).

Use: As of July 2015, there were 41 States and the District of Columbia that had some form of ALR or ALS law (IIHS, 2015). Thirty-five States had minimum license suspensions of at least 90 days, as recommended by NHTSA.

Effectiveness: Many State ALR and ALS laws have been in place for decades, and much of the research examining the effectiveness of these laws is now dated. For example, a summary of 12 evaluations through 1991 found ALR and ALS laws reduced crashes of different types by an average of 13% (Wagenaar, Zobek, Williams, & Hingson, 2000). A more recent study examining the long-term effects of license suspension policies across the United States concluded that ALR reduces alcohol-related fatal crash involvement by 5%, saving an estimated 800 lives each year (Wagenaar & Maldonado-Molina, 2007). See DeYoung (2013a) for a review of the research on the effectiveness of ALR/ALS laws.

Costs: ALR/ALS laws require funds to design, implement, and operate a system to record and process administrative license actions. In addition, a system of administrative hearing officers must be established and maintained. Some States have recovered ALR or ALS system costs through offender fees (Century Council, 2008; NHTSA, 2008a).

Time to implement: Six to 12 months are required to design and implement the system and to recruit and train administrative hearing officers.

Other issues:

- **Two-track system:** Under ALR or ALS laws, drivers face both administrative and criminal actions for DWI. The two systems operate independently. Drivers whose licenses have been suspended or revoked administratively still may face criminal actions that also may include license suspension or revocation. This two-track system has been challenged in some States. All State supreme courts have ruled against these challenges (NHTSA, 2008a).
- **Driving with a suspended license:** Some DWI offenders continue to drive on occasion with suspended or revoked licenses (Lenton, Fetherston, & Cercarelli, 2010; McCartt, Geary, & Nissen, 2002). For strategies to reduce driving with a suspended or revoked license, see Neuman, Pfefer, Slack, Hardy, and Waller(2003), and Chapter 1, Sections 4.2, 4.3 and 5.4.
- **Delaying license reinstatement:** Many DWI offenders do not reinstate their licenses when they are eligible to do so. About half (49%) of DWI offenders delay license reinstatement for at least a year, while 30% delay reinstatement for 5 years or more (Voas, Tippetts, & McKnight, 2010). Studies show offenders who delay reinstatement are more likely to recidivate than those who have their licenses restored (Voas et al., 2010). This suggests it may be important to encourage DWI offenders to reinstate their licenses once eligible, but with appropriate controls such as ignition interlocks (see Section 4.2) and close monitoring (see Section 4.4).
- **Hearings:** An effective ALR system will restrict administrative hearings to the relevant facts: that the arresting officer had probable cause to stop the vehicle and require a BrAC test and that the driver refused or failed the test. Such a system will reduce the number of hearings requested, reduce the time required for each hearing, and minimize the number of licenses that are reinstated. When an administrative hearing is not restricted in this way, it can serve as an opportunity for the defense attorney to question the arresting officer about many aspects of the DWI case. This may reduce the chance of a criminal DWI conviction (Hedlund & McCartt, 2002). Officers often spend substantial time appearing in person at ALR hearings, and a case may be dismissed if an officer fails to appear. Some States use telephonic hearings to solve these problems (Wiliszowski, Jones, & Lacey, 2003).

1.2 Open Container

Effectiveness: ★★★	Cost: $	Use: High	Time: Short

Open-container laws prohibit the possession of any open alcoholic beverage container and the consumption of any alcoholic beverage by motor vehicle drivers or passengers. These laws typically exempt passengers in buses, taxis, and the living quarters of mobile homes.

In 1998, Congress required States to enact open-container laws or have a portion of their Federal-aid highway construction funds redirected to alcohol-impaired driving or hazard elimination activities (NHTSA, 2008b). To comply, State open-container laws must:

- Prohibit possession of alcoholic beverage containers and consumption of alcohol in motor vehicles;
- Cover the entire passenger area;
- Apply to all types of alcoholic beverages;
- Apply to all vehicle occupants;
- Apply to all vehicles on public highways; and
- Provide for primary enforcement of the law.

Certain exceptions are permitted. For additional information, see www.fhwa.dot.gov/map21/guidance/guidepentransprov.cfm.

Use: As of January 2017, there were 40 States and the District of Columbia that had open-container laws that complied with the Federal requirements (GHSA, 2017).

Effectiveness: A study of four States that enacted laws in 1999 found the proportion of alcohol-involved fatal crashes appeared to decline in three of the four States during the first six months after the laws were implemented, but the declines were not statistically significant (Stuster, Burns, & Fiorentino, 2002). In general, the proportion of alcohol-involved fatal crashes was higher in States with no open-container laws than in States with laws (Stuster et al., 2002). Open container laws are associated with fewer alcohol-related fatalities (Ying, Wu, & Chang, 2013; Whetten-Goldstein, Sloan, Stout, & Liang, 2000). Survey data in both law and no-law States show strong public support for open-container laws (NHTSA, 2008b).

Costs: Open-container law costs depend on the number of offenders detected and the penalties applied to them.

Time to implement: Open-container laws can be implemented as soon as appropriate legislation is enacted.

1.3 High-BAC Sanctions

Effectiveness: ★★★	Cost: $	Use: Medium	Time: Short

Almost all States increase the penalties for the standard impaired-driving (DWI) offense for repeat offenders. Some States also have increased the penalties for drivers with high BACs, typically .15 to .20. In 2015, 67% of alcohol-impaired-driving fatalities were in crashes that involved at least one driver with a BAC of .15 of higher (FARS data).

High-BAC sanctions are based on the observation that many high-BAC drivers are habitual impaired-driving offenders, even though they may not have records of previous arrests and convictions. Moreover, drivers with high BACs put themselves and other road users at risk; over half (55%) of the drivers with BACs of .01 or higher involved in fatal crashes in 2015 had BACs of .15 or greater (NCSA, 2016a). Enhanced sanctions for high-BAC drivers vary by State, and may include mandatory assessment and treatment for alcohol abuse problems, close monitoring or home confinement, installation of an ignition interlock, and vehicle or license plate sanctions (see Chapter 1, Sections 4.1, 4.2, 4.3 and 4.4). NHTSA recommends that sanctions for first-time offenders with high BACs be comparable to those for repeat offenders (NHTSA, 2008c).

Use: As of October 2015, there were 45 States and the District of Columbia that had increased penalties for drivers with high BACs (NCSL, 2015). Alaska, Arkansas, Connecticut, Hawaii, and Mississippi do not have increased penalties for drivers with high BACs.

Effectiveness: In the only evaluation of high-BAC sanctions to date, McCartt and Northrup (2003, 2004) found that Minnesota's law appears to have increased the severity of case dispositions for high-BAC offenders, although the severity apparently declined somewhat over time. They also found some evidence of an initial decrease in recidivism among high-BAC first offenders (which again dissipated with time). The BAC test refusal rate declined for first offenders and was unchanged for repeat offenders after the high-BAC law was implemented. The authors pointed out that Minnesota's law had a high threshold of .20 BAC, relatively strong administrative and criminal sanctions, and strong penalties for BAC test refusal.

Costs: High-BAC sanctions will produce increased costs if the high-BAC penalties are more costly per offender than the lower-BAC penalties. Over a longer period, if high-BAC sanctions reduce recidivism and deter alcohol-impaired driving, then costs will decrease.

Time to implement: High-BAC sanctions can be implemented as soon as appropriate legislation is enacted.

Other issues:

- **Test refusal:** High-BAC sanctions may encourage some drivers to refuse the BAC test unless the penalties for test refusal are at least as severe as the high-BAC penalties. See Chapter 1, Section 1.4.
- **Child endangerment laws:** Similar to high-BAC laws, child endangerment laws recognize there are certain instances where impaired drivers pose extreme risk to others. In 2015, there were 181 children 14 or younger who were killed in alcohol-impaired-

driving crashes. Of those, 92 were occupants of vehicles with drivers who had BACs of .08 or higher (NCSA, 2016a). Child endangerment laws create a separate offense or enhance DWI penalties for impaired drivers who carry children. Presently, 46 States and the District of Columbia have separate or higher penalties for impaired drivers who have children in their vehicles (Advocates for Highway & Auto Safety, 2014).

1.4 BAC Test Refusal Penalties

Effectiveness: ★★★	Cost: $	Use: Unknown	Time: Short

All States have implied consent laws stipulating that people implicitly consent to be tested if they are suspected of impaired driving (NHTSA, 2008d). However, some drivers refuse to provide breath or blood samples for BAC tests. Nationwide, an average of 24% of drivers arrested for DWI refuse the BAC test, although this figure ranges from 1% to 82% depending on the State (Jones & Nichols, 2012; Namuswe, Coleman, & Berning, 2014). A driver's BAC is a critical piece of evidence in an alcohol-impaired-driving case. The absence of a BAC test can make it more difficult to convict the impaired driver.

All States have established separate penalties for BAC test refusal, typically involving administrative license revocation or suspension. If the penalties for refusal are less severe than the penalties for failing the test, many drivers will refuse. The model DWI code sets a more severe penalty for test refusal than for test failure (NCUTLO, 2000).

Reduced test refusal rates will help the overall DWI control system by providing better BAC evidence. Having driver BACs may increase DWI and high-BAC DWI convictions, increase the likelihood that prior DWI offenses will be properly identified, and provide the courts with better evidence for offender alcohol assessment. For a thorough discussion of issues related to BAC test refusal, see NHTSA's 2008 *Report to Congress* (Berning et al., 2008). See also Voas et al. (2009) for a history of implied consent laws in the United States and a review of the research on breath test refusal.

Use: The relative penalties in each State for failing and refusing a BAC test cannot be categorized in a straightforward manner due to the complexity of State alcohol-impaired-driving laws and the differences in how these laws are prosecuted and adjudicated. All States except Wyoming impose administrative sanctions for test refusal (NHTSA, 2016). See NHTSA's Digest of Impaired Driving and Selected Beverage Control Laws for more detail on each State's laws (NHTSA, 2016a).

A recent U.S. Supreme Court decision, *Birchfield v. North Dakota*, upheld the ability of States to criminalize refusal for breath testing, but not for warrantless blood tests. The implications of the *Birchfield* decision are described in more detail in Lemons and Birst (2016).

Effectiveness: Zwicker, Hedlund, and Northrup (2005) found that test refusal rates appear to be lower in States where the consequences of test refusal are greater than the consequences of test failure. No study has examined whether stronger test refusal penalties are associated with reduced alcohol-impaired crashes.

Costs: There are no direct costs of increasing penalties for BAC test refusal.

Time to implement: Increased BAC test refusal penalties can be implemented as soon as appropriate legislation is enacted.

Other issues:

- **Criminalizing test refusal:** As of 2016, BAC test refusal was a criminal offense in 15 States (NCSL, 2016). Criminalizing test refusal may reduce refusal rates and increase the likelihood of convictions for DWI (Jones & Nichols, 2012). It also ensures the drivers will be identified as repeat offenders upon subsequent arrests.
- **Warrants:** To reduce breath test refusals and increase the number of drivers successfully prosecuted for DWI, some States issue warrants for drivers who refuse to provide breath tests. Issued by a judge or magistrate, the warrant requires the driver to provide a blood sample, by force if necessary. One study reviewed how warrants are used in four States – Arizona, Michigan, Oregon, and Utah (Hedlund & Beirness, 2007). They found that warrants may successfully reduce breath test refusals and result in more pleas, fewer trials, and more convictions. Although warrants require additional time for law enforcement, officers report the chemical evidence obtained from the warrant are of great value and worth the effort to obtain (Haire, Leaf, Presser, & Solomon, 2011). Note that following the *Birchfield v. North Dakota* Supreme Court decision, warrants are required for blood tests unless there are exigent circumstances (see Lemons & Birst, 2016).

1.5 Alcohol-Impaired-Driving Law Review

Effectiveness: ★★★	Cost: $$	Use: Unknown	Time: Medium

Alcohol-impaired-driving laws in many States are extremely complex. They are difficult to understand, enforce, prosecute, and adjudicate, with many inconsistencies and unintended consequences. In many States, a thorough review and revision would produce a system of laws that would be far simpler and more understandable, efficient, and effective.

DWI laws have evolved over the past 30 years to incorporate new definitions of the offense of driving while impaired (illegal per se laws), new technology and methods for determining impairment (e.g., BAC tests, SFSTs), and new sentencing and monitoring alternatives (e.g., electronic monitoring, alcohol ignition interlocks). Many States modified their laws to incorporate these new ideas without reviewing their effect on the overall DWI control system. The result is often an inconsistent patchwork. Robertson and Simpson (2003) summarized the opinions of hundreds of law enforcement officers, prosecutors, judges, and probation officials across the country: "Professionals unanimously support the simplification and streamlining of existing DWI statutes" (p. 18). See also Hedlund and McCartt (2002).

About a year before it disbanded, the National Committee on Uniform Traffic Laws and Ordinances prepared a model DWI law, which has been incorporated into the Uniform Vehicle Code (NCUTLO, 2000). It addressed BAC testing, BAC test refusals, higher penalties for high-BAC drivers, ALR hearing procedures, and many other issues of current interest. States can use the NCUTLO model as a reference point in reviewing their own laws. In addition, the Traffic Injury Research Foundation has a guidebook to assist policymakers in leading a strategic review of DWI systems, with the goal of streamlining systems and closing loopholes that can be exploited by offenders (Robertson, Vanlaar, & Simpson, 2007). NHTSA also has created several guidebooks, including one to assist States in establishing impaired-driving statewide task forces to review key legislation and improve current DWI systems (Fell & Langston, 2009), and another to assist officials and the general public in establishing task forces at local or regional levels (Fell, Fisher, & McKnight, 2011).

At a State's request, NHTSA will facilitate an Impaired Driving Assessment to evaluate the State's impaired-driving system and to make recommendations for strengthening its programs, policies, and practices. NHTSA and the SHSO assemble an assessment team comprised of national and State experts in impaired driving. The team reviews and documents the strengths and weaknesses of the State's existing impaired-driving system.

Use: No data is available on which States have reviewed and revised their DWI laws.

Effectiveness: A recent study examined outcomes in States that conducted NHTSA-led IDAs or Special Management Reviews (Fell, Auld-Owens, & Snowden, 2013). States varied in the degree to which they followed through with the recommendations outlined in the assessments. However, as a group, States which conducted an IDA or SMR demonstrated a greater reduction in fatal crashes than States which did not conduct assessments.

To date, no studies have examined the effectiveness of law reviews in reducing alcohol-impaired crashes. The effect of a law review will depend on the extent of inconsistencies and inefficiencies in a State's current laws. A law review can be an important action a State takes to address its alcohol-impaired-driving problem, because a thorough law review will examine the function of the entire DWI control system and will identify problem areas. The immediate effect of a law review should be a more efficient and effective DWI control system.

Costs: The review will require substantial staff time. Implementation costs of course will depend on the extent to which the laws are changed.

Time to implement: It can take considerable time to identify qualified stakeholders and establish a task force to conduct the law review.

2. Deterrence: Enforcement

2.1 Publicized Sobriety Checkpoints

Effectiveness: ★★★★★	Cost: $$$	Use: Medium	Time: Short

At a sobriety checkpoint, law enforcement officers stop vehicles at a predetermined location to check whether the driver is impaired. They either stop every vehicle or stop vehicles at some regular interval, such as every third or tenth vehicle. The purpose of checkpoints is to deter driving after drinking by increasing the perceived risk of arrest. To do this, checkpoints should be highly visible, publicized extensively, and conducted regularly, as part of an ongoing sobriety checkpoint program. Fell, Lacey, and Voas (2004) provide an overview of checkpoint operations, use, effectiveness, and issues. See Fell, McKnight, and Auld-Owens (2013) for a detailed description of six high-visibility enforcement programs in the United States, including enforcement strategies, visibility elements, use of media, funding, and many other issues.

Use: Sobriety checkpoints are authorized in 38 States and the District of Columbia (NHTSA, 2016a), but few States conduct them regularly. According to the GHSA (2015a), only 16 States conduct checkpoints on a weekly basis. The main reasons checkpoints are not used more frequently are lack of law enforcement personnel and lack of funding (Fell, Ferguson, Williams, & Fields, 2003). A possible solution for this is to combine resources with other agencies. Specifically, the results of a survey by Eichelberger and McCartt (2015) found that 40% of agencies that conducted checkpoints reported pooling resources with other law enforcement agencies.

Effectiveness: The CDC's systematic review of 15 high-quality studies found that checkpoints reduce alcohol-related fatal crashes by 9% (Guide to Community Preventive Services, 2012). Similarly, a meta-analysis found that checkpoints reduce alcohol-related crashes by 17%, and all crashes by 10 to 15% (Erke, Goldenbeld, & Vaa, 2009). Publicized sobriety checkpoint programs are proven effective in reducing alcohol-related crashes among high-risk populations including males and drivers 21 to 34 years old (Bergen et al., 2014).

In recent years, NHTSA has supported a number of efforts to reduce alcohol-impaired driving using publicized sobriety checkpoint programs. Evaluations of statewide campaigns in Connecticut and West Virginia involving sobriety checkpoints and extensive paid media found decreases in alcohol-related fatalities following the program, as well as fewer drivers with positive BACs at roadside surveys (Zwicker, Chaudhary, Maloney, & Squeglia, 2007; Zwicker, Chaudhary, Solomon, Siegler, & Meadows, 2007). In addition, a study examining demonstration programs in 7 States found reductions in alcohol-related fatalities between 11% and 20% in States that employed numerous checkpoints or other highly visible impaired-driving enforcement operations and intensive publicity of the enforcement activities, including paid advertising (Fell, Langston, Lacey, & Tippetts, 2008). States with lower levels of enforcement and publicity did not demonstrate a decrease in fatalities relative to neighboring States. See also NHTSA's Strategic Evaluation States initiative (NHTSA, 2007a; Syner et al., 2008), the *Checkpoint Strikeforce* program (Lacey et al., 2008), and the national Labor Day holiday campaign: *Drunk Driving. Over the Limit. Under Arrest* (Solomon et al., 2008).

Costs: The main costs are for law enforcement time and for publicity. A typical checkpoint using 15 or more officers can cost $5,000 to $7,000 (Robertson & Holmes, 2011). However, law enforcement costs can be reduced by operating checkpoints with smaller teams of 3 to 5 officers (NHTSA, 2002; NHTSA, 2006b; Stuster & Blowers, 1995). Law enforcement agencies in two rural West Virginia counties were able to sustain a year-long program of weekly low-staff checkpoints. The proportion of nighttime drivers with BACs of .05 g/dL and higher was 70% lower in these counties compared to drivers in comparison counties that did not operate additional checkpoints (Lacey, Ferguson, Kelley-Baker, & Rider, 2006). These smaller checkpoints can be conducted for as little as $500 to $1,500 (Maistros, Schneider, & Beverly, 2014). NHTSA has a guidebook available to assist law enforcement agencies in planning, operating and evaluating low-staff sobriety checkpoints (NHTSA, 2006b).

Checkpoint publicity can be costly if paid media are used. For the *Checkpoint Strikeforce* program, paid media budgets ranged from $25,000 in West Virginia to $433,000 in Maryland (Fell et al., 2013). Publicity for checkpoints should also include earned media.

Time to implement: Sobriety checkpoints can be implemented very quickly if officers are trained in detecting impaired drivers, SFST, and checkpoint operational procedures. See NHTSA (2002) for implementation information.

Other issues:

- **Legality:** Checkpoints currently are permitted in 38 States and the District of Columbia (NHTSA, 2016a). Twelve States do not allow checkpoints, either because there is no statutory provision (Alaska, Mississippi, and South Carolina) or because checkpoints violate the State's constitution or are prohibited under State law (Idaho, Iowa, Michigan, Minnesota, Montana, Oregon, Rhode Island, Texas, Washington, Wisconsin, and Wyoming). States where checkpoints are not permitted may use other enforcement strategies such as saturation patrols (see Chapter 1, Section 2.2).
- **Visibility:** Checkpoints must be highly visible and publicized extensively to be effective. Communication and enforcement plans should be coordinated. Messages should clearly and unambiguously support enforcement. Paid media may be necessary to complement news stories and other earned media, especially in a continuing checkpoint program. See Fell et al. (2013) for additional recommendations concerning checkpoint visibility.
- **Arrests:** The primary purpose of publicized sobriety checkpoint programs is to deter impaired driving, not to increase arrests. However, impaired drivers detected at checkpoints should be arrested and arrests should be publicized, but arrests at checkpoints should not be used as a measure of effectiveness. The number of contacts would be a more appropriate measure. A secondary value of publicized sobriety checkpoint programs is that checkpoints may also be used to check for valid driver licenses, seat belt use, outstanding warrants, stolen vehicles, and other traffic and criminal infractions.
- **Combining checkpoints with other activities:** To enhance the visibility of their law enforcement operations, some jurisdictions combine checkpoints with other activities, such as saturation patrols or enforcement of open container laws (Sanem et al., 2015). For example, some law enforcement agencies conduct both checkpoints and saturation patrols

during the same weekend. Others alternate checkpoints and saturation patrols on different weekends as part of a larger publicized impaired-driving enforcement effort. According to the results of a survey conducted with State patrol agencies and local law enforcement agencies, the prevalence of self-reported alcohol-impaired driving was lower in States where sobriety checkpoints, saturation patrols, and enforcement of open container laws were conducted (Sanem et al., 2015). These results demonstrate the potential value of law enforcement agencies implementing multiple enforcement-related strategies to more effectively reduce alcohol-impaired driving. NHTSA strongly supports that officers conducting such activities be trained in the SFST battery. DREs can supplement sobriety checkpoints to detect drivers who are impaired with substances besides alcohol.

- **Standardized Field Sobriety Tests:** Officers have used SFSTs for more than 20 years to identify impaired drivers. The SFST is a three-test battery - the horizontal gaze nystagmus test, the walk-and-turn test, and the one-leg-stand test. Research shows the combined components of the SFST are 91% accurate in identifying drivers with BACs above the illegal limit of .08 (Stuster & Burns, 1998). However, some police agencies do not require officers to receive SFST training. State Highway Safety Offices may request an SFST assessment (and SFST with DRE-module add-on assessment) which looks at a State’s application of the basic law enforcement tool for detecting impaired drivers through their NHTSA Regional Office.

2.2 High-Visibility Saturation Patrols

Effectiveness: ★★★★	Cost: $$	Use: High	Time: Short

A saturation patrol (also called a blanket patrol or dedicated DWI patrol) consists of a large number of law enforcement officers patrolling a specific area looking for impaired drivers. These patrols usually take place at times and locations where impaired-driving crashes commonly occur. Like publicized sobriety checkpoint programs, the primary purpose of publicized saturation patrol programs is to deter driving after drinking by increasing the perceived risk of arrest. To do this, saturation patrols should be publicized extensively and conducted regularly, as part of an ongoing saturation patrol program. A "how-to" guide for planning and publicizing saturation patrols and sobriety checkpoints is available from NHTSA (2002). NHTSA strongly recommends that officers conducting these activities be trained in the SFST battery.

Use: A survey conducted by the Century Council (2008) reported that 44 States used saturation patrols.

Effectiveness: A demonstration program in Michigan, where sobriety checkpoints are prohibited by State law, revealed that saturation patrols can be effective in reducing alcohol-related fatal crashes when accompanied by extensive publicity (Fell, Langston, Lacey, & Tippetts, 2008).

Costs: The main costs are for law enforcement time and for publicity. Saturation patrol operations are quite flexible in both the number of officers required and the time that each officer participates in the patrol. As with sobriety checkpoints, publicity can be costly if paid media is used.

Time to implement: Saturation patrols can be implemented within 3 months if officers are trained in detecting impaired drivers and in SFST. See NHTSA (2002) for implementation information.

Other issues:

- **Legality:** Saturation patrols are legal in all jurisdictions.
- **Publicity:** As with sobriety checkpoints, saturation patrols should be highly visible and publicized extensively to be effective in deterring impaired driving. Communication and enforcement plans should be coordinated. Messages should clearly and unambiguously support enforcement. Paid media may be necessary to complement news stories and other earned media, especially in a continuing saturation patrol program (Goodwin et al., 2005, Strategy B1).
- **Arrests:** Saturation patrols can be very effective in arresting impaired drivers. For example, law enforcement officers in Minnesota conducted 290 saturation patrols during 2006, in which they stopped 33,923 vehicles and arrested 2,796 impaired drivers (Century Council, 2008). Similar to publicized sobriety checkpoint programs, publicized saturation patrol programs are also effective in detecting other driving and criminal offenses.

2.3 Breath Test Devices

Effectiveness: ★★★★†	Cost: $$	Use: High	Time: Short

†Proven for increasing arrests

A breath test device is a stationary or portable alcohol sensor used to measure a driver's breath alcohol concentration (BrAC). Law enforcement officers use breath test devices in the field to help establish probable cause for a DWI arrest. The driver blows into a mouthpiece and the breath test device displays either a numerical BrAC level, such as .12, or a BrAC range, such as a red light for any BAC at or above .08.

Several breath test device models are available commercially. They are generally quite accurate and reliable. There are two categories of breath test devices. Evidential Breath Test (EBT) devices are State-approved and conform to established standards. The results from EBTs are used as evidence in court. Preliminary Breath Test (PBT) devices, also known as screeners, are hand-held devices used at the roadside by officers to establish probable cause prior to arrest. NHTSA provides a "Conforming Products List" of alcohol testing (EBT) and screening (PBT) instruments, as well as calibration units for these devices. Only devices included on NHTSA's Conforming Products Lists are eligible for purchase using Federal funds.

- NHTSA Conforming Products List of Evidential Breath Alcohol Measurement Devices, Docket No. NHTSA–2012–0061, Federal Register, Vol. 77, No. 115, Thursday, June 14, 2012), available at www.gpo.gov/fdsys/pkg/FR-2012-06-14/pdf/2012-14581.pdf
- NHTSA Conforming Products List of Screening Devices to Measure Alcohol in Bodily Fluids, Docket No. NHTSA–2012–0062, Federal Register, Vol. 77, No. 115, Thursday, June 14, 2012, available at www.gpo.gov/fdsys/pkg/FR-2012-06-14/pdf/2012-14582.pdf
- NHTSA Conforming Products List of Calibrating Units for Breath Alcohol Testers, Docket No. NHTSA–2012–0063, Federal Register, Vol. 77, No. 204, Monday, October 22, 2012, available at www.transportation.gov/sites/dot.gov/files/docs/20121022_CPL_Calibrating_Units.pdf

Some States may maintain a separate list of approved devices they have tested and approved for purchase.

Use: PBTs are often used to establish probable cause for arrest, but they are rarely used as evidence in court. One exception is California, which allows PBT results as evidence of presence of alcohol (Nesci, 2015). California officers can use PBT evidence to enforce zero-tolerance laws for drivers under 21; an officer at the roadside can issue a citation and seize the driver's license (Ferguson, Fields, & Voas, 2000). EBTs are commonly used to provide evidence of alcohol impairment that is presented in court.

Effectiveness: Law enforcement officers generally agree that breath test devices are useful. Sixty-nine percent of the 2,731 law enforcement officers surveyed by Simpson and Robertson (2001) supported greater breath test devices availability and use. Breath test devices are especially valuable for two classes of drivers who may appear to perform normally on many tasks: drivers with high tolerance to alcohol (Simpson & Robertson, 2001) and drivers under 21 who may be in violation of zero-tolerance laws (Ferguson et al., 2000). A breath test device also can be useful at crash scenes where a driver is injured and unable to perform an SFST. There is some evidence that breath test devices use increases DWI arrests and reduces alcohol-involved fatal crashes (Century Council, 2008).

Costs: Breath test devices cost from $200 to $2,000 apiece, with PBTs typically costing less than EBTs. Many law enforcement departments have only a limited number of breath test devices and many patrol officers do not have regular access to them. Officers surveyed by Simpson and Robertson (2001) estimated that three-fourths of all DWI arrests occur on routine patrols, so DWI detection would be substantially improved if every patrol officer had a breath test device.

Time to implement: Breath test devices can be used as soon as they are purchased and officers are trained in their use and maintenance. Breath test devices instruments must have regular calibration checks. Most law enforcement agencies have the facilities to conduct these checks.

Other issues:

- **The "one test" rule:** Some State statutes allow only one chemical BAC test to be taken from a driver arrested for DWI. These States do not use PBTs because an evidential BAC test cannot be requested if an officer previously has taken a PBT test in the field.
- **Other drugs:** The PBT and EBT devices commonly used are designed strictly for identifying alcohol and cannot detect the presence of drugs other than alcohol.

2.4 Passive Alcohol Sensors (PAS)

Effectiveness: ★★★★†	Cost: $$	Use: Unknown	Time: Short

†Proven for detecting impaired drivers

A passive alcohol sensor is a device to detect alcohol presence in the air. The sensor usually is integrated into a flashlight or clipboard. Officers hold the flashlight or clipboard near the driver's mouth, where it measures alcohol presence in the air where the driver is breathing. The PAS can be used without the driver's knowledge and without any probable cause because the PAS is considered "an extension of the officer's nose" and records information that is "in plain view" (Preusser, 2000).

Several PAS models are available commercially. They generally are reliable and effective at detecting alcohol in the surrounding ambient air. In one study, both breath samples and PAS measures were obtained from over 12,000 drivers. Results showed that a PAS score was a strong predictor of a driver's BAC status, leading to the conclusion that "the PAS can be an effective tool for officers when deciding whether to initiate a DWI investigation" (Voas, Romano, & Peck, 2006). NHTSA does not maintain a list of PAS models.

Use: PAS units typically are used at the vehicle window after a traffic stop or at a checkpoint. A PAS report of alcohol presence may give the officer probable cause to request further examination with SFSTs or a PBT device. No data is available on how many PAS units are in use.

Effectiveness: The PAS is especially effective at detecting impaired drivers at checkpoints, where officers must screen drivers quickly with little or no opportunity to observe the drivers on the road. Evaluations show that officers using PAS devices at checkpoints can detect 50% more drivers at BACs of .10 or higher than officers not using PAS (Century Council, 2008; Farmer, Wells, Ferguson, & Voas, 1999; Fell et al., 2004; Voas, 2008). The PAS appears to be especially effective in assisting officers who rarely make arrests for DWI (Fell, Compton, & Voas, 2008).

Costs: PAS units cost from $300 to $700 apiece.

Time to implement: PAS units can be used as soon as they are purchased and officers are trained in their use and maintenance. Training can usually be accomplished quickly.

Other issues:

- **Acceptance by law enforcement:** Officers tend to dislike using the PAS. Common reasons given by officers for not using PAS units are that they require them to be closer to the drivers than they wish to be, they require some portion of officers' attention at a time when they may have other things to be concerned about (including personal safety), or they may keep officers from having a hand free. Other officers believe they can detect the odor of alcohol accurately without assistance from PAS devices (Preusser, 2000).
- **Other drugs:** As with a PBT, a PAS cannot detect the presence of drugs other than alcohol.

2.5 Integrated Enforcement

Effectiveness: ★★★	Cost: $	Use: Unknown	Time: Short

Impaired drivers are detected and arrested through regular traffic enforcement and crash investigations as well as through special impaired-driving checkpoints and saturation patrols. A third opportunity is to integrate impaired-driving enforcement into special enforcement activities directed primarily at other offenses such as speeding or seat belt nonuse, especially as impaired drivers often speed or fail to wear seat belts. (Such operations can be particularly effective when conducted at night.)

Use: There is no data on how frequently integrated enforcement methods are used.

Effectiveness: Jones, Joksch, Lacey, Wiliszowski, and Marchetti (1995) conducted a three-site evaluation of integrated impaired driving, speed, and seat belt use enforcement. Sites that combined high publicity with increased enforcement reduced crashes likely to involve alcohol (such as single-vehicle nighttime crashes) by 10% to 35%. They concluded that the results were encouraging, but not definitive. The *Massachusetts Saving Lives* comprehensive programs in six communities used integrated enforcement methods. The programs reduced fatal crashes involving alcohol by 42% (Hingson et al., 1996). About half the speeding drivers detected through these enforcement activities had been drinking and about half the impaired drivers were speeding. See also Voas and Lacey (2011), Goodwin et al. (2005, Strategy B2), and Stuster (2000).

Costs: As with other enforcement strategies, the primary costs are for law enforcement time and for publicity.

Time to implement: Impaired driving can be integrated into other enforcement activities within 3 months if officers are trained in detecting impaired drivers and in SFST.

Other issues:

- **Publicity:** Integrated enforcement activities should be publicized extensively to be effective in deterring impaired driving and other traffic offenses. Paid media may be necessary to complement news stories and other earned media, especially in an ongoing program (Goodwin et al., 2005, Strategy B2).
- **Priorities:** Integrated enforcement activities send a message to the public and to law enforcement officers alike that traffic safety is not a single-issue activity.
- **Citizen reporting programs:** Some jurisdictions have dedicated programs where drivers can call to report suspected impaired drivers. Such programs can generate support for law enforcement efforts and increase the perception in the community that impaired drivers will be caught. A study of a grassroots DWI witness reward program in Stockton, California, found a significant decrease in alcohol-related injury/fatality crashes following the program, relative to six comparison communities (Van Vleck & Brinkley, 2009). Mothers Against Drunk Driving (MADD) Canada launched a program in 2007 called “Campaign 911” to encourage the general public to report impaired drivers. Calls to 911 increased sharply after the program was implemented, as did the number of

vehicles stopped and the number of criminal charges issued (Solomon & Chamberlain, 2013). The effect of the program on crashes was not examined. NHTSA offers a manual for law enforcement agencies and local organizations that are interested in establishing a citizens' DWI reporting program in their communities (Kelley-Baker, Brainard, Lacey, Vishnuvajjala, & Cobb, 2008).

3. Deterrence: Prosecution and Adjudication

3.1 DWI Courts

Effectiveness: ★★★★†	Cost: $$$	Use: Low	Time: Medium

† Proven for reducing recidivism

Based on the drug court model, DWI courts are specialized courts dedicated to changing the behavior of DWI offenders through intensive supervision and treatment. A dedicated DWI court provides a systematic and coordinated approach to prosecuting, sentencing, monitoring, and treating DWI offenders. Prosecutors and judges in DWI courts specialize in DWI cases. A DWI court's underlying goal is to change offenders' behavior by identifying and treating their alcohol abuse problems and by holding offenders accountable for their actions.

Intensive supervision is a key component of DWI courts. Probation officers monitor offenders closely and report any probation infraction to the judge immediately for prompt action. Restrictions and monitoring are gradually relaxed as offenders demonstrate responsible behavior. DWI courts follow the model established by over 3,000 Drug courts around the Nation (NCDI, 2015; Huddleston, Marlowe, & Casebolt, 2008; NADCP, 2009; Goodwin et al., 2005, Strategy D3). See Brunson and Knighten (2005), Practice #1, for a comprehensive overview of DWI courts.

A DWI court can reduce recidivism because judge, prosecutor, probation staff, and treatment staff work together as a team to assure that alcohol treatment and other sentencing requirements are satisfied for offenders on an individual basis. A key feature of a DWI court is that the team meets regularly, giving all parties an opportunity to discuss the status of a case. Judges can then immediately revise restrictions, if appropriate. DWI courts can be more efficient and effective than regular courts because judges and prosecutors closely supervise the offenders and are familiar with the complex DWI laws, evidentiary issues, sentencing options, and the offenders. NHTSA (2003a) describes the operation of a DWI court in Albuquerque, New Mexico.

Use: As of August 2016, the National Center for DWI Courts reported 279 designated DWI courts in 40 States (NCDC, 2016). In addition, there were 447 hybrid DWI/drug courts, which are drug courts that also take DWI offenders. States with the most designated DWI courts include Michigan (22), Georgia (20), Missouri (19), Wisconsin (14), Minnesota (13), and Colorado (13).

NHTSA, in collaboration with the National Center for DWI Courts, conducted an online survey with DWI courts and DWI/drug courts to obtain specific information about how the courts were being operated (NHTSA, 2016b). A total of 105 DWI and DWI/drug courts responded to the survey in its entirety. Of the programs that responded, 44% indicated they serve primarily rural areas, 33% serve primarily urban areas, and 22% serve primarily suburban areas. Respondents indicated a range in the number of DWI participants currently active in their programs from fewer than 10 to more than 200 (NHTSA, 2016b).

Effectiveness: A systematic review found that DWI courts appear to be effective at reducing recidivism, although the available studies had too many shortcomings to draw definitive conclusions (Marlowe et al., 2009). A more recent meta-analysis of 28 studies suggests DWI courts reduce recidivism among DWI offenders by approximately 50% compared to traditional court programs (Mitchell, Wilson, Eggers, & MacKenzie, 2012). However, the authors note that more rigorous experimental evaluations of DWI courts are still needed.

A number of individual program evaluations show that DWI courts can be successful. Low DWI recidivism rates have been found for graduates of DWI courts in Athens (Georgia), Maricopa County (Arizona), Los Angeles County (California), and elsewhere (Marlowe et al., 2009). One study in Michigan found that DWI court participants were 19 times *less* likely to be rearrested for DWI within 2 years than a comparison group of offenders who were in traditional probation (Michigan Supreme Court & NPC Research, 2008). Another study of three DWI courts in Georgia found that offenders who graduated from the court program had a 9% recidivism rate within the next 4 years, compared to a 24% recidivism rate for a comparison group of offenders processed in traditional courts (Fell, Tippetts, & Langston, 2011).

Evaluations have shown that close monitoring and individualized sanctions for DWI offenders reduce recidivism (see Chapter 1, Section 4.4). When these are incorporated within a comprehensive DWI court program, their effect is likely to be even greater.

Costs: DWI court costs are difficult to estimate and compare with regular courts. Costs may be greater because more probation officers will be needed to reduce caseloads and to provide close monitoring, and because judges must allocate time to meet regularly with probationers and to deal with any probation violations. However, total time offenders spend in jail is reduced, thus saving the justice system time and money (Michigan Supreme Court & NPC Research, 2008). Moreover, DWI courts may reduce long-term system costs substantially if they decrease DWI recidivism as expected.

According to the meta-analysis conducted by Mitchell, Wilson, Eggers, and MacKenzie (2012), the cost of DWI courts is lower than standard probation. In Arizona, DWI court costs an average of $534 per participant per month compared with $758 for traditional probation (Solop et al., 2003) and in New Mexico, DWI court costs $654 per participant compared with $2,125 for standard probation, leading to an overall savings of $247,010 for the jurisdiction over two and a half years (Guerin & Pitts, 2002). The results of these evaluations indicate that while DWI courts provide more intensive and expensive services than standard probation, they still cost less to administer due to the shortened time required for supervising participants and the reduced use of incarceration (Harron & Kavanaugh, 2015).

Time to implement: DWI courts can be implemented 4 to 6 months after the participating organizations agree on the program structure if enough trained prosecutors, judges, probation officers, and treatment providers are available. Otherwise, planning and implementation may require a year or more.

Other Information:

- **Traffic Safety Resource Prosecutors:** DWI cases can be highly complex and difficult to prosecute, yet they are often assigned to the least experienced prosecutors. In one survey, about half of prosecutors and judges said the training and education they received prior to assuming their position was inadequate for preparing them to prosecute and preside over DWI cases (Robertson & Simpson, 2002a). Traffic Safety Resource Prosecutors (TSRPs) are current or former prosecutors who specialize in the prosecution of traffic crimes, and DWI cases in particular. They provide training, education, and technical support to other prosecutors and law enforcement agencies within their States.

- **Judicial Outreach Liaisons (JOLs)**: These are current or former judges experienced in handling DWI cases. Many JOLs have presided over DWI or drug courts. They share information and provide education to judges and other court personnel about DWI cases. NHTSA has developed a manual to assist new TSRPs (NHTSA, 2007b) and guidelines for creating State JOLs (NHTSA, 2013a).

3.2 Limits on Diversion and Plea Agreements

Effectiveness: ★★★★†	Cost: $	Use: Medium	Time: Short

† Proven for increasing convictions

Diversion programs defer sentencing while a DWI offender participates in some form of alcohol education or treatment. In many States, charges are dropped or the offender's DWI record is erased if the education or treatment is completed satisfactorily.

A survey of prosecutors found that of defendants who plead guilty, 67% negotiated a plea agreement resulting in a reduced penalty (Robertson & Simpson, 2002a). Negotiated plea agreements are a necessary part of efficient and effective DWI prosecution and adjudication. However, plea agreements in some States allow offenders to eliminate any record of a DWI offense and to have their penalties reduced or eliminated.

Effective DWI control systems can use a variety of adjudication and sanction methods and requirements. The key feature is that an alcohol-related offense must be retained on the offender's record (Hedlund & McCartt, 2002; Goodwin et al., 2005; NTSB, 2000; Robertson & Simpson, 2002a). Otherwise, offenders who recidivate will receive less severe penalties than if the original charge had been retained on their record.

Use: As of 2006, there were 33 States that provided for diversion programs in State law or statewide practice. Local courts and judges in some additional States also offer diversion programs (NHTSA, 2006c). The Century Council (2008) documented diversion programs restrictions in several States. As of December 2014, there were 22 States that had laws limiting plea agreements in certain cases (NHTSA, 2016a).

Effectiveness: The evidence for the effectiveness of diversion programs has been mixed (Voas & Fisher, 2001). Although a few studies have shown diversion programs reduce recidivism, others have shown no benefits. However, there is substantial anecdotal evidence that diversion programs, by eliminating the offense from the offender's record, allow repeat offenders to avoid being identified (Hedlund & McCartt, 2002). Eliminating or establishing limits on diversion programs should remove a major loophole in the DWI control system.

Wagenaar et al. (2000) reviewed 52 studies of plea agreement restrictions applied in combination with other DWI control policies and found an average reduction of 11% across various outcome measures such as rates of crashes/fatalities/injuries, alcohol-involved crashes, and roadside BAC levels. However, the effects of plea agreement restrictions by themselves cannot be determined in these studies. The only direct study of plea agreement restrictions was completed over 20 years ago (Surla & Koons, 1989; NTSB, 2000). It found that plea agreement restrictions reduced recidivism in all three study communities.

Costs: Costs for eliminating/limiting diversion programs can be determined by comparing the per-offender costs of the diversion program and the non-diversion sanctions. Similarly, costs for restricting plea agreements will depend on the relative costs of sanctions with and without the plea agreement restrictions. In addition, if plea agreements are restricted, some charges may be dismissed or some offenders may request a full trial, resulting in significant costs.

Time to implement: Eliminating/limiting diversion programs and restricting plea agreements statewide may require changes to a State's DWI laws. Once legislation is enacted, policies and practices can be changed within 3 months. Individual prosecutor offices and courts may change local policies and practices without statewide legislation.

3.3 Court Monitoring

Effectiveness: ★★★†	Cost: $	Use: Low	Time: Short

† Proven for increasing convictions

In court monitoring programs, citizens observe, track, and report on DWI court or administrative hearing activities. Court monitoring provides data on how many cases are dismissed or pled down to lesser offenses, how many result in convictions, what sanctions are imposed, and how these results compare across different judges and different courts. Court monitoring programs usually are operated and funded by citizen organizations such as Mothers Against Drunk Driving (MADD).

Use: As of 2006, court monitoring programs were active in at least 13 States (Syner, 2006). It is generally believed that court monitoring has decreased substantially since the mid-1980s, when Probst, Lewis, Asunka, Hershey, and Oram (1987) identified over 300 programs in the United States.

Effectiveness: Shinar (1992) found that court-monitored cases in Maine produced higher conviction rates and stiffer sentences than unmonitored cases. Probst et al. (1987) found that judges, prosecutors, and other officials in 51 communities believed that court monitoring programs helped increase DWI arrests, decrease plea agreements, and increase guilty pleas.

Costs: The main requirement for a court monitoring program is a reliable supply of monitors. Monitors typically are unpaid volunteers from advocacy groups like MADD, or similar organizations. Modest funds are needed to establish and maintain court monitoring records and to publicize the results.

Time to implement: Court monitoring programs can be implemented very quickly if volunteer monitors are available. A few weeks will be required to set up the program and train monitors.

3.4 Sanctions

Effectiveness: ☆☆	Cost: Varies	Use: Varies	Time: Varies

This countermeasure involves the standard court sanctions for DWI offenses, which include driver's license suspension or revocation, fines, jail, community service, and victim impact panels. All States use some combination of these sanctions. Some States set mandatory minimum levels for some sanctions, which often increase for second and subsequent offences.

Effectiveness Concerns: *Most of these measures are widely used. Their respective effectiveness has been examined in multiple research studies. Although there have been some positive research findings, the balance of evidence regarding the effectiveness of these countermeasures remains inconclusive.*

Further information about the known research, potential effectiveness, costs, use, and time to implement are available in Appendix A1, Section 3.4.

4. Deterrence: DWI Offender Treatment, Monitoring, and Control

4.1 Alcohol Problem Assessment and Treatment

Effectiveness: ★★★★★	Cost: Varies	Use: High	Time: Varies

It is widely recognized that many DWI first offenders and most repeat offenders are dependent on alcohol or have alcohol abuse problems. They likely will continue to drink and drive unless their alcohol abuse problems are addressed. A DWI arrest provides an opportunity to identify offenders with alcohol abuse problems and to refer them to treatment as appropriate. However, treatment should not be provided in lieu of other sanctions or as part of a plea bargain or diversion program that eliminates the record of a DWI offense (see Chapter 1, Section 3.2).

Alcohol problem assessment can take many forms, from a brief paper-and-pencil questionnaire to a detailed interview with a treatment professional. Alcohol treatment can be even more varied, ranging from classroom alcohol education programs to long-term inpatient facilities. For brief overviews of alcohol assessment and treatment programs and further references see Century Council (2008), Dill and Wells-Parker (2006), Voas and Lacey (2011), NCHRP (2005, Strategy C4), and Robertson, Simpson, and Parsons (2008).

Part of the assessment process is determining the likelihood that an offender will continue to drive impaired. Under a cooperative agreement with NHTSA, the American Probation and Parole Association developed a screening tool – the Impaired Driving Assessment (IDA) – to determine an offender's risk of recidivism and to help determine the most appropriate and effective community supervision program to reduce that risk (Lowe, 2014). Pilot testing of the IDA revealed that probation failure is commonly associated with extensive prior legal histories, mental health problems, and higher levels of alcohol/drug use.

Use: All States have provisions under State law for alcohol treatment for DWI offenders (NHTSA, 2015). However, the nature of the treatment – and to whom it applies – varies greatly. Some States mandate treatment, especially for repeat offenders, but usually treatment requirements are at the court's discretion.

Effectiveness: Even the best of the many assessment instruments currently in use is subject to error. Chang, Gregory, and Lapham (2002) found that none of the assessment instruments studied correctly identified more than 70% of offenders who were likely to recidivate. However, the assessment process itself can have therapeutic benefits. See Chapter 1, Section 5.1 on alcohol screening and brief interventions.

Wells-Parker, Bangert-Drowns, McMillan, and Williams (1995) reviewed the studies evaluating treatment effectiveness. They found that, on average, treatment reduced DWI recidivism and alcohol-related crashes by 7 to 9%. Treatment appears to be most effective when combined with other sanctions and when offenders are monitored closely to assure that both treatment and sanction requirements are met (Century Council, 2008; Dill & Wells-Parker, 2006).

Costs: Treatment expenses vary widely depending on program type. However, several studies suggest alcohol abuse treatment can be cost effective. For example, a study from California found every dollar spent on treatment potentially saved taxpayers up to $7 (Gerstein et al., 1994). Offenders can bear some of the costs of both assessment and treatment, though provisions must be made for indigent offenders.

Time to implement: Implementation time also varies depending on program type. The simplest can be implemented in several months, while others may take years.

Other issues:

- **Treatment options:** There are many effective treatment options for alcohol abuse problems including cognitive-behavioral therapy, group counseling, pharmacological interventions (e.g., naltrexone, acamprosate), and brief interventions (see Chapter 1, Section 5.1). It is important that treatment be tailored to the individual. Also, combining therapies can result in better outcomes because DWI offenders usually have a range of diverse and complex problems (Dill & Wells-Parker, 2006).
- **DWI Courts:** Alcohol problem assessment and treatment are an integral part of DWI courts. In addition, a DWI court can sanction offenders who fail to complete assigned treatment programs. For more information, see Chapter 1, Section 3.1.
- **Other mental health issues:** Alcohol assessment and treatment provide an opportunity to address other problems that may underlie or contribute to problems with alcohol. One study found that more than 60% of DWI repeat offenders have experienced other psychiatric disorders in addition to alcohol-related problems, such as post-traumatic stress disorder, anxiety disorders, and bipolar disorder (Shaffer et al., 2007). This is substantially higher than the rate of about 30% for the general population.

4.2 Alcohol Ignition Interlocks

Effectiveness: ★★★★★†	Cost: $$	Use: Medium	Time: Medium

† Proven for reducing recidivism

An alcohol ignition interlock prevents a vehicle from starting unless the driver provides a breath sample with a BrAC lower than a pre-set level, usually .02. Interlocks typically are used as a condition of probation for DWI offenders, to prevent them from driving while impaired by alcohol after their driver's licenses have been reinstated.

Interlocks are highly effective in allowing a vehicle to be started by sober drivers, but not by alcohol-impaired drivers. A post-start retest requires the driver to remain sober while driving. A data recorder logs the driver's BrAC at each test and can be used by probation officers to monitor the offender's drinking and driving behavior. Marques and Voas (2010) provide an overview of interlock use, effectiveness, operational considerations, and program management issues. Marques (2005), Beirness and Robertson (2005), and Robertson, Vanlaar, and Beirness (2006) summarize interlock programs in the United States and other countries and discuss typical problems and solutions. See also Brunson and Knighten (2005), Practice #5, Neuman, Pfefer, Slack, Hardy, and Waller (2003, Strategy C2), and proceedings from the 11th Annual International Alcohol Interlock Symposium (Robertson, Holmes, & Vanlaar, 2011).

NHTSA offers an ignition interlock toolkit to assist policymakers, highway safety professionals, and advocates (Mayer, 2014). In addition, NHTSA has published a report, *Case Studies of Ignition Interlock Programs*, featuring State ignition interlock programs (Fieldler, Brittle, & Stafford, 2012) and an *Evaluation of State Ignition Interlock Programs: Interlock Use Analysis from 28 States 2006-2011* (Casanova-Powell, Hedlund, Leaf, & Tison, 2015). Finally, NHTSA has created model guidelines to assist States in developing and implementing highly effective interlock programs based on successful practices in the United States and other countries (NHTSA, 2013b).

Use: All 50 States and the District of Columbia allow interlocks to be used for some DWI offenders (NHTSA, 2013a). In 30 States, the District of Columbia, and 4 California counties, interlocks are mandatory for all convicted offenders, including first offenders (IIHS, 2017). Four States (Indiana, Montana, North Dakota, and South Dakota) have no mandatory interlock requirements (IIHS, 2017).

Despite widespread laws, a relatively small percentage of eligible offenders have an interlock installed. However, interlock use has more than doubled in the past 5 years, from 146,000 in 2008 to 328,743 in 2015 (based on information supplied by 8 interlock manufacturers, 2015). Given the roughly 1.4 million arrests in the United States each year for DWI, the ratio of installed interlocks to arrests is approximately 1 in 5. Use of interlocks is substantially higher when they are required as a prerequisite to license reinstatement. For example, among DWI offenders in Florida who were subject to the State's interlock requirement, 93% installed interlocks once they qualified for reinstatement (Voas, Tippetts, Fisher, & Grosz, 2010). Use of interlocks is also higher when interlocks are offered as an alternative to home confinement via electronic monitoring (Roth, Marques, & Voas, 2009). Through a combination of these measures, New Mexico installed interlocks in the vehicles of half of all convicted DWI offenders in 2007 – the highest level of penetration of any State (Marques, Voas, Roth, & Tippetts, 2010). Finally, use of interlocks in a pilot program in California was higher in the four pilot counties that required interlocks for DWI offenders (42.4%) than in non-pilot counties (4.3%) (Chapman, Oulad Daoud, & Masten, 2015). The authors concluded that the main reason for this significant increase was due to the fact that interlock installation was mandatory in pilot counties, while interlock installation was optional in non-pilot counties.

Effectiveness: A review of 15 studies of interlock effectiveness found that offenders who had interlocks installed in their vehicles had arrest recidivism rates that were 75% lower than drivers who did not have interlocks installed (Elder et al., 2011; see also GAO, 2014). Findings were similar for first offenders and repeat offenders. After interlocks were removed, however, the effects largely disappeared, with interlock and comparison drivers having similar recidivism rates. Similarly, a study conducted in California found that the strong and reliable reduction in recidivism diminished over time for DWI offenders that had one or two prior DWI convictions (California DMV, 2016).

Although only five studies have examined the effects of interlocks on crashes, the limited evidence suggests that alcohol-related crashes decrease while interlocks are installed in vehicles (Elder et al., 2011; Vanlaar Hing & Robertson, 2015). However, the limited effect of interlocks on crashes should still be considered inconclusive, as the positive findings are contrasted by another study that reported significantly higher crash rates for DWI offenders enrolled in interlock programs relative to comparison DWI offenders (California DMV, 2016).

One limitation of interlock research is that study participants often are not randomly assigned to interlock or no-interlock groups, so there may be important pre-existing differences between groups (GAO, 2014). However, research suggests that interlocks are a highly effective method for preventing alcohol-impaired driving – and possibly crashes – while they are installed.

Costs: Presently, offenders pay approximately \$65 to \$90 per month for interlocks, not including installation fees that can range from \$100 to \$250 (Marques & Voas, 2010). Offenders usually pay these costs; however, some States such as Illinois and New Mexico have indigent funds and unaffordability criteria to reduce the costs for low income offenders.

Time to implement: Interlock programs may require enabling legislation. Once authorized, interlock programs require 4 to 6 months to implement a network of interlock providers.

Other issues:

- **Barriers to use:** Interlocks have demonstrated their effectiveness in controlling impaired driving while they are installed. In light of this success, their limited use may be due to several factors, such as lengthy license suspension periods, offenders who delay license reinstatement, judges who lack confidence in the interlock technology or who fail to enforce "mandatory" interlock requirements, interlock costs, and localities that lack enough interlock providers. In an effort to increase the number of offenders who drive interlock-equipped vehicles, some States have made the alternatives to interlocks more undesirable. For example, pilot programs in Indiana and New Mexico found that roughly two-thirds of offenders chose to have interlocks installed when the alternative was house arrest with electronic monitoring (Marques et al., 2010; Voas, Blackman, Tippetts, & Marques, 2001). Other States allow offenders to shorten (or eliminate) the license suspension period if they are willing to operate an interlock-installed vehicle. For example, Colorado reduced the license suspension period from 1 year to one month for offenders who apply for an interlock (NCSL, 2014a). Arkansas, Maine, Mississippi, and Nebraska recently passed similar laws. For a discussion of barriers to interlock use, see Beirness and Marques (2004), Beirness, Clayton, and Vanlaar (2008), Beirness and Robertson (2005), and Neuman, Pfefer, Slack, Hardy, and Waller (2003, Strategy C2). For a discussion on how States have successfully overcome obstacles encountered with interlock programs, see Casanova-Powell, Hedlund, Leaf, and Tison (2015).

- **Compliance with interlocks:** Some offenders have relatively high rates of breath test failures and other violations, typically near the beginning of their participation in an interlock program (Vanlaar, McKiernan, & Robertson, 2013; Vanlaar, Robertson, Schaap, & Vissers, 2010). Offenders become familiar with the equipment, and in some cases may test the limits of the devices. Presently, few jurisdictions use the compliance data collected by interlocks to identify offenders who may be at high risk for recidivism. The data could also be used to require an extension of the interlock period for those with poor compliance, or even to inform treatment options (Marques et al., 2010). To improve compliance with interlocks, it is important to closely monitor offenders during their participation in an interlock program. One study found that offenders who were closely monitored (e.g., their data was reviewed weekly and they received letters documenting their progress) had fewer initial breath test failures and other indicators of non-compliance than offenders who received standard monitoring through the State licensing office (Zador, Ahlin, Rauch, Howard, & Duncan, 2011). Similarly, an in-depth study of three State interlock programs found non-compliance was highest in the State with less consistent monitoring practices (California) than in the two States (Florida and Texas) with stronger monitoring practices (Vanlaar et al., 2013). Monitoring the number of miles driven on interlock vehicles can prevent offenders from circumventing the devices by driving another vehicle. Some States set vehicle usage criteria for the number of miles the offender will likely be driving per week while the interlock is installed. If the mileage on the interlock-equipped vehicle is unexpectedly low, further sanctions can be put in place (Mayer, 2014).
- **First-time offenders:** There are special issues concerning interlocks and first-time offenders. In many States, first offenders are not monitored by the criminal justice system. Consequently, it can be difficult to respond to violations and to ensure that first-time offenders complete the interlock program. Despite challenges in closely monitoring first-time offenders, evidence suggests interlocks effectively reduce recidivism among this group while the interlock is installed (Marques et al., 2010; McCartt, Leaf, Farmer, & Eichelberger, 2012). For more information about issues in implementing interlock programs with first-time offenders, see Robertson, Homes, and Vanlaar (2010).
- **Rural areas:** For offenders living in rural areas, access to an interlock service provider may be problematic (Cheesman, Kleiman, Lee, & Holt, 2014). Interlock service providers may be limited or non-existent in rural jurisdictions, requiring offenders to drive long distances to get an interlock installed or serviced. To improve the availability of

interlocks, States can require vendors to provide service to rural areas as a prerequisite for obtaining a contract with the State (NHTSA, 2014d).

- **Public support:** There is strong support among the general public for ignition interlocks. In two national surveys, approximately 80% of respondents approved of requiring interlocks in the vehicles of convicted DWI offenders, including first offenders (AAA Foundation, 2014; McCartt, Wells, & Teoh, 2010). Moreover, about 65% of respondents favored having alcohol detection technology in *all* new vehicles. The general public also believes strongly that interlocks work. In a NHTSA survey, respondents were asked about the effectiveness of eight strategies to reduce or prevent impaired driving. Interlocks ranked highest in the percentage who rated the strategy “very effective” (63%) (Moulton et al., 2010).
- **General Deterrence**: The implementation of ignition interlock programs targeting DWI offenders does not seem to produce a general deterrence effect among the broader driving population. In particular, an evaluation of general deterrence was conducted in California by comparing recidivism rates in four counties that participated in a pilot program involving mandatory interlock installation to recidivism rates in all other California counties (Chapman, Oulad Daoud, & Masten, 2015). The study found that mandatory interlock installation was ineffective at reducing county-wide DWI recidivism below those of the comparison counties. This lack of difference in conviction rates held for drivers with one, two, or three-or-more prior DWI convictions. Note that this study did not track local advertising of the program in the four pilot counties, so it is unknown if the absence of a general deterrence effect was affected by the level of outreach effort.

4.3 Vehicle and License Plate Sanctions

Effectiveness: ★★★★[†]	Cost: Varies	Use: Medium	Time: Short

[†] Proven for reducing recidivism

In recent years, many States have implemented sanctions affecting a DWI offender's license plate or vehicle. These sanctions are intended to prevent the offender from driving the vehicle while the sanctions are in effect, and also to deter impaired driving by the general public. Vehicle and plate sanctions include:

- Special license plates for drivers whose licenses have been revoked or suspended. The plates allow family members and other people to drive the offender's vehicle but permit law enforcement to stop the vehicle to verify that the driver is properly licensed.
- License plate impoundment. Officers seize and impound or destroy the license plate.
- Vehicle immobilization. Vehicles are immobilized on the offender's property with a "boot" or "club."
- Vehicle impoundment. Vehicles are stored in a public impound lot.
- Vehicle forfeiture. Vehicles are confiscated and sold at auction.

NHTSA (2008e), DeYoung (2013b), and Voas, Fell, McKnight, and Sweedler (2004) give an overview of vehicle and license plate sanctions and are the basic references for the information provided below. See also Brunson and Knighten (2005), Practice #4, and Neuman, Pfefer, Slack, Hardy, and Waller(2003), Strategies B1, B2, and C1. All vehicle and license plate sanctions require at least several months to implement.

Use, effectiveness, and costs:

- Special license plates: Special license plates are permitted in Georgia, Hawaii, Michigan, Minnesota, New Jersey, and Ohio (Voas, McKnight, Falb, & Fell, 2008). Ohio requires special plates for all first-time offenders with BACs of .17 and above and for all repeat offenders. Effectiveness and costs have not been evaluated in any State. In the 1990s, Oregon and Washington adopted a version of this strategy by allowing arresting officers to place a "zebra stripe" sticker on the license plate at the time of arrest. Oregon's program proved effective in reducing DWI recidivism but Washington's did not. Use has been discontinued in both States (Neuman, Pfefer, Slack, Hardy, & Waller, 2003, Strategy B1; NHTSA, 2008e).
- License plate impoundment: License plate impoundment is used in at least 9 States (NHTSA, 2016a). In Minnesota, license plate impoundment administered by the arresting officer was shown to reduce both recidivism and driving with a suspended license, especially among the youngest offenders (Leaf & Preusser, 2011; Rogers, 1995). Since plate impoundment does not involve the courts, it occurs quickly, consistently, and efficiently (Neuman, Pfefer, Slack, Hardy, & Waller, 2003, Strategy B2; NHTSA, 2008e; NTSB, 2000). Nine States allow for impounding a vehicle's registration (NHTSA, 2016a).
- Vehicle immobilization: Laws in 16 States allow vehicle immobilization (Voas et al., 2008). An evaluation in Ohio found that immobilization reduced recidivism (Voas, Tippetts, & Taylor, 1998). Costs are minimal compared to impoundment or forfeiture (Neuman, Pfefer, Slack, Hardy, & Waller, 2003, Strategy C1; NTSB, 2000).

- Vehicle impoundment: Twenty-Seven States and the District of Columbia allow for vehicle impoundment and some use it extensively (Voas et al., 2008). Vehicle impoundment reduces recidivism while the vehicle is in custody and to a lesser extent after the vehicle has been released. The strategy is costly, as storage fees can be $20 daily and owners may abandon low-value vehicles rather than pay substantial storage costs (Neuman, Pfefer, Slack, Hardy, & Waller, 2003, Strategy C1; NTSB, 2000). In California, impoundment programs are administered largely by towing contractors and supported by fees paid when drivers reclaim their vehicles or by the sale of unclaimed vehicles. An evaluation of California's impoundment law found both first-time and repeat offenders whose vehicles were impounded had fewer subsequent arrests for driving with a suspended license and fewer crashes (DeYoung, 1997).
- Vehicle forfeiture: 29 States have provisions allowing vehicle forfeiture for impaired driving and/or driving with a suspended license (NHTSA, 2016a); however, there is little information on its use or effectiveness. Vehicle forfeiture programs must pay storage costs until the vehicles are sold or otherwise disposed (Neuman, Pfefer, Slack, Hardy, & Waller, 2003, Strategy C1; NTSB, 2000).

Other issues:

- **To whom are vehicle sanctions applied:** Most vehicle sanctions have been applied to repeat offenders rather than first offenders, although some States also apply vehicle sanctions to high-BAC first offenders (e.g., BACs of .15 or higher). If someone other than the offender owns the vehicle, the vehicle owner should be required to sign an affidavit stating they will not allow the offender to drive the vehicle while the suspension is in effect (NHTSA, 2008e).
- **Administrative issues:** All license plate and vehicle sanctions require an administrative structure to process the license plates or vehicles. Laws should permit officers to impound vehicles or license plates at the time of arrest so offenders do not have the opportunity to transfer vehicle ownership (NHTSA, 2008e).

4.4 DWI Offender Monitoring

Effectiveness: ★★★★†	Cost: $$$	Use: Unknown	Time: Varies

† Proven for reducing recidivism

The most successful methods for controlling convicted DWI offenders and reducing recidivism have the common feature that they monitor offenders closely. Note that while these methods monitor sobriety, they do not actually prevent someone from drinking or driving the vehicle. Close monitoring can be accomplished at various levels and in various ways, including a formal intensive supervision program, home confinement with electronic monitoring, and dedicated detention facilities. South Dakota's 24/7 Sobriety Project is one example of an intensive supervision program. Participants are usually multiple offenders who are required to use no alcohol or drugs as a condition of remaining in the community and avoiding incarceration. The program includes twice daily breath testing, transdermal devices that monitor for alcohol consumption, and random drug testing. If an offender tests positive for alcohol or drugs, they are taken into custody and appear before a judge within 24 hours. The goal of the program is to ensure that sanctions are swift and certain. South Dakota's 24/7 Sobriety Project has been adopted in additional States including: Idaho, Montana, North Dakota, Washington, and Wyoming.

For overviews of DWI offender monitoring and further references, see Century Council (2008) and Goodwin et al. (2005, Strategy D4). See also Wiliszowski, Fell, McKnight, and Tippetts (2011) for more information about intensive supervision programs and descriptions of eight different programs, and Fisher, McKnight, and Fell (2013) for additional details about South Dakota's 24/7 Sobriety Project. Information about transdermal alcohol monitoring, including six case studies, can be found in McKnight, Fell, and Auld-Owens (2012). DWI courts and alcohol ignition interlocks, which are discussed in Chapter 1, Sections 3.1 and 4.2, also assist in monitoring offenders closely. Finally, guidelines for community supervision of DWI offenders are available from NHTSA (Dunlap, Mullins, & Stein, 2008).

Use: Little data is available showing how extensively these programs are used. The most commonly used transdermal device is SCRAM (Secure Continuous Remote Alcohol Monitoring). In 2011, there were approximately 50,000 persons being monitored with SCRAM devices in the United States, roughly two-thirds of whom were DWI offenders (Fell & McKnight, 2013). In total, 49 States have used the SCRAM device with at least some offenders, and 34 States have used the device with more than 1,000 offenders (Fell & McKnight, 2013). The number of States using other types monitoring programs and devices is unknown.

Effectiveness: Intensive supervision programs, home confinement with electronic monitoring, and dedicated detention facilities all have been evaluated in individual settings and show substantial reductions in DWI recidivism. Studies examining the effectiveness of the 24/7 Sobriety Program implemented in North and South Dakota have found reductions in recidivism among participants enrolled in the program for DWI convictions (Kilmer, Nicosia, Heaton, & Midgette, 2013; Kubas, Kayabas, & Vachal, 2015; Loudenburg, Drube, & Leonardson, 2010). In South Dakota, implementation of the 24/7 Sobriety Program resulted in a 12% decrease in repeat DWI arrests, and a 4% decrease in collisions by participants (Kilmer, Nicosia, Heaton, &

Midgette, 2013). In other studies, recidivism was reduced by one-half in an intensive supervision program in Oregon (Lapham, Kapitula, C'de Baca, & McMillan, 2006) and by one-third in an electronic monitoring program in Los Angeles County, California (Brunson & Knighten, 2005; Jones, Wiliszowski, & Lacey, 1996). A dedicated detention facility in Baltimore County had a 4% recidivism rate 1 year after program completion, compared to a normal recidivism rate of 35% for offenders (Century Council, 2008).

A recent study examined the effectiveness of Intensive Supervision Programs in Nebraska and Wisconsin. These programs used SCRAM to provide continuous monitoring of sobriety for drivers that had alcohol-related offenses (Tison et al., 2015). Offenders assigned to SCRAM were matched to a control group of comparable offenders that were not assigned to SCRAM. Recidivism, measured as re-arrests for an alcohol offense during the first two years following arrest, occurred at a slightly higher rate in the SCRAM group relative to the control group in both States (7.6% versus 6.2% in WI; 9.8% versus 7.7% in NB, neither of which were statistically significant). However, a significant positive outcome was that there was virtually no recidivism while on SCRAM, and the SCRAM offenders who did recidivate remained compliant longer than offenders in the control group (360 versus 271 days in WI; 458 versus 333 days in NE). The authors noted that the SCRAM population may represent a particularly high-risk group of offenders, thus higher long-term recidivism was expected.

Costs: All close monitoring programs are more expensive than the standard high-caseload and low-contact probation but less expensive than jail. Offenders in 24/7 programs typically pay $4 per day for breath testing, while electronic monitoring fees typically range from $5 to $10 per day (Fell & McKnight, 2013). A goal of 24/7 programs is to be self-sufficient (i.e., entirely funded by offenders). New Mexico estimated that intensive supervision costs $2,500 per offender per year compared to $27,500 per offender per year for jail (Century Council, 2008). Dedicated detention facility costs can approach jail costs: $37 per day in the Baltimore County dedicated detention facility compared to $45 per day for jail (Century Council, 2008). Offenders can bear some program costs, especially for the less expensive alternatives (Century Council, 2008).

Time to implement: All close monitoring programs require many months to plan and implement. Dedicated facilities require years to plan and build.

4.5 Lower BAC Limits for Repeat Offenders

Effectiveness: ★★★★	Cost: $	Use: Low	Time: Short

All States now have an illegal per se BAC limit of .08. Utah has enacted a .05 law, but it will not go into effect until December 30, 2018. All States also have a BAC limit of .02 or lower for drivers under 21. These laws reinforce the minimum drinking age 21 laws in all States that prohibit people under 21 from purchasing or possessing alcohol in public. As of 2015, 4 States set BAC limits of .02 or .04 for people convicted of DWI to emphasize that they should not be driving after drinking even moderate amounts (NCSL, 2015).

Use: Four States have lowered BAC limits for people convicted of DWI (NCSL, 2015).

Effectiveness: In 1988, Maine established a .05 g/dL BAC limit for 1 year after a first DWI offense and for 10 years after a subsequent offense. Violators received an administrative license suspension. In 1995, this BAC limit was lowered to .00. Hingson, Heeren, and Winter (1998) evaluated the 1988 law and concluded that it reduced the proportion of repeat offender drivers in fatal crashes by 25%. Jones and Rodriguez-Iglesias (2004) evaluated the overall effects of both laws, using data from 1988-2001. They also concluded that the laws contributed to a reduction in the proportion of repeat offenders in fatal crashes, primarily due to a reduction in drivers at BACs of .10 and higher.

Costs: Implementation and operation costs are minimal. Jones and Rodriguez-Iglesias (2004) found that Maine's laws had little or no effect on the operations of the DWI control system.

Time to implement: Lower BAC limit laws can be implemented as soon as legislation is enacted.

Other issues:

- **Lower BAC limits for *all* drivers:** Laboratory studies show impairment in driving ability begins at levels below .08 g/dL BAC. Consequently, many countries, and some U.S. jurisdictions (e.g., Colorado and West Virginia), impose penalties for all drivers who have BACs of .05 or higher (not just repeat offenders). Evaluations from other countries suggest lower BAC limits reduce alcohol-impaired crashes (NHTSA, 2003b). For example, a law introduced in British Columbia, Canada, in 2010 included an administrative three-day license suspension and possible vehicle impoundment for drivers with BAC levels from .05 to .08. The law was intended to maximize deterrence by increasing the certainty and swiftness of sanctions. In the year after the law took effect, there was a 40% decrease in alcohol-related fatal crashes (Macdonald et al., 2013). Moreover, roadside surveys revealed a 44% decrease in drivers with BACs of .05 or higher, and a 59% decrease in drivers with BACs over .08 (Beirness & Beasley, 2014). In sum, administrative penalties beginning at .05 g/dL BAC appear to increase deterrence among the general population without creating an additional burden on the court system. A small majority (63%) of drivers in the United States support lowering the BAC limit for all drivers from .08 to .05 (AAA Foundation, 2014). The National Transportation Safety Board (NTSB) has recommended a BAC level of .05 for all drivers (NTSB, 2013).

5. Prevention, Intervention, Communications, and Outreach

Prevention and intervention.

Prevention and intervention strategies seek to reduce drinking, or to prevent driving by people who have been drinking. Prevention and intervention work through laws, policies, and programs that:

- control hours, locations, and promotions of alcohol sales;
- implement responsible alcohol service practices;
- control alcohol purchase and use through increased alcohol taxes and restrictions on consumption in public locations such as parks and sports facilities; or
- provide alternatives to driving for people who have been drinking.

Prevention and intervention measures are especially important for those under 21 years old. These are discussed in the Youth section that follows, with further discussion of one and two star countermeasures included in Appendix A1.

Many prevention and intervention measures fall under the authority of a State's alcohol control board rather than the SHSO. However, the SHSO can be a critical partner in many prevention and intervention activities. Only countermeasures directly associated with drinking and driving are discussed in this section. For information regarding more general countermeasures directed at alcohol, see Grube and Stewart (2004), Toomey and Wagenaar (1999), and Alcohol Epidemiology Program (2000).

Communications and outreach.

Communications and outreach strategies seek to inform the public of the dangers of driving while impaired by alcohol and to promote positive social norms of not driving while impaired. As with prevention and intervention, education through various communications and outreach strategies is especially important for youth under 21 years old. Education may occur through formal classroom settings, news media, paid advertisements and public service announcements, and a wide variety of other communication channels such as posters, billboards, web banners, and the like.

Communications and outreach strategies are a critical part of many deterrence and prevention strategies. This section discusses only stand-alone communications and outreach countermeasures.

5.1 Alcohol Screening and Brief Intervention

Effectiveness: ★★★★★	Cost: $$	Use: Medium	Time: Short

Alcohol screening uses a few questions to estimate the level and severity of alcohol use and to determine whether a person may be at risk of alcohol misuse or dependence (SAMHSA, 2007). Brief interventions are short, one-time encounters with people who may be at risk of alcohol-related injuries or other health problems. Brief interventions focus on the awareness of the problem and motivation toward behavior change (SAMHSA, 2015). The combination of alcohol screening and brief intervention is most commonly used with injured patients in emergency departments or trauma centers. Patients are screened for alcohol abuse problems and, if appropriate, are counseled on how alcohol can affect injury risk and overall health. Patients also may be referred to a follow-up alcohol treatment program. Brief interventions take advantage of a “teachable moment” when a patient can be shown that alcohol use can have serious health consequences.

Higgins-Biddle and Dilonardo (2013) and Dill, Wells-Parker, and Soderstrom (2004) provide a summary of alcohol screening and brief intervention studies. Also, NHTSA and the American Public Health Association (APHA) have produced an alcohol and brief intervention guide for public health practitioners (Guard & Rosenblum, 2008). Finally, NHTSA offers a toolkit to assist in conducting screening and brief intervention on college campuses (Quinn-Zobeck, 2007).

Use: Approximately one-half of trauma centers screen patients for alcohol abuse problems and one- third use some form of brief intervention (Goodwin et al., 2005, Strategy A4; Schermer et al., 2003). Alcohol screening and brief interventions also are used in colleges, primary care medical facilities, and social service settings (Goodwin et al., 2005, Strategy A4). Brief interventions have also been used to reduce DWI among young adults and adolescents (Tanner-Smith & Lipsey, 2015).

Effectiveness: Many studies show that alcohol screening and brief interventions in medical facilities can reduce drinking and self-reported driving after drinking (D’Onofrio & Degutis, 2002; Moyer, Finney, Swearingen, & Vergun, 2002; Wilk, Jensen, & Havighurst, 1997). Dill et al. (2004) reviewed nine studies that evaluated alcohol screening and brief intervention effects on relevant outcomes, such as personal alcohol use and motor vehicle collision injuries. These studies generally found that alcohol screening and brief interventions reduced both drinking and alcohol-related traffic crashes and injuries. In their 2015 meta-analysis, Steinka-Fry, Tanner-Smith, and Hennessy examined the effectiveness of brief interventions in reducing driving after drinking among adolescents and young adults 11 to 25 years old. Based on 12 studies reported in 30 documents, results indicated that brief interventions were associated with modest, but positive reductions in driving after drinking and the related consequences among young adults and adolescents. They also suggest that brief interventions may constitute a cost-effective preventative approach for addressing drinking and driving, which is widespread in these age groups.

Costs: Alcohol screening and brief interventions in medical facilities require people with special training to administer the intervention. However, several studies show the intervention is cost effective, and substantially reduces future health care costs (e.g., hospital and emergency room visits) (Guard & Rosenblum, 2008).

Time to implement: Procedures for alcohol screening and brief interventions are readily available from APHA (Guard & Rosenblum, 2008), the American College of Emergency Physicians (ACEP, 2006), and the National Institute on Alcohol Abuse and Alcoholism (NIAAA, 2005), and can be implemented as soon as staff is identified and trained.

Other issues:

- **Alcohol exclusion laws:** An alcohol exclusion law (Uniform Accident and Sickness Policy Provision Law or UPPL) allows insurance companies to deny payment to hospitals for treating patients who are injured while impaired by alcohol or a non-prescription drug (NHTSA, 2008f). These laws may cause hospitals to be reluctant to determine the BACs of injured drivers and may limit the use of alcohol screening (although screening does not measure the patient's BAC). As of May 2015 alcohol exclusion laws were in effect in 37 States (GHSA, 2015b), though the extent to which insurance companies deny payment is, at best, sporadic.

5.2 Mass Media Campaigns

Effectiveness: ★★★	Cost: $$$	Use: High	Time: Medium

A mass media campaign consists of intensive communications and outreach activities regarding alcohol-impaired driving that use radio, television, print, and other mass media, both paid and/or earned. Mass media campaigns are a standard part of every State's efforts to reduce alcohol-impaired driving. Some campaigns publicize a deterrence or prevention measure such as a change in a State's DWI laws or a checkpoint or other highly visible enforcement program. Others promote specific behaviors such as the use of designated drivers, illustrate how impaired driving can injure and kill, or simply urge the public not to drink and drive. Campaigns vary enormously in quality, size, duration, funding, and many other ways. Effective campaigns identify a specific target audience and communications goal and develop messages and delivery methods that are appropriate to – and effective for – the audience and goal (Williams, 2007).

Use: Most States use some form of alcohol-impaired-driving mass media campaign every year. Mass media campaigns are an essential part of many deterrence and prevention countermeasures that depend on public knowledge to be effective.

Effectiveness: Most mass media campaigns are not evaluated. Elder et al. (2004) studied the few available high-quality evaluations. The campaigns being evaluated were carefully planned, well-funded, well-executed, achieved high levels of audience exposure (usually by using paid advertising), had high-quality messages that were pre-tested for effectiveness, and were conducted in conjunction with other impaired-driving activities. These mass media campaigns were associated with a 13% reduction in alcohol-related crashes. In general, mass media outreach works best when it is one part of a multifaceted campaign that includes HVE (See Sections 2.1, 2.2 in this chapter). Levy, Compton, and Dienstfrey (2004) documented the costs and media strategy of a high-quality national media campaign and its effects on driver knowledge and awareness.

Costs: High-quality and effective mass media campaigns are expensive. Funds are needed for market research, design, pre-testing, and production. Paid advertising expenses depend on the media chosen and the media markets needed to reach the target audience.

Time to implement: A high-quality mass media campaign will require at least 6 months to research, plan, produce, and distribute.

Other issues:

- **Campaign quality:** Poor-quality or stand-alone campaigns that are not tied to program activities are unlikely to be effective. Similarly, although public service announcements are a relatively inexpensive way to deliver messages about impaired driving, they are likely to be aired infrequently, reach small audiences, miss the target audience and have little or no effect. To be successful, mass media campaigns must be carefully pre-tested, communicate information not previously known, be long-term, and have substantial funding (Williams, 2007).
- **Comprehensive media strategy:** Mass media campaigns should be planned as part of an

overall communications and outreach strategy that supports specific impaired-driving activities, such as enforcement.

- **Fear appeals:** A common approach in media campaigns is to provoke fear or anxiety by depicting the severe negative consequences of impaired driving (e.g., injuries/deaths; grieving family members). Although commonly used, the evidence suggests this approach can potentially *increase* undesirable behaviors (Wundersitz, Hutchinson, & Wooley, 2010). For this reason, fear appeals should be used with caution and other types of approaches should be considered first.
- **Social norms campaigns:** Social norms marketing campaigns are a more recent approach to reducing alcohol-related crashes. They are built on the premise that an individual's behavior is influenced by his or her perceptions of how most people behave. A study in Montana demonstrated the potential effectiveness of this approach. Surveys of young adults 21 to 34 years old in Montana revealed that only 20% had driven in the previous month after consuming two or more alcoholic drinks, although more than 90% thought their peers had done so. Based on this finding, a paid media campaign was developed with the normative message, "MOST Montana Young Adults (4 out of 5) Don't Drink and Drive." By the end of the campaign, there was a 13.7% difference in young adults who reported driving after drinking relative to a comparison community (Linkenbach & Perkins, 2005). During the campaign, reported drunk driving among young adults in target counties decreased from 22.9% to 20.9%, while the percentage in non-targeted counties increased from 16.9% to 28.6% (Linkenbach & Perkins, 2005).
- **Social media:** NHTSA and some States have begun using social networking sites to reach the general public with messages concerning alcohol-impaired driving. Although sites such as Facebook, Twitter, and YouTube can effectively and inexpensively reach large numbers of people, there are no evaluations of alcohol-impaired-driving campaigns that use this approach. Similar to mass media campaigns and other types of communication described above, social media is unlikely to be effective as a stand-alone strategy; however, it may be a useful approach when combined with other communications to support specific impaired-driving activities.

5.3 Responsible Beverage Service

Effectiveness: ☆☆	Cost: $$	Use: Medium	Time: Medium

This countermeasure covers a range of alcohol sales policies and practices that prevent or discourage restaurant and bar patrons from drinking to excess or from driving while impaired by alcohol. This includes both server training programs and management policies.

Effectiveness Concerns: *This countermeasure is widely used. Its effectiveness has been examined in several research studies; however, server training programs are the only segment of responsible beverage service for adults that has been adequately documented and evaluated. Research suggests that server training programs can be effective if they involve intensive, high-quality, face-to-face server training that is accompanied by strong and active management support (Shults et al. 2001). When server training programs are not intensive and are not supported, they are unlikely to result in greater refusals of service to intoxicated patrons. Despite these positive research findings, the balance of evidence regarding countermeasure effectiveness remains inconclusive.*

Further information about the known research, potential effectiveness, costs, use, and time to implement are available in Appendix A1, Section 5.3.

5.4 Alternative Transportation

Effectiveness: ☆☆	Cost: $$	Use: Unknown	Time: Short

This countermeasure covers methods by which people can get to and from places where they drink without having to drive. Alternative transportation supplements normal public transportation provided by subways, buses, taxis, and other means. Most of these programs operate only for short periods of the year, such as the Christmas and New Year's holidays.

Effectiveness Concerns: *This countermeasure has only been examined in a few studies. Although some of the studies report reductions in crash rates, there is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement are available in Appendix A1, Section 5.4.

5.5 Designated Drivers

Effectiveness: ☆☆	Cost: $	Use: Medium	Time: Short

Designated drivers are people who agree not to drink so they can drive their friends who have been drinking. Formal designated driver programs in drinking establishments provide incentives such as free soft drinks for people who agree to be designated drivers. Usually, designated driver arrangements are completely informal. Designated driver programs focus on specific actions taken at drinking establishments, which contrast with designated driver mass media campaigns that seek to generally raise awareness of this countermeasure and promote its informal use among the general driving population (see Section 5.2)

Effectiveness Concerns: *The countermeasure effectiveness has been examined in a few research studies. There have been some positive research findings in terms of driver awareness of the countermeasure. However, the balance of evidence regarding the effectiveness of this countermeasure in reducing crashes remains inconclusive.*

Further information about the known research, potential effectiveness, costs, use, and time to implement are available in Appendix A1, Section 5.5.

6. Underage Drinking and Drinking and Driving

Teenagers drink and drive less often than adults, but they are more likely to crash when they do drink and drive (Williams, 2003). Teenagers' brains are still developing, and they are inexperienced with both driving and drinking. Consequently, they have a higher crash risk at all BAC levels than adult drivers (Mayhew et al., 1986; Zador, Krawchuck, & Voas, 2000). Alcohol-related crashes among teenagers are typically associated with driving at nighttime, on weekends, and with passengers (Bingham, Shope, Parow, & Raghunathan, 2009).

Many of the countermeasures described in previous sections of this chapter apply not only to adults, but to teenagers as well. However, there are some countermeasures to reduce drinking and alcohol-related crashes that are directed specifically to those under 21 years old.

Since 1988, minimum-drinking-age laws in all States prohibit youth under 21 from possessing alcohol. Most States also prohibit minors from purchasing and consuming alcohol beverages. These laws influence all youth impaired-driving strategies. For people 21 and older, drinking is legal, but driving with a BAC of .08 or higher is not. The message for those under 21 is unambiguous: they should not be drinking at all, and they certainly should not be driving after drinking.

Zero-tolerance laws in all States reinforce this message by setting a maximum BAC limit of .02 or less for drivers under 21. This effectively prohibits driving after drinking any amount of alcohol. Presently, zero-tolerance laws are not actively publicized or enforced by many States. In addition, compliance checks of alcohol vendors can reduce the availability of alcohol to those under 21, though again this strategy is not used as widely as it could be. There are many other policies and programs reinforcing the no-drinking message that are directed primarily at adults (beer keg registration, social host liability) or take place in schools or youth organizations (Students Against Destructive Decisions [SADD] chapters, alcohol-free prom and graduation parties). Youth receive education and information about alcohol and alcohol-impaired driving in schools and colleges, through licensing agencies, and through media directed to youth.

The minimum-drinking-age laws and the no-drinking message for youth mean that youth impaired-driving activities must work hand-in-hand with activities to control youth drinking. With the exception of zero-tolerance law enforcement and alcohol vendor compliance checks, many of the countermeasures discussed next require cooperative activities between traditional highway safety organizations, such as law enforcement and motor vehicle departments, and community, health, and educational organizations with a social agenda broader than traffic safety.

6.1 Minimum Legal Drinking Age 21 Laws

Effectiveness: ★★★★★	Cost: $	Use: High	Time: Low

The primary strategy to reduce underage drinking, as well as drinking and driving, has been restricting access to alcohol via minimum purchase age laws. Since July 1988, the minimum legal drinking age (MLDA) has been 21 in all States. There is strong evidence that MLDA-21 laws reduce drinking, driving after drinking, and alcohol-related crashes and injuries among youth (Hingson et al., 2004; McCartt, Hellinga, & Kirley, 2010; Shults et al., 2001; Wagenaar & Toomey, 2002). In fact, MLDA-21 laws reduced youth drinking and driving more than youth drinking alone (using the measurements of self-reporting and testing of impaired drivers in fatal crashes). Drinking and driving has become less socially acceptable among youth, and more youth have separated their drinking from their driving (Hedlund et al., 2001).

The implementation of MLDA-21 laws for alcohol vendors, adults, and youth differ substantially from State to State. See the Alcohol Policy Information System (APIS) for State-by-State summaries of some of the key provisions: http://alcoholpolicy.niaaa.nih.gov/State_Profiles_of_Underage_Drinking_Laws.html.

Use: The minimum age to purchase alcohol is 21 years old in all 50 States and the District of Columbia.
Effectiveness: Several reviews point to the effectiveness of MLDA-21 laws. Shults et al. (2001) identified 33 published studies examining the effects of changing the legal drinking age. Overall, changes to the MLDA affected alcohol-related crashes by 10% to 16%, with crashes decreasing when the MLDA was raised, and increasing when it was lowered. Wagenaar and Toomey (2002) reviewed 79 high-quality studies examining the relationship between the MLDA and crashes. Of these studies, 58% found fewer crashes associated with a higher MLDA, whereas none found fewer crashes associated with a lower MLDA. These findings prompted McCartt, Hellinga, and Kirley (2010) to conclude: "The highway safety benefits of MLDA-21 have been proven, and the cause and effect relationship between MLDA and highway crashes is clear. Deaths go up when the drinking age is lowered, and they go down when it is raised" (p. 180). NHTSA estimates that MLDA-21 laws have saved 30,860 lives since 1975, and an estimated 537 lives in 2015 alone (NCSA, 2017).

Costs: There are no direct costs of MLDA-21 laws. Costs may be needed for enforcement of MLDA-21 laws. (See Chapter 1, Sections 6.2 and 6.3).

Time to implement: MLDA-21 laws can be implemented as soon as appropriate legislation is enacted.

Other issues:

- **Repealing MLDA-21 laws:** From 2007 to 2010, six States introduced legislation allowing at least some people under 21 to purchase and consume certain types of alcoholic beverages (McCartt et al., 2010). To date, none of these bills have passed. Perhaps the most notable (and highly publicized) effort to lower the MLDA was a statement signed by approximately 120 college and university presidents in 2008 suggesting the MLDA be lowered to 18. This group questioned the validity of MLDA-21 research, and advocated for education in place of laws to reduce drinking among young people. Many organizations, including NHTSA, have opposed lowering the legal drinking age. There has been more research on the MLDA than perhaps any other alcohol-control policy (Wechsler & Nelson, 2010). Most traffic safety experts have concluded that MLDA-21 laws are effective, and they recommend strengthening enforcement of MLDA-21 laws and establishing policies to support them. For further discussion of this issue, see Wechsler and Nelson (2010) and McCartt, Hellinga, and Kirley (2010).

6.2 Zero-Tolerance Law Enforcement

Effectiveness: ★★★	Cost: $$	Use: Unknown	Time: Short

Zero-tolerance laws set a maximum BAC of .02 or less for drivers under 21 years old. Violators have their driver's licenses suspended or revoked. There is strong evidence that zero-tolerance laws reduce alcohol-related crashes and injuries (Voas & Lacey, 2011; Goodwin et al., 2005, Strategy B3; Shults et al., 2001). Fell, Fisher, Voas, Blackman, and Tippetts (2009) estimate that zero-tolerance laws save 159 lives each year.

However, zero-tolerance laws often are not actively enforced or publicized (Hedlund et al., 2001; Voas & Lacey, 2011). Studies have found that young drivers are not arrested in proportion to their involvement in alcohol-related crashes (Hingson, Assailly, & Williams, 2004). One exception is the State of Washington, where a study found that arrests for alcohol violations among 16- to 20-year-old drivers increased by about 50% after the zero-tolerance law went into effect (McCartt, Blackman, & Voas, 2007). Enforcement may be greater in Washington because the law allows officers to request a test for alcohol based on suspicion of either a DWI or zero-tolerance offense. In other States where drivers can only be tested if DWI is suspected, zero-tolerance laws may be more difficult to enforce.

Use: Zero-tolerance laws have been in effect in all States since 1998. The degree to which zero-tolerance laws are enforced in States is unknown.

Effectiveness: An early study in Maryland found that alcohol-involved crashes for drivers under 21 dropped by 21% in six counties after the zero-tolerance law was implemented. After the law was publicized extensively, these crashes dropped by an additional 30% (Blomberg, 1992). No other studies have examined the effect of increasing enforcement and publicity for an existing zero-tolerance law. Lacey, Jones, and Wiliszowski (2000) documented how zero-tolerance laws are administered and enforced in four States. Highly publicized enforcement has proven effective in increasing compliance with many traffic safety laws and reducing crashes and injuries: see for example sobriety checkpoints (Chapter 1, Section 2.1) and seat belt use mobilizations (Chapter 2, Section 2.1).

Costs: Zero-tolerance laws can be enforced during regular patrols or during special patrols directed at times and areas when young impaired drivers may be present. Enforcement will require moderate costs for appropriate training, publicity, and perhaps equipment (see Other Issues).

Time to implement: Enforcement programs can be implemented within three or four months, as soon as appropriate training, publicity, and equipment are in place.

Other issues:

- **Zero-tolerance-law provisions:** Zero-tolerance laws are far easier to enforce if the offense is an administrative rather than criminal violation, and if law enforcement officers can use PBTs (preliminary breath test devices) at the roadside to determine if the law has been violated and, if so, to seize the driver's license (Jones & Lacey, 2001).

Some State laws require the same probable cause as for a standard DWI arrest, or even require a full DWI arrest, before a BAC test for a zero-tolerance-law violation can be administered. In these States, the zero-tolerance law is not enforced independently of the standard DWI law, and in fact young drivers may not be aware of the zero-tolerance law (Hingson et al., 2004).

- **PBT and PAS:** Preliminary breath test devices (PBTs) are important to effective and efficient enforcement in States that allow PBT use for zero-tolerance laws. A passive alcohol sensor (PAS) can help officers detect violators who have consumed alcohol. See Chapter 1, Sections 2.3 and 2.4.
- **Holding juveniles in custody:** A complication of enforcing zero-tolerance laws is deciding how and where to hold young offenders once they are taken into custody. NHTSA helped produce an implementation guide for developing a juvenile holdover program (NHTSA, 2001).

6.3 Alcohol Vendor Compliance Checks

Effectiveness: ★★★†	Cost: $$	Use: Unknown	Time: Short

† Proven for reducing sales to underage people

In all 50 States, alcohol venders are required to verify the age of young customers to be sure they are at least 21 years old. However, several studies suggest young people can obtain alcohol without much difficulty. Across various studies, young buyers successfully purchased alcohol in 44% to 97% of attempts without showing identification (Goodwin et al., 2005, Strategy A3). To reduce the likelihood that alcohol vendors sell alcohol to underage people, law enforcement officers can conduct frequent compliance checks. In a compliance check or “sting,” law enforcement officers watch as underage people attempt to purchase alcohol and cite the server or vendor for an MLDA-21 violation if a sale is made. Vendors can include on premise retailers (e.g., bars and restaurants) or off-premise outlets (e.g., convenience stores or liquor stores).

An effective compliance check program works primarily through deterrence. The goal is to increase the perception among vendors they will be caught if they sell alcohol to underage people. To maximize deterrence, compliance checks should be:

- Conducted frequently and on an unscheduled basis. Vendors should know that compliance checks are taking place, but should not know exactly when they will occur.
- Conducted at all vendors, not just a sample of vendors in the community. One study showed the benefits of compliance checks did not generalize to vendors who were not checked (Wagenaar, Toomey, & Erickson, 2005).
- Well-publicized among vendors and the community at large. This will discourage young people from trying to obtain alcohol, and encourage vendors to put policies and procedures in place that prevent the sale of alcohol to underage customers.
- Sustained over time. The effects of compliance checks decay over a few months, so an ongoing program is needed to maintain deterrence (Wagenaar et al., 2005).

A useful resource on how to conduct compliance checks is the Alcohol Epidemiology Program’s *Alcohol Compliance Checks: A Procedures Manual for Enforcing Alcohol Age-of-Sale Laws*, available at www.aep.umn.edu/wp-content/uploads/2012/04/comp_check_maunal_-updated_2013.docx.

Use: Although many jurisdictions conduct compliance checks of alcohol retailers at least occasionally, few jurisdictions do so frequently or regularly.

Effectiveness: Several studies document that well-publicized and vigorous compliance checks reduce alcohol sales to youth; for example, a review of eight high quality studies found that compliance checks reduced sales to underage people by an average of 42% (Elder et al., 2007). The effect of compliance checks on motor vehicle crashes has not been studied.

Costs: Compliance checks require time from law enforcement. These costs can be supported, in part, through alcohol license fees or fines collected from non- compliant vendors.

Time to implement: Compliance checks can be implemented within 3 months if officers are trained in proper procedures.

Other issues:

- **Penalties for violations:** To increase the likelihood that penalties will be quickly and consistently enforced, all penalties for violations should be administrative in nature (Goodwin et al., 2005, Strategy A3). Also, the penalties must be substantial enough to deter alcohol vendors from selling to underage people. Some States employ graduated penalties for vendors who fail compliance checks, where both fines and suspension periods increase with each violation (Goodwin et al., 2005, Strategy A3).

6.4 Other Minimum Legal Drinking Age 21 Law Enforcement

Effectiveness: ★★★	Cost: Varies	Use: Varies	Time: Varies

MLDA-21 law enforcement is very limited in many communities (Hedlund et al., 2001). Enforcement can take several forms, as summarized by Stewart (1999):

- *Actions directed at alcohol vendors*: compliance checks to verify that vendors will not sell to youth (see Chapter 1, Section 6.3), dram shop liability laws or responsible beverage training laws.
- *Actions directed at youth*: "use and lose" laws that confiscate the driver's license of an underage drinker, "Cops in Shops" directed at underage alcohol purchasers, law enforcement "party patrols" using party dispersal techniques, and penalties for using false identification.
- *Actions directed at adults*: beer keg registration laws, enforcement of laws prohibiting purchasing alcohol for youth, shoulder tap operations, and programs to limit parties where parents provide alcohol to youth.

While these enforcement strategies have been used frequently, few have been evaluated. Several strategies are briefly described below, along with any supporting research evidence.

"Use and lose" laws: These laws allow confiscation of the driver's license or postpone licensure for a period of time for youth who violate a State's MLDA-21 law. Ulmer et al. (2001) investigated "use and lose" law implementation and effects in Pennsylvania. License suspensions for violations of MLDA-21 appeared to reduce subsequent traffic violations and crashes. In a national study, Fell et al. (2009) found "use and lose" laws were associated with a 5% decrease in fatal crashes among underage drivers. The study estimated that 165 lives would be saved each year if all States had these laws. "Use and lose" laws can be implemented quickly and inexpensively once enacted. To be effective, they should be publicized extensively. As of 2016, 29 States and the District of Columbia had mandatory "use and lose" laws and another 10 States had "use and lose" authority that may be applied in varying circumstances (Alcohol Policy Information System, 2016a).

Keg registration laws: These laws link beer keg purchasers to an identification number on the keg, which provides a method of identifying adults who supply beer to parties attended by youth. As of 2015, 29 States and the District of Columbia had mandatory keg registration laws (APIS, 2015). In a study on the effectiveness of these laws, keg registration was shown to be associated with reduced traffic fatality rates in 97 U.S. communities (Cohen, Mason, & Scribner, 2001). However, the authors could not conclude that keg registration *caused* the lower fatality rates. A study by Fell, Scherer, and Voas (2015) found that keg registration laws were associated with a decrease in per-capita beer consumption, but an increase in the ratio of drinking to sober underage drivers involved in fatal crashes.

Media campaigns: Ohio has conducted a statewide media campaign, *Parents Who Host Lose the Most*, since 2000, and it is now also used in other States and communities. The campaign informs parents and youth about Ohio's underage drinking laws and attempts to discourage parents from providing alcohol to underage drinkers at parties. Telephone surveys in 2006 showed that about 55% of parents and youth had heard messages about underage drinking

(Applied Research Center, 2008). About two-thirds of those who had heard a message said that it prompted a conversation between parents and their teenagers about drinking. In comparison with surveys conducted in 2001, there was a 42% decrease among youth who reported knowing of parents who host parties where alcohol is served to teens.

Underage Drinking Tipline: In 2006, Kansas launched a statewide underage drinking tipline: 866-MustB21 and Pennsylvania uses 1-888-UNDER21. The toll-free tiplines operate 24 hours a day, 7 days a week, for citizens to report parties involving underage drinking, plans to purchase alcohol for underage people, and willingness of retailers to sell alcohol to underage people. The effect of the tiplines has not been evaluated. Nebraska introduced a statewide underage drinking tipline in 2009, using the same phone number as Kansas.

Social Host Liability: Under social host laws, adults who host underage drinking parties (specific laws), or who allow underage drinking to occur on their property (general laws), can be held accountable if a young person is subsequently involved in a crash. This liability might discourage adults (parents, older siblings, and friends) from purchasing alcohol for underage people or hosting an underage party. Conducting source investigations, in which law enforcement teams identify the providers of the alcohol, can be resource intensive and time consuming (Curtis & Ramirez, 2011). Moreover, the few research studies that have examined the effect of social host liability laws have obtained conflicting findings (Voas & Lacey, 2011). Nonetheless, comprehensive and well-publicized efforts to hold providers accountable appear to be promising. Social host laws, and their accompanying penalties, vary from State to State. A description of each State’s social host laws may be found in NHTSA’s *Digest of Impaired Driving and Selected Beverage Control Laws* (NHTSA, 2015). Another good resource is available from the Alcohol Policy Information System (2016b).

Comprehensive community programs: Several comprehensive community initiatives have reduced youth drinking and alcohol-related problems (Hingson et al., 2004; Shults et al., 2009). These initiatives typically bring together several community government departments, such as schools, health, and law enforcement, with alcohol sellers, parents, youth, and citizen organizations. They may include school-based programs, law enforcement, media, and other intervention strategies. They require strong leadership and organization. They may take many months to plan and implement. Costs depend on the activities included. One example is a campaign conducted in Huntington, West Virginia, that included checkpoints to look for violations of the MLDA-21 law, checks of alcohol outlets to reduce sales to minors, and publicity for program activities. Roadside surveys conducted before and during the program showed a 93% drop in 16- to 20-year-old drivers having BACs greater than .05 g/dL (IIHS, 2008). Another promising program is Oregon’s *Reducing Youth Access to Alcohol*. The program involves community mobilization including “reward and reminder” visits (where vendors receive rewards if they decline to sell alcohol to a minor), regular compliance checks, enforcement of minor in possession laws, and media advocacy. The program has been effective in reducing the sale of alcohol to minors: successful purchase attempts by minors dropped from 24% before the program to 5% afterwards. Additionally, the individual communities with the strongest programs also experienced reductions in underage drinking (Flewelling et al., 2013). NHTSA has produced a guide on how communities can prevent underage drinking, available at: one.nhtsa.gov/people/injury/alcohol/Community%20Guides%20HTML/Guides_index.html.

6.5 Youth Programs

Effectiveness: ☆☆	Cost: Varies	Use: High	Time: Medium

This countermeasure involves youth drinking-and-driving prevention programs that seek to motivate youth not to drink, not to drink and drive, and not to ride with a driver who has been drinking. Although some programs use scare tactics, many employ positive messages and methods by providing positive role models that discourage alcohol use, promoting positive norms that do not involve alcohol, and encouraging youth activities that do not involve or lead to alcohol use. A more recent type of approach focuses on "social norms" or "normative feedback" that provides students with accurate information about drinking.

Effectiveness Concerns: *This countermeasure has been examined in several research studies. Although there have been some positive research findings, the balance of evidence regarding countermeasure effectiveness remains inconclusive.*

Further information about the known research, potential effectiveness, costs, use, and time to implement are available in Appendix A1, Section 6.5.

7. Drug-Impaired Driving

The impairing effects of alcohol and the dangers of drinking and driving are well-documented. By contrast, there is considerably less research investigating the potentially impairing effects of drugs on drivers. Berning and Smither (2014), Compton, Vegega, and Smither (2009) and Stewart (2006) summarize some of the challenges in studying, measuring, and creating countermeasures to address drug-impaired driving:

- There is a wide range of drugs, both licit and illicit, that can potentially impair driving. Moreover, the list of drugs in common usage is constantly changing.
- Although the relationship between BAC and driving impairment is clear and well-documented, the relationship between blood levels of drugs and driving impairment has not been established for drugs other than alcohol.
- Alcohol leaves the body in a predictable pattern, whereas other drugs are eliminated at many rates; hence, timing is critical when conducting a drug test. In addition, blood levels of certain drugs can accumulate with repeated administrations, and can be detected well after impairment has ceased.
- It is not unusual for drivers to take more than one impairing drug at the same time or to combine drugs with alcohol. Although individual drugs, taken at normal doses, may not impair driving, drug effects may be synergistic when taken together and substantially increase the risk of a crash.
- Alcohol can be measured reliably through breath tests, but other types of drugs can only be measured through more intrusive tests of bodily fluids such as blood, urine, or saliva.

Despite these challenges, a growing body of research suggests that many illicit, prescription, and over-the-counter drugs may impair a driver's ability to operate a vehicle (for reviews, see Couper & Logan, 2004; Jones, Shinar, & Walsh, 2003; and Kelly, Darke, & Ross, 2004). Much of this research has involved laboratory or experimental studies using driving simulators, although some epidemiological studies have examined the effect of drugs on crash prevalence and risk. See Compton et al. (2009) for a discussion of this research.

In most cases, the research investigating the effect of drugs on driving has had variable results, in large part depending on the type of methodology employed. The crash risk associated with specific types of drugs is summarized below.

- **Benzodiazepines:** Common benzodiazepines include Valium, Xanax, and Klonopin. Several studies suggest benzodiazepine users are at increased risk of being involved in a crash (Movig et al., 2004; Rapoport et al., 2009), although some studies have not found these results. The risk appears to depend on the type of benzodiazepine used, the dose, the time since last use, and whether the drug was combined with alcohol (Dassanayake, Michie, Carter, & Jones, 2011; Leung, 2011).
- **Marijuana:** The findings for marijuana also have been mixed, although a recent meta-analysis of epidemiological data concluded marijuana doubles the risk of a property damage or fatal crash (Asbridge, Hayden, & Cartwright, 2012). However, another study found only a 50% increase in the risk of property damage crashes, and no increase in the risk of fatal or injury crashes (Elvik, 2013). A large-scale study in Virginia found no elevated crash risk for THC users after adjusting for demographic variables and alcohol use (Compton & Berning, 2015). Generally, the risk appears highest when marijuana has

been used recently, and especially when marijuana is combined with alcohol (Beirness & Simpson, 2006; Sewell, Poling, & Sofuoglu, 2009).

- **Stimulants:** There have been fewer studies examining the risks of stimulants such as amphetamines and cocaine on driving. The available studies suggest stimulants are strongly associated with fatal crashes (Elvik, 2013).
- **Narcotics:** Several studies have showed that narcotic drugs such as morphine, heroin, and opiates increase crash risk. One case-control study found a three times higher risk of a fatal crash when a driver is under the influence of a narcotic (Li et al., 2013). However, this study used FARS data which has a number of limitations with respect to the interpretation, reporting, and testing of drug impairment in fatal crashes (Berning & Smither, 2014).
- **Antihistamines:** The relationship between antihistamines and motor vehicle crashes is ambiguous (Moskowitz & Wilkinson, 2004). A small connection has been found between first-generation antihistamines and crashes, but second-generation antihistamines appear to cause less sedation.
- **Antidepressants:** Second generation antidepressant medications such as selective serotonin reuptake inhibitors (SSRIs) do not seem to impair driving performance, but this is not necessarily the case with older types of antidepressants (Brunnauer & Laux, 2013).

Compton et al. (2009) describe four basic issues that must be addressed to better understand the extent of the problem of drug-impaired driving:

- What drugs impair driving ability?
- What drug dose levels are associated with impaired driving?
- How frequently are impairing drugs being used by drivers?
- What drugs are associated with higher crash rates?

In sum, there are still sizeable gaps in our understanding of the effects of drugs on driving. In their review of drug-impaired driving, Jones et al. (2003) concluded: "The role of drugs as a causal factor in traffic crashes involving drug-positive drivers is still not understood… Current research does not enable one to predict with confidence whether a driver testing positive for a drug, even at some measured level of concentration, was actually impaired by that drug at the time of crash" (p. 96). Perhaps the one consistent finding across studies is the risk of driver impairment increases substantially when drugs are combined with alcohol.

Similar to alcohol-impaired driving, drug-impaired driving is primarily addressed through a combination of laws, enforcement, and education. Relatively few countermeasures have been developed to address drug-impaired driving, and there has been little evaluation of drug-impaired-driving countermeasures. Much more research is needed to better understand the nature and degree of traffic safety risk posed by drugs, as well as the effectiveness of potential countermeasures to address this issue. See the guide on drug-impaired driving produced by the Center for Problem-Oriented Policing for more information about drug-impaired-driving countermeasures (CPOP, 2012).

7.1 Enforcement of Drug-Impaired Driving

Effectiveness: ★★★	Cost: $$	Use: Unknown	Time: Short

Enforcement of drug-impaired-driving laws can be difficult. Typically, drug-impaired driving is only investigated when a driver is obviously impaired but the driver's BAC is low. If drivers have BACs over the illegal limit, many officers and prosecutors do not probe for drugs as in many States drug-impaired driving carries no additional penalties.

Although several devices are available that allow officers to screen suspects for illegal drug use at point-of-contact, none have been proven to be accurate and reliable (Compton et al., 2009). Many law enforcement agencies employ drug recognition experts (DREs) to assist in investigating potential drug-impaired-driving cases. (NHTSA recommends that DREs participate in HVE activities and checkpoints, and respond to serious and fatal crashes.) DREs use a standardized procedure to observe a suspect’s appearance, behavior, vital signs, and performance on psychophysical and physiological tests to determine whether and what type of drug or drug category may have been used. If drug intoxication is suspected, a blood or urine sample is collected and submitted to a laboratory for confirmation. NHTSA has developed the Advanced Roadside Impaired Driving Enforcement (ARIDE) training, which bridges the gap between the SFST and the DRE training programs. This program is available to those who are already certified to conduct the SFST and requires 16 hours of training (International Association of Chiefs of Police, 2017).

Use: As of August 2014, all 50 States and the District of Columbia had Drug Evaluation and Classification (DEC) programs, which are designed to train officers to become DREs (GHSA, 2015c). These programs have prepared approximately 1,500 instructors and trained more than 8,000 officers (National Sobriety Testing Resource Center, 2016). During 2015, there were 27,000 drug enforcement evaluations conducted by DREs (National Sobriety Testing Resource Center, 2014). This is equivalent to less than four evaluations per DRE. This suggests drug-impaired-driving arrests are not as common in comparison to arrests for alcohol- impaired driving. However, it should be noted that the number of drug-impaired-driving arrests cannot be known as many States only record “impaired-driving” arrests, and do not separate alcohol from drug arrests. Additionally, many arrests are a combination of drugs and alcohol.

Recently, Porath-Waller, and Beirness (2014) investigated the validity of using Standardized Field Sobriety Testing in detecting drug impairment among suspected drug-impaired drivers. Results of their study indicate central nervous system (CNS) stimulants, CNS depressants, narcotic analgesics, and cannabis are significantly associated with impairment on SFST. Specifically, users of all drug types were significantly more likely to sway while balancing and use their arms to maintain balance on the one-leg-stand. Users of CNS depressants, CNS stimulants, and narcotic analgesics were significantly less likely to keep their balance while listening to test instructions on the walk-and-turn test. Finally, users of CNS depressants were significantly more likely to experience lack of smooth pursuit and distinct nystagmus at maximum deviation on the horizontal gaze nystagmus test.

Effectiveness: Several studies have shown DRE judgments of drug impairment are corroborated by toxicological analysis in 85% or more of cases (NHTSA, 1996). However, one experimental laboratory study found DREs' ability to distinguish between impaired and non-impaired people was moderate to poor for several types of drugs including marijuana, codeine, and amphetamines (Shinar, Schechtman, & Compton, 2000). This study showed DREs tended to rely on just one or two "pivotal" cues to identify specific drug impairment. To date, there have been no studies examining the effectiveness of enforcement in reducing drug-impaired driving or crashes.

Costs: As with other enforcement strategies, the primary costs are for law enforcement time and training. The time to conduct a DRE evaluation can be 2 to 3 hours. Training includes 72 hours of classroom instruction and approximately 50 hours of field work.

Time to implement: Drug-impaired-driving enforcement can be integrated into other enforcement activities within 3 months; however, time will be needed to train DREs in detecting drug impairment. DRE training consists of 9 days of classroom instruction, and DRE candidates are also required to perform a number of supervised field evaluations to become certified (Compton et al., 2009).

7.2 Drug-Impaired-Driving Laws

Effectiveness: ☆	Cost: Unknown	Use: Medium†	Time: Short

†Use for drug per se laws

This countermeasure involves laws that prohibit the use of impairing drugs by drivers. This includes impairment-based statutes, which stipulate that prosecution must prove the driver was impaired (for example, by driving recklessly or erratically). It also includes per se laws in which it is illegal to operate a motor vehicle if there is any detectable level of a prohibited drug in a driver's system. Hence, a positive drug test is sufficient for conviction, which is equivalent to "zero tolerance."

Effectiveness Concerns: *To date, there have been no evaluations of the effect of drug-impaired-driving laws on the prevalence of drug-impaired driving or crashes.*

Further information about the known research, potential effectiveness, costs, use, and time to implement are available in Appendix A1, Section 7.2.

7.3 Education Regarding Medications

Effectiveness: ☆	Cost: Unknown	Use: Unknown	Time: Long

This countermeasure involves providing education to physicians, pharmacists, and patients about the potential risk of motor vehicle crashes associated with certain prescription medications. Instruction targeting pharmacists can include modules that cover potentially driver-impairing prescription drugs, laws relating to medication use and DWI, and the role of pharmacists in counseling patients regarding medications and driving risk. More generally, education can also include use of clear warning labels on drug packaging.

Effectiveness Concerns: *This countermeasure has only been examined in a few studies. Although some of the studies report increased awareness by pharmacists of the effects of medication, there is no evidence of increased awareness among drivers. Overall, there is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement are available in Appendix A1, Section 7.3.

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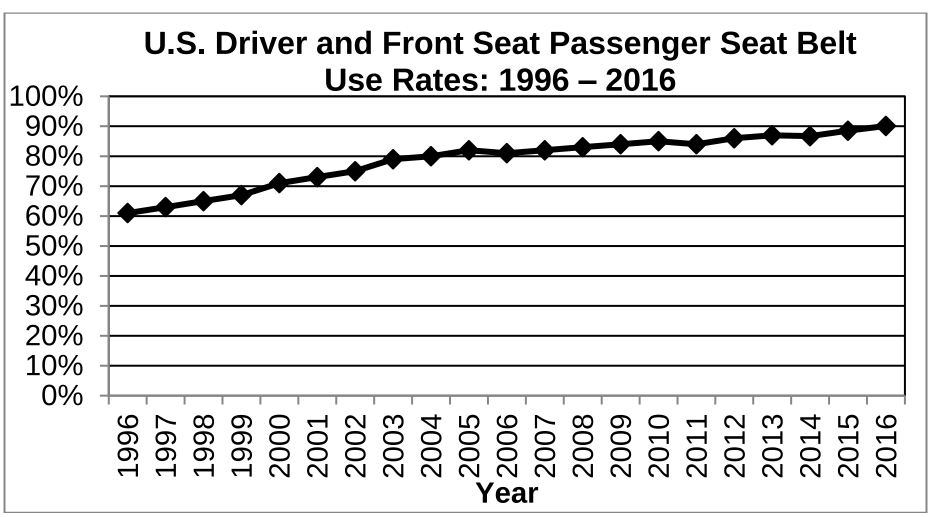
2. Seat Belts and Child Restraints

Overview

Abundant research has shown that correctly using an appropriate child restraint or seat belt is the single most effective way to save lives and reduce injuries in crashes. Lap and shoulder combination seat belts, when used, reduce the risk of fatal injury to front-seat passenger car occupants by 45% and the risk of moderate-to-critical injury by 50% (Kahane, 2015). For light-truck occupants, seat belts reduce the risk of fatal injury by 60% and moderate-to-critical injury by 65% (Kahane, 2015).

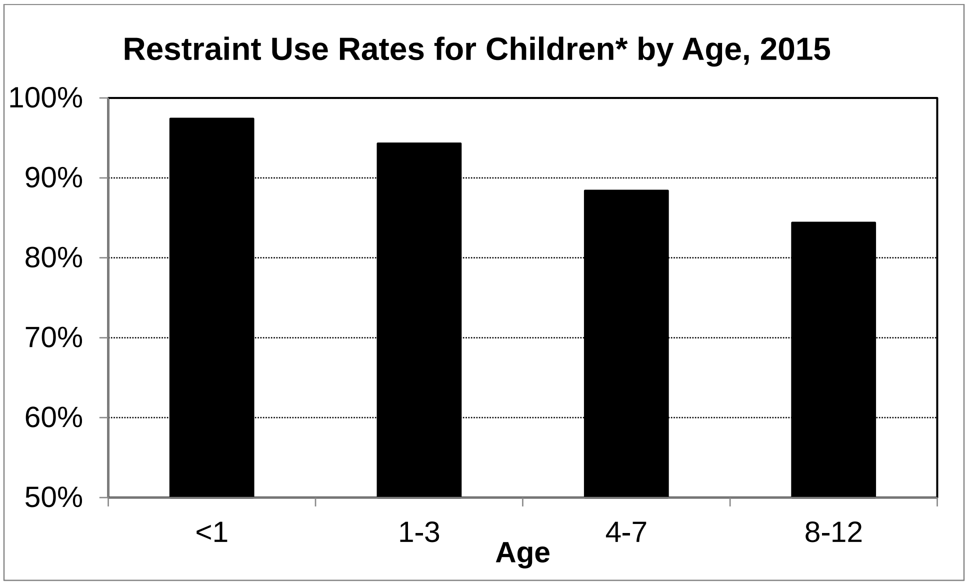
NHTSA estimates that correctly used child restraints are even more effective than seat belts in reducing fatalities. Child restraints reduce fatalities by 71% for infants younger than 1 year old and by 54% for children 1 to 4 years old in passenger cars. In light trucks, the fatality reductions are 58% for infants and 59% for children 1 to 4 years old (NCSA, 1996; Kahane, 2015). In addition, research conducted by the Partners for Child Passenger Safety Program at the Children's Hospital of Philadelphia found that belt-positioning booster seats reduce the risk of injury to children 4 to 8 years in crashes by 45% when compared to the effectiveness of seat belts alone (Arbogast, Jermakian, Kallan, & Durbin, 2009). However, unrestrained children continue to be overrepresented in motor vehicle fatalities, which indicates that additional lives can be saved by increasing restraint use among children (Sauber-Schatz, West, & Bergen, 2014).

Trends. The challenge is to convince all passenger vehicle occupants to buckle up. Current data show that observed daytime seat belt use nationwide was 90.1% in 2016 for adult drivers and right-front seat passengers (Pickrell, 2017). Seat belt use was over 90% in 19 States, the District of Columbia, and one U.S. Territory with 3 States, achieving belt use rates higher than 95% (California, 96.5%; Georgia, 97.2%; and Oregon, 96.2%); however, seat belt use was less than 75% in 2 States (New Hampshire, 70.2%, and South Dakota, 74.2%) (Pickrell, 2017). Nationally, seat belt use has increased dramatically since seat belt use laws went into effect in the early 1980s (Pickrell & Li, 2016). With the exception of 2011, the National seat belt use rate has been steadily increasing since at least 1996.



Source: Pickrell (2017)

In general, overall restraint use for children is higher than what is demonstrated in the adult population, particularly among the youngest children. In 2015, restraint use for children less than 13 years old was 89.2%, down from 91.1% in 2013 (Li, Pickrell, & KC, 2016). Restraint use ranged from 97.4% for infants under 1 year old, to 84.4% for children 8 to 12 (Li, Pickrell, & KC, 2016).



*Restraint use rates do not indicate correct use.
Source: Li, Pickrell, and KC (2016)

However, restraint use for children is more complicated than simply "restrained versus unrestrained." In addition to overall restraint use, it is also important to consider correct restraint use. The current NHTSA recommendations include keeping children rear-facing until the rear-facing capabilities of the car seat are outgrown, then forward-facing with a harness until the harness is outgrown by height or weight, and then booster seat use until the seat belt fits properly on its own (Durbin, Committee on Injury, Violence, and Poison Prevention, 2011; NHTSA, 2014b).

The 2015 National Survey of the Use of Booster Seats (Li, Pickrell, & KC, 2016) details the observed restraint use for children under 1, 1 to 3, 4 to 7, and 8 to 12. Since 2013, the proportion of children riding with the appropriate restraint for their age, size, and weight decreased slightly (Li, Pickrell, & KC, 2016). In 2015, 87.4% of children under 1 were observed in the appropriate rear-facing seats, down from 90.1% in 2013. Rear-facing and eventually forward-facing car seats are appropriate for children 1 to 3. The 2015 NSUBS found that 77.0% of children 1 to 3 used the appropriate restraint, compared to 82.9% in 2013. Just 62.4% of children 4 to 7 were restrained using the appropriate forward-facing car seat or booster seat, which is down from 66.6% in 2013. Children 8 to 12 should use a booster seat until a seat belt fits properly. Of children 8to 12, 83% were appropriately restrained, compared to 88.5% in 2013. Child restraint use varies by race and ethnicity. Across children younger than 13, Hispanics had the highest restraint use for infants birth to 12 months (100%) and non-Hispanic Whites and Asian non-Hispanics children had the highest restraint use for children 1 to 3 (98.8% and 99.2%, respectively), children 4 to 7 (94.7% and 94.3%, respectively), and children 8 to 12 (91.7% and

92.2%, respectively). Non-Hispanic Black children had the lowest restraint use rates (birth to 12 months, 91.0%; 1 to 3, 85.4%, 4 to 7, 78.4%; 8 to 12, 72.4%).

Despite high observed belt use rates, many unrestrained people die in crashes each year. In 2015, 22,411 passenger vehicle occupants were killed in crashes (NCSA, 2017). Of these, where restraint use was known, 48% were unrestrained. Of the 663 children under 13, who died in passenger vehicles in 2015, 35% were unrestrained (FARS data).

History of Occupant Restraint Laws. All new passenger cars had some form of seat belts beginning with lap belts in 1964, shoulder belts in 1968, and integrated lap and shoulder belts in 1974 (ACTS, 2001). However, few occupants used the belts. The first widespread survey completed in 19 cities in 1982, observed 11% belt use for drivers and front-seat passengers (Williams & Wells, 2004). This survey became the benchmark for tracking belt use nationally, until the National Occupant Protection Use Survey (NOPUS) began in 1994.

New York enacted the first belt use law in 1984 with other States soon following. Evaluations of the first seat belt laws found that seat belt use increased following implementation of the law from baseline levels of about 15% to 20% to post-law use rates of about 50% (Nichols & Ledingham, 2008). As of November 2016, all States except New Hampshire require adult passenger vehicle drivers and front seat occupants to wear seat belts and 28 States also require seat belts for all rear seat passengers (GHSA, 2016a; IIHS, 2016). Thirty-four States have primary enforcement seat belt use laws that permit law enforcement officers to stop and cite a violator independent of any other traffic violation. Fifteen States have secondary enforcement laws that allow law enforcement officers to cite violators only after they first have been stopped for some other traffic violation.

From 1978 to 1985, every State and the District of Columbia passed laws requiring child restraints for young child passengers (Kahane, 1986), and most of these laws have since been amended and strengthened to include more children and to close loopholes and exemptions. Still, great variation exists on the requirements and ages covered by State child restraint laws. See IIHS (2016) and GHSA (2016b) for a summary of State law requirements.

For more information on the history of belt systems, belt use laws, enforcement programs, and belt use trends, see Kahane (2015), ACTS (2001), Solomon et al. (2004), Milano, McInturff, and Nichols (2004), NCHRP (2004), NHTSA (2001, 2003b), Williams and Wells (2004), and Hedlund, Gilbert, Ledingham, and Preusser (2008).

Strategies to Improve the Safety of Passenger Vehicle Occupants

The most effective strategy for achieving and maintaining restraint use at acceptable levels is well publicized high-visibility enforcement of strong occupant restraint use laws. The effectiveness of high-visibility enforcement has been documented repeatedly in the United States and abroad. The strategy's three components – laws, enforcement, and publicity – cannot be separated: effectiveness decreases if any one of the components is weak or missing (Nichols & Ledingham, 2008; Tison & Williams, 2010).

These high-visibility, short-duration seat belt law enforcement programs that in the past were called STEPs (selective traffic enforcement programs), "STEP waves," or "blitzes," were demonstrated in individual communities in the late 1980s. North Carolina's *Click It or Ticket* program took this model statewide beginning in 1993 and raised the use rate above 80% (Williams & Wells, 2004). The *Click It or Ticket* model expanded nationwide in 2003 (Solomon, Compton, & Preusser, 2004) and belt use increased in almost all States from 2000 to 2006, in part due to the *Click It or Ticket* seat belt enforcement programs (Tison & Williams, 2010). Since then, most States have continued to increase or maintain their seat belt use rates (Chen & Webb, 2016).

Other strategies have been implemented to increase the correct use of child restraints. Child restraint misuse is an issue that has been a concern for many years. In reaction to the high levels of child restraint misuse and incompatibility issues between seat belts and child restraints, a concept of standardized child restraint installation, initially called ISOFIX, was completed as an international standard in 1999 (Klinich, Manary, & Weber, 2012). The intent of ISOFIX, later renamed as LATCH (lower anchors and tethers for children) as implemented in the United States, was to provide a simpler way to install child restraints and reduce misuse using special attachments on the car seat that fasten to anchors built into the vehicle. LATCH consists of two components in the vehicle – the lower anchors and the top tether anchor – with complimentary connectors on the child restraint. However, even with LATCH, misuse remains a problem with forward-facing car seats. The National Child Restraint Use Special Study (NCRUSS) conducted in 2011, found that only 48% of forward-facing child restraints were installed using the top tether, which is an important component of the LATCH system (Greenwell, 2015). It should be noted that at the time of data collection, tether use with car seats installed with the seat belt was not promoted.

The NCRUSS examined misuse rates of car seats and booster seats in a nationally representative sample of 4,167 vehicles (Greenwell, 2015). A group of subject matter experts determined what constituted "misuse" of child restraints. Misuse was defined as an installation of the car seat/booster to the vehicle, or restraining the child in such a way that could reduce the protection of the car seat/booster in the event of a crash. Restraint-use errors varied by restraint type. Overall misuse was estimated to be 46%. Estimated misuse by restraint type was 61% for forward-facing car seats, 49% for rear-facing car seats, 44% for rear-facing convertible car seats, 24% for backless booster seats, and 16% for high-back booster seats. The most common errors for rear-facing car seats were more than three inches of lateral movement, car seat angle of less than 30 degrees (if child was less than 1), and harness slack of more than 2 inches. The most common errors for booster seats were lap belt across the abdomen/ribcage, shoulder belt behind arm or back, seat belt not buckled, and child's head above the vehicle seat back.

In order to combat this misuse, programs have been implemented to provide parents and other caregivers with "hands-on" assistance with the installation and use of child restraints. The NHTSA Standardized Child Passenger Safety Training Course, complemented by the national certification process (administereded by Safe Kids Worldwide) developed and implemented a system to train safety professionals and other interested parties in the fundamentals of correctly choosing and installing the proper car seat for child passengers and correct placement of the child in the car seat. People who successfully completed the course are certified to educate the public in using child restraints properly and provide caregivers with this “hands-on” assistance (Womack, De La Zerda, Block, & Guzzetta, 2005). Currently, there are over 39,000 certified CPS technicians and instructors (Safe Kids Worldwide, 2016).

Child passenger safety inspection stations are places or events where parents and caregivers can receive assistance from certified CPS technicians, and are popular services provided by a variety of local CPS programs. Child passenger safety inspection stations are commonly housed at public health departments, fire departments, law enforcement agencies, healthcare organizations, family and social services departments, and other organizations that serve the community, including economically disadvantaged populations.

Resources

The agencies and organizations listed below can provide more information on seat belt use and child passenger safety, and links to numerous other resources.

Seat Belts and Child Passenger Safety

- National Highway Traffic Safety Administration:
    - Occupant Protection – www.nhtsa.gov/risky-driving/seat-belts#resources-resources; one.nhtsa.gov/Driving-Safety/Occupant-Protection
    - Car Seats and Booster Seats – www.nhtsa.gov/equipment/car-seats-and-booster-seats
    - Research and Evaluation – www.nhtsa.gov/behavioral-research; one.nhtsa.gov/Driving-Safety/Research-&-Evaluation
    - Behavioral Safety Research Reports – ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- AAA:
    - Seat Belts – http://exchange.aaa.com/safety/roadway-safety/safety-belts/
    - Child Passenger Safety – http://exchange.aaa.com/safety/child-safety/
- AAA Foundation for Traffic Safety: www.aaafoundation.org
- American Academy of Pediatrics, Annual Car Seat Information For Families guide: www.healthychildren.org/English/safety-prevention/on-the-go/Pages/Car-Safety-Seats-Information-for-Families.aspx
- Automotive Safety Program, Riley Hospital for Children: www.preventinjury.org
- Centers for Disease Control and Prevention, Injury Prevention & Control: Motor Vehicle Safety: www.cdc.gov/Motorvehiclesafety/index.html
- Center for Injury Research and Prevention, The Children’s Hospital of Philadelphia: http://injury.research.chop.edu/traffic-injury-prevention/child-passenger-safety#.WMauPU2Qzcs
- Governors Highway Safety Association: www.ghsa.org/html/issues/occprotection/index.html
- Insurance Institute for Highway Safety:
    - Safety Belt Use – www.iihs.org/iihs/topics/t/safety-belts/topicoverview
    - Children – www.iihs.org/iihs/topics/t/child-safety/topicoverview
- National Safety Council:
    - Child Passenger Safety – www.nsc.org/learn/safety-knowledge/Pages/Child-Passenger-Safety.aspx

  - Child Safety Seats & Boosters - www.nsc.org/safety_road/DriverSafety/Pages/ChildPassengerSafety.aspx
- Safe Kids Worldwide:
  - Seat Belts: www.safekids.org/safetytips/field_risks/seatbelt
  - Car Seats: www.safekids.org/car-seat
  - Booster Seats: www.safekids.org/safetytips/field_risks/booster-seat
- Safe Ride News Publications: www.saferidenews.com
- National Child Passenger Safety Board: cpsboard.org
- SafetyBeltSafe U.S.A.: www.carseat.org
  University of Michigan Transportation Research Institute: www.cpsbestpractice.org

Key terms

- Primary enforcement seat belt use laws permit law enforcement officers to stop and cite a violator independent of any other traffic violation. Child Passenger Safety laws are primary, unless they are covering older children in the rear seat.
- Secondary enforcement laws allow law enforcement officers to cite violators only after they first have been stopped for some other traffic violation

Seat Belt and Child Restraint Countermeasures

Countermeasures to increase seatbelt and child restraint use are listed in the table below. The table is intended to provide a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. Effectiveness is shown using a five-star rating system:

- Countermeasures that receive ★★★★ or ★★★★★ have been determined to be effective.
- Countermeasures that receive ★★★ are considered promising, and likely to be effective.
- Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States, communities and other organizations are encouraged to use ★★★, and especially ★★★★ or ★★★★★, countermeasures. They should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

Further details about the symbols and terms used are included after the table. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate.

Each countermeasure to increase seat belt and child restraint use is discussed individually in this chapter. Full descriptions are included for ★★★, ★★★★ and ★★★★★ countermeasures. Brief descriptions are included for ☆ and ☆☆ countermeasures. Further details about the ☆ and ☆☆ countermeasures are included in Appendix A2 to this report.

Countermeasures Targeting Adults

1. Seat Belt Use Laws

Countermeasure	Effectiveness	Cost	Use	Time
1.1 State Primary Enforcement Seat Belt Use Laws	★★★★★	$	Medium	Short
1.2 Local Primary Enforcement Seat Belt Use Laws	★★★★	$	Low	Short
1.3 Increased Seat Belt Use Law Penalties	★★★★†	$	Low	Short

†Effectiveness has been demonstrated for increased fines but has not yet been demonstrated for driver's license points.

2. Seat Belt Law Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Short Term, High-Visibility Seat Belt Law Enforcement	★★★★★	$$$	Medium†	Medium
2.2 Integrated Nighttime Seat Belt Enforcement	★★★★	$$$	Unknown	Medium
2.3 Sustained Enforcement	★★★	Varies	Unknown	Varies

†Used in many jurisdictions but often only once or twice each year

3. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Supporting Enforcement	★★★★★	Varies	Medium	Medium
3.2 Strategies for Low-Belt-Use Groups	★★★★†	Unknown	Unknown	Medium

†For programs supporting enforcement

Countermeasures Targeting Children and Youth

4. Child/Youth Occupant Restraint Laws

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Strengthening Child/Youth Occupant Restraint Laws	★★★★★	$	High	Short

5. Child Restraint/Booster Seat Law Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
5.1 Short High-Visibility CR Law Enforcement	★★★★★	$$$	Medium	Medium

6. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
6.1 Strategies for Older Children	★★★	Varies	Unknown	Medium
6.2 Strategies for Child Restraint and Booster Seat Use	★★★†	Varies	Unknown	Medium

† For stand-alone programs not supporting enforcement

7. Other Strategies

Countermeasure	Effectiveness	Cost	Use	Time
7.1 School Programs	★★★	Varies	Unknown	Varies
7.2 Inspection Stations	★★★	$$	High	Short

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by increases in observed occupant restraint use and decreases in motor vehicle occupant crash injuries. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, and/or facilities
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities
These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less
These estimates do not include the time required to enact legislation or establish policies.

Countermeasures Targeting Adults

1. Seat Belt Use Laws

1.1 State Primary Enforcement Seat Belt Use Laws

Effectiveness: ★★★★★	Cost: $	Use: Medium	Time: Short

Primary enforcement seat belt use laws permit law enforcement officers to stop and cite a violator independent of any other traffic violation. Secondary enforcement laws allow law enforcement officers to cite violators only after they first have been stopped for some other traffic violation.

Use: As of November 2016, there were 34 States and the District of Columbia that had primary belt use laws, 15 States had secondary enforcement laws, and New Hampshire had no belt use law applicable to adults (GHSA, 2016a; IIHS, 2016). However, some States only have primary enforcement for certain occupants (for instance drivers or people older than a specified age) and secondary enforcement for other occupants (for example, North Carolina’s seat belt law is primary for drivers and front seat passengers 16 and older but secondary for rear seat passengers 16 and older).

Effectiveness: In 2016, belt use averaged 91.2% in the 34 States and District of Columbia with primary belt laws and 83.0% in States with weaker enforcement laws (Pickrell, & Li, 2016). Nichols, Tippetts, et al. (2010) examined the relationship between the type of seat belt law enforcement and seat belt use from 1997 to 2008. Compared with secondary laws, primary laws were associated with a higher observed seat belt use (10 to 12% higher) and higher seat belt use among front-seat occupants killed in crashes (9% higher).

The Centers for Disease Control and Prevention’s systematic review of 13 high-quality studies (Shults, Nichols, Dinh-Zarr, Sleet, & Elder, 2004) found that primary laws increase belt use by about 14 percentage points and reduce occupant fatalities by about 8% compared to secondary laws. Similarly, Nichols, Tippetts, Fell, Eichelberger, and Haseltine (2014) found that primary enforcement laws were associated with a 9- to 10-percentage-point increase in belt use. In another study, Farmer and Williams (2005) found that passenger vehicle driver death rates dropped by 7% when States changed from secondary to primary enforcement.

Research has provided strong support that changing from secondary to primary enforcement seat belt laws increases occupant seat belt use during the nighttime hours as well as the daytime hours (Chaudhary, Tison, & Casanova, 2010; Masten, 2007). Chaudhary et al. (2010) evaluated the effects of Maine's change from secondary to primary enforcement of their seat belt law. Observational surveys conducted over an 18-month period after this change went into effect measured increases in seat belt use from 77% to 84% during the daytime and from 69% to 81% at night.

Hedlund et al. (2008) studied the effects of primary law changes on seat belt use and occupant fatalities in Michigan, New Jersey, Washington, Delaware, Illinois, and Tennessee. Strong evidence was found that primary seat belt laws increase seat belt use. Furthermore, statistically significant decreases in the number of front-seat passenger vehicle occupant fatalities were found in Michigan and Washington and the decrease in New Jersey was marginally significant. The lack of significant effects on fatalities in Illinois and Tennessee, as well as a marginal increase in Delaware, was attributed in part to the short amount of time since the implementation of the primary provisions in these States as well as the small number of fatalities in Delaware.

Costs: Once legislation has been enacted to upgrade a secondary law to primary, the costs are to publicize the change and enforce the new law. Publicity costs to inform the public of the law change should be low because the media will cover the law change extensively. Law enforcement can adapt its secondary law enforcement strategies for use under the primary law or may be able to use new strategies permitted by the primary law. States wishing to increase enforcement and publicity to magnify the effect of the law change will incur additional costs (see Chapter 2, Section 2.1).

Time to implement: A primary belt use law can be implemented as soon as the law is enacted unless it has a delayed effective date.

Other issues:

- **Partial coverage seat belt laws:** Most State belt use laws cover passengers over a specified age and are designed to work in combination with child passenger safety laws covering younger passengers. However, belt use laws do not cover adult rear seat passengers in 22 States (GHSA, 2016a; IIHS, 2016. The National Occupant Protection Use Survey (NOPUS) found higher observed rear seat belt use in States with belt laws covering all seating positions than in States not requiring rear seat belt use (80% and 66% in 2014, respectively) (Pickrell, Choi, & KC, 2016). A recent analysis in Iowa, which has primary laws for front-seat passengers but no law for rear-seat passengers, found that occupants reported using seat belts 30-40% less often if they were a passenger in the rear than in the front (Reyes et al., 2014). This is consistent with findings obtained using National household survey data from the ConsumerStyles 2012 database (Bhat et al., 2015). Most States' laws exempt some vehicles, such as those designed for more than 10 passengers, taxis, postal delivery vehicles, farm vehicles, pickup trucks, or vehicles not required to have seat belts (Glassbrenner, 2005). Some States exempt passengers for specified medical or physical reasons (Glassbrenner, 2005). A good belt use law should be comprehensive, covering all seating positions equipped with a seat belt in all passenger vehicles (ACTS, 2001; NCUTLO, 2000; NHTSA, 2003b; NHTSA, 2006b). Such a law sends a clear and consistent message to the public.
- **Opposition to primary seat belt laws:** Opponents of primary seat belt use laws claim that primary laws impinge on individual rights and provide opportunities for law enforcement to harass minority groups (St. Louis, Mercer, & Eby, 2011). Studies in several States have found that minority groups were ticketed at similar or lower rates than others after a primary law was implemented (Shults et al., 2004; Tison, Williams, Chaudhary, & Nichols, 2011). When Michigan changed from a secondary to a primary law, harassment complaints were very uncommon both before and after the law change. The proportion of seat belt use citations issued to minority groups decreased under the primary law. In a telephone survey, the vast majority of people who actually received seat belt citations did not feel that they were singled out on the basis of race, age, or gender.

However, some minorities and young drivers reported perceptions of harassment (Eby, Kostyniuk, Molnar, Vivoda, & Miller, 2004).

- **Effect on low-seat-belt-use groups:** Studies in States that changed their law from secondary to primary show that belt use increased across a broad range of drivers and passengers. In some States, belt use increased more for low-belt-use groups, including Hispanics, African-Americans, and impaired drivers, than for all occupants (Shults et al., 2004). This was also found in Florida where the greatest gains were among males, African-Americans, pickup truck occupants, younger occupants, and those on local roads (Nichols, Chaffe, & Solomon, 2012).
- **Impact of regional characteristics on effectiveness of primary seat belt laws:** Recent research suggests that primary seat belt laws may be less effective in regions with certain economic, societal, and cultural characteristics. Specifically, there is initial evidence that primary seat belt laws were only associated with higher belt use rates in States that had higher levels of academic achievement and higher health rankings (Ash, Edwards, & Porter, 2014). Moreover, primary law States that had a high proportion of rural roads relative to urban roads were also associated with no significant increase in seat belt usage in comparison to States with secondary seat belt laws.

1.2 Local Primary Enforcement Seat Belt Use Laws and Ordinances

Effectiveness: ★★★★	Cost: $	Use: Low	Time: Short

In some States with secondary enforcement belt use laws, individual communities have enacted and enforced community-wide primary laws or ordinances. These laws differ from statewide laws only in that they are enacted, publicized, and enforced locally.

Use: No data is available on how many communities have primary laws.

Effectiveness: The effectiveness of this countermeasure has not been thoroughly examined. The limited available evidence and extrapolation from the effectiveness of primary seat belt enforcement laws at the State level suggest that this countermeasure should work at the local level (Lucke et al., 2004).

St. Louis County, Missouri, implemented a primary seat belt use ordinance in March 2007. Following implementation of this ordinance, the St. Louis County Police Department conducted an intense high-visibility enforcement campaign, accompanied by publicity in the form of variable message boards and permanent road signs, along an 8-mile corridor on State Highway 21. Observational surveys were conducted along the Highway 21 corridor and a control site prior to the start of the enforcement and immediately after its conclusion. The observational surveys measured an increase in belt use from 83% to 88% along the Highway 21 corridor and a small, 59% to 57% decrease in belt use along the control corridor (Nichols, Solomon, Chaffe, & Preusser, 2010).

Costs: As with a statewide law, the costs are for publicity and enforcement. Both must be directed to the community itself.

Time to implement: As with a statewide law, a local law can be implemented as soon as it is enacted. The law's debate and passage likely will generate initial publicity.

Other issues: See the discussion under Chapter 2, Section 1.1, Primary Enforcement Belt Use Laws.

1.3 Increased Belt Use Law Penalties: Fines and Driver's License Points

Effectiveness: ★★★★[†]	Cost: $	Use: Low	Time: Short

[†]Effectiveness has been demonstrated for increased fines but has not yet been demonstrated for driver's license points

Penalties for most belt use law violations are low. As of November 2016, a violation resulted in a typical fine of $25 or more in all but 14 States (IIHS, 2016). Low fines may not convince nonusers to buckle up and may also send a message that belt use laws are not taken seriously.

Most States penalize serious traffic law violations by assessing demerit points against a driver's license. Drivers lose their licenses if they accumulate more than a specified number of points within a specified period of time.

Use: As of November 2016, there were 13 primary law States and 2 secondary law States that had maximum fines of $30 or more for at least some occupants (IIHS, 2016). As of November 2016, 2 jurisdictions, the District of Columbia, and New Mexico, assessed driver license points for all seat belt law violations and 11 jurisdictions assessed points for violations of child safety seat laws (IIHS, 2016).

Effectiveness: The effect of driver's license points on belt use has not been evaluated. Houston and Richardson (2006) studied the effects of belt law type (primary or secondary), fine level, and coverage (front seat only or front and rear seats) using belt use data from 1991 to 2001. They found that primary belt laws and higher fines increase belt use.

Nichols, Tippetts, et al. (2010 and 2014) examined the relationship between seat belt violation fines and belt use and found that increasing fines was associated with increased belt use. Increasing a State's fine from $25 to $60 was associated with an increase of 3% to 4% in both observed belt use and belt use among front-seat occupants killed in crashes, an effect that was additive with increases attributed to the type of seat belt law. Increasing the fine from $25 to $100 was associated with an increase of 6% to 7% for these measures; however, there were diminishing returns for fines above this amount (Nichols, Tippetts, et al., 2014).

Costs: The direct costs associated with increasing fine levels or assessing driver's license points are minimal.

Time to implement: Both measures can be implemented as soon as they are publicized and appropriate changes are made to the motor vehicle records systems.

Other issues:

- **Balance:** If penalties are excessively low, then they may have little effect. If they are excessively high, then law enforcement officers may be reluctant to issue citations and judges may be reluctant to impose them. States should choose penalty levels that strike an appropriate balance.
- **Penalty levels are part of a system:** Penalty levels are part of the complete system of well-publicized enforcement of strong belt use laws. Appropriate penalty levels help

make strong laws. But without effective enforcement, judicial support, and good publicity, increased penalties may have little effect.

2. Seat Belt Law Enforcement

2.1 Short-Term, High-Visibility Seat Belt Law Enforcement

Effectiveness: ★★★★★	Cost: $$$	Use: Medium†	Time: Medium

† Used in many jurisdictions but often only once or twice each year

The most common high-visibility seat belt law enforcement method consists of short (typically lasting for two weeks), intense, highly publicized periods of increased belt law enforcement, frequently using checkpoints (in States where checkpoints are permitted), saturation patrols, or enforcement zones. This short-duration seat belt enforcement method was developed in Canada in the 1980s (Boase, Jonah, & Dawson, 2004) and demonstrated in several United States communities (Williams & Wells, 2004). It was implemented statewide in North Carolina in 1993 using the *Click It or Ticket* slogan (Reinfurt, 2004), and subsequently adopted in other States under different names and sponsors (Solomon et al., 2004). NHTSA's *Click It or Ticket* high-visibility enforcement model is described in detail in Solomon, Chaudhary, and Cosgrove (2003) and Solomon, Chaffe, and Cosgrove (2007).

All high-visibility enforcement programs include communications and outreach strategies that use some combination of earned media (news stories) and paid advertising. Communications and outreach can be conducted at local, State, regional, or national levels.

Use: Most States currently conduct short-term, high-visibility belt law enforcement programs in May of each year as part of national seat belt mobilizations (Nichols, Chaffee, Solomon, & Tison, 2016). Some States also conduct seat belt mobilizations in November. NHTSA has supported these campaigns. Nearly 10,000 law enforcement agencies took part in the May 2013 campaign (Nichols et al., 2016). See Milano et al. (2004) for a detailed account of the history and evolution of the national campaigns.

Effectiveness: Hedlund et al. (2008) compared 16 States with high seat belt rates and 15 States with low seat belt rates. The single most important difference between the two groups was the level of enforcement, rather than demographic characteristics or the amount spent on media. High-belt-use States issued twice as many citations per capita during their *Click It or Ticket* campaigns as low-belt-use States. Level of enforcement is also related to type of seat belt law. Nichols et al. (2016) found that law enforcement in primary belt use law States issued more seat belt citations in the 2013 campaign than did law enforcement in secondary belt use law States.

CDC's systematic review of 15 high-quality studies (Dinh-Zarr et al., 2001; Shults et al., 2004) found that short-term, high-visibility enforcement programs increased belt use by about 16 percentage points, with greater gains when pre-program belt use was lower. Because many of the studies were conducted when belt use rates were considerably lower than at present, new programs likely will not have as large an effect. Following the enforcement program, belt use often dropped by about 6 percentage points demonstrating the ratchet effect typical of these programs (belt use increases during and immediately after the program and then decreases somewhat, but remains at a level higher than the pre-program belt use).

The May 2002 *Click It or Ticket* campaign evaluation demonstrated the effect of different media strategies. Belt use increased by 8.6 percentage points across 10 States that used paid advertising extensively in their campaigns. Belt use increased by 2.7 percentage points across 4 States that used limited paid advertising and increased by only 0.5 percentage points across 4 States that used no paid advertising (Solomon, Ulmer, & Preusser, 2002). Milano et al. (2004) summarize an extensive amount of information from national telephone surveys conducted in conjunction with each national campaign from 1997 to 2003.

Smaller-scale campaigns limited to a single travel corridor can yield a short-term improvement in observed seat belt usage along the corridor, but the effects appear to be limited to the enforcement area. Specifically, a high-visibility enforcement campaign conducted along a route frequented by commuters used inexpensive roadway signs and magnetic message strips on enforcement vehicles within the corridor, but only a press release was available to residents in a nearby city, which was typically the destination for commuters (Elliot, Solomon, & Preusser, 2014). Although observed belt use improved significantly within the corridor, observed belt use and overall awareness of the seat belt campaign was unchanged in the nearby city. A likely explanation for this difference is lack of exposure to the location-specific campaign, since most respondents from the city reported traveling the route less than once a month.

Since 2002, and especially after 2003, there has been a history of using extensive paid advertising both nationally and within States to support the Click it or Ticket campaign with clear enforcement images and messages (Milano, 2004). The 2013 *Click It or Ticket* (CIOT) campaign used extensive paid advertising ($8 million nationally and $11 million in individual States). National observed seat belt use following CIOT was statistically unchanged from 2012 to 2013 (86% and 87%, respectively). While the effect of CIOT on observed belt use cannot be isolated from the effect of other interventions, national observed seat belt use increased from 79% to 87% over 11 years of CIOT activity (2003 – 2013) (Nichols et al., 2016).

Costs: High-visibility enforcement campaigns are expensive. They require extensive time from State highway safety office and media staff and often from consultants to develop, produce, and distribute publicity and time from law enforcement officers to conduct the enforcement. Paid advertising increases a campaign's effectiveness, but can be quite expensive. In the average State, paid advertising costs were nearly $350,000 for the 2007 campaign (Solomon, Preusser, et al., 2009). More recently, the 2013 *Click It or Ticket* campaign used extensive paid advertising ($8 million nationally and $11 million in individual States).

Time to implement: A high-visibility enforcement program (including media) requires 4 to 6 months to plan and implement.

Other issues:

- **Effects in primary and secondary belt law States:** High-visibility enforcement campaigns are effective in both primary and secondary law States. NHTSA's 2003 evaluation found that belt use increased by 4.6 percentage points across the primary law States and by 6.6 percentage points across the secondary law States with the primary law States having had higher use rates before the campaigns (Solomon et al., 2003). NHTSA's evaluation of the 2004 *Click It or Ticket* campaign found that the campaign increased belt use in 25 secondary jurisdictions by an average of 3.7 percentage points. Belt use decreased in the remaining 5 jurisdictions by an average of 2.3 percentage points (Solomon et al., 2007).

- **Effects on low-belt-use groups:** CDC's systematic review observed that short-term, high-visibility enforcement campaigns increased belt use more among traditionally lower-belt-use groups, including young drivers, rural drivers, males, African-Americans, and Hispanics (Shults et al., 2004). See Chapter 2, Section 3.2 for further discussion on strategies to reach low-belt-use groups. Similarly, a more recent study also found that increases in observed seatbelt use within an enforcement area were greatest among the groups that had the lowest baseline usage rates, such as males, passengers, and drivers of pick-up trucks (Elliot, Solomon, & Preusser, 2014).

2.2 Integrated Nighttime Seat Belt Enforcement

Effectiveness: ★★★★	Cost: $$$	Use: Low	Time: Medium

Short-term, high-visibility seat belt law enforcement programs (Chapter 2, Section 2.1) require substantial funding and law enforcement resources. In addition, a number of States have experienced smaller gains in seat belt use associated with enforcement campaigns after conducting them for several years (Nichols & Ledingham, 2008). These programs also have been conducted almost exclusively during the daylight hours, and the available data suggest that belt use is lower at night (Chaudhary, Alonge, & Preusser, 2005; Hedlund et al., 2004; Nichols & Ledingham, 2008).

In 2015, 57% of passenger vehicle occupants killed in crashes at nighttime were unrestrained (NCSA, 2017). In contrast, 40% of fatally injured passenger vehicle occupants in daytime crashes were unrestrained. Furthermore, according to FARS data for the 10-year period from 2006 to 2015, nighttime seat belt use was on average 18 percentage points lower than daytime belt use (FARS data).

Available data and program evaluations suggest that more emphasis on seat belt enforcement during the late-night hours and in conjunction with alcohol laws can provide additional gains in seat belt use and injury reduction (Nichols & Ledingham, 2008). Retaining the short-term, high-intensity enforcement model but including other traffic safety issues such as impaired driving (DWI) and excessive speed, can be effective since the same drivers tend to drink, speed, and not buckle up. In particular, combined DWI and belt law checkpoints, saturation patrols, or enforcement zone operations can be conducted at night, when belt use is lower, DWI higher, and crash risk greater than during the day. Enforcement activities should be conducted in locations with adequate lighting or by using light enhancing technologies. The first demonstration of this strategy took place in 2004 in Reading, Pennsylvania (Chaudhary et al., 2005). See Chapter 1, Section 2.5 “Integrated Enforcement” for further discussion on combined seat belt and alcohol enforcement.

Use: There is little information available on how frequently integrated nighttime, high-visibility enforcement strategies are used. One demonstration of a nighttime program in Pennsylvania was conducted in 2004 (Chaudhary et al., 2005), another demonstration program involving three North Carolina communities was conducted in 2007 (Solomon, Chaffe, & Preusser, 2009), Washington State conducted a two-year statewide high-visibility nighttime seat belt enforcement program from May 2007 through May 2009 (Thomas, Blomberg, & Van Dyk, 2010), and Oklahoma and Tennessee conducted multiple enforcement waves from November 2011 to August 2013 (Nichols, Chaffe, & Solomon, 2016).

Effectiveness: A 2004 nighttime high-visibility belt enforcement program in Reading, Pennsylvania, increased nighttime front-seat-occupant belt use by 6 percentage points, from 50% to 56%. Daytime belt use increased by 3 percentage points, from 56% to 59% (Chaudhary et al., 2005).

A 2007 evaluation of three high-visibility enforcement demonstration programs designed to improve nighttime seat belt use in three communities – two in North Carolina with a primary seat belt law and one in West Virginia with a secondary law -- concluded that nighttime high-visibility seat belt law enforcement programs can be effective for increasing nighttime belt use. Furthermore, roadside breath tests used to collect BAC measures in one North Carolina community indicated that the program also decreased drinking and driving (Solomon, Chaffe, et al., 2009).

An evaluation of the first year of the Washington nighttime seat belt enforcement program found that the program, which used a combination of high-visibility enforcement and both paid and earned media, has contributed to an increase in observed nighttime belt use (from 94.6% to 95.7%) without a decrease in daytime belt use. The program also looked at the characteristics of observed drivers (through self-report, driving, and criminal records). While impossible to summarize all their findings, it is clear that there are notable differences between unrestrained and restrained drivers by time of day. For example, unrestrained nighttime drivers were 2.7 times more likely than restrained daytime drivers to have had a felony arrest and 3.0 times more likely to have had an alcohol citation. The program continued through May 2009 (Thomas, Blomberg, & Van Dyk, 2010).

A recent evaluation study examined the effectiveness of the *More Cops More Stops* (MCMS) high-visibility enforcement program implemented in Oklahoma and Tennessee (Nichols, Chaffe, & Solomon, 2016). The program addressed multiple traffic safety issues with one integrated message. The MCMS program covered impaired driving, seat belt, and speeding enforcement under a single message. During four of the six campaign waves, MCMS activity was accompanied by *Click It or Ticket* (CIOT) or *Drive Sober or Get Pulled Over* (DSOGPO) statewide campaigns. The effectiveness of the MCMS program was limited. While there were some positive outcomes in terms of increased recognition of the MCMS slogan and some increases in awareness of general traffic enforcement, overall driver perceptions of the risk of a traffic stop did not increase. The integrated program (i.e., MCMS plus statewide campaigns) likely had an impact on seat belt usage, although observational surveys provided little evidence that the MCMS phases yield gains above and beyond that associated with the statewide campaigns. However, one of the five market areas (Memphis) experienced a significant increase in daytime and nighttime seat belt usage. While the evaluation did find some positive outcomes associated with the overall program (MCMS plus statewide), the evaluation found no evidence of MCMS being an effective tool for enhancing the effect of the CIOT and DSOGPO statewide campaigns. An additional consideration was that the MCMS integrated program was taxing on law enforcement, and challenging to maintain for the full program duration.

Costs: The costs of combined high-visibility enforcement programs are similar to and probably somewhat greater than the costs of programs directed exclusively at belt law violators (Chapter 2, Section 2.1). Publicity must be directed at different offenses in turn, and law enforcement officers must have the training and equipment to address different offenses. Nighttime programs may entail somewhat higher costs if new night-vision technology is used.

Time to implement: Integrated and nighttime high-visibility enforcement programs require 4 to 6 months to plan and implement.

2.3 Sustained Enforcement

Effectiveness: ★★★	Cost: Varies	Use: Unknown	Time: Varies

Some jurisdictions, including California, Illinois, Kentucky, Oregon, and Washington, enforce their belt use laws vigorously as part of customary traffic enforcement activities.

Use: The extent of vigorous sustained belt law enforcement, with or without extensive publicity, is unknown.

Effectiveness: There are few studies of the effectiveness of sustained enforcement (Hedlund, Preusser, & Shults, 2004). California, Oregon, and Washington, States that are reported to use sustained enforcement, have recorded statewide belt use well above national belt use rates since 2002 (California: 91 to 97%; Oregon: 88 to 96%; Washington: 93 to 95%) (Chen & Webb, 2016).

Nichols and Ledingham (2008) conducted a review of the impact of enforcement, as well as legislation and sanctions, on seat belt use over the past two decades and concluded that sustained enforcement (implemented as a component of regular patrols or as special patrols) is as effective as “blitz” enforcement (short-term, high-visibility enforcement) and unlike blitz campaigns, is not usually associated with abrupt drops in belt use after program completion.

Costs: Sustained enforcement may require funds for publicity. As with short-term, high-visibility enforcement programs, publicity costs will depend on the mix of earned and paid media.

Time to implement: Sustained enforcement by law enforcement officers can be implemented once the law enforcement agency develops and implements a sustained seat belt enforcement plan. Extensive publicity will take three or four months to plan and implement initially, but this time will decrease once the program has been implemented for some period of time.

3. Communications and Outreach

3.1 Supporting Enforcement

Effectiveness: ★★★★★	Cost: Varies	Use: Medium	Time: Medium

Effective, high-visibility communications and outreach are an essential part of successful seat belt law high-visibility enforcement programs (Solomon et al., 2003). Paid advertising can be a critical part of the media strategy. Paid advertising brings with it the ability to control message content, timing, placement, and repetition (Milano et al., 2004).

Use: All high-visibility enforcement programs include communications and outreach strategies that use some combination of earned media (news stories) and paid advertising. Communications and outreach can be conducted at local, State, regional, or national levels.

Effectiveness: The May 2002 *Click It or Ticket* campaign evaluation demonstrated the effect of different media strategies. Belt use increased by 8.6 percentage points across 10 States that used paid advertising extensively in their campaigns. Belt use increased by 2.7 percentage points across 4 States that used limited paid advertising and increased by only 0.5 percentage points across 4 States that used no paid advertising (Solomon et al., 2002). Milano et al. (2004) summarize an extensive amount of information from national telephone surveys conducted in conjunction with each national campaign from 1997 to 2003.

Costs: Paid advertising can be expensive. On average across participating States' paid advertising costs were about $2,200,000 for the 2013 campaign (Nichols et al., 2016).

Time to implement: An effective media campaign requires 4 to 6 months to plan and implement.

Other Issues:
Social media: NHTSA and some States have begun using social networking sites to reach the general public with messages concerning seat belt use. Although sites such as Facebook, Twitter, and YouTube can effectively and inexpensively reach large numbers of people, there are no evaluations of seat belt use campaigns that use this approach. The Centers for Disease Control and Prevention offer tools to help with using social media, including a social media toolkit and guide for writing social media (www.cdc.gov/socialmedia/tools/guidelines). In addition, there is information available on NHTSA's traffic safety marketing website (www.trafficsafetymarketing.gov/marketing-tools/social-media).

3.2 Strategies for Low-Belt-Use Groups

Effectiveness: ★★★★†	Cost: Varies	Use: Unknown	Time: Medium

† For programs supporting enforcement

Nationally, daytime seat belt use is at 90.1% (Pickrell & Li, 2016), with 43 States and the District of Columbia having seat belt use at 80% or higher (Pickrell, 2017). This indicates the large majority of drivers and passengers are wearing their seat belts during daytime hours; however, there remains a proportion of the population who still do not buckle up regularly.

Generally, seat belt use rates for male occupants are lower than rates for female occupants, 86.6% and 90.7% respectively in 2015 (Pickrell, Li, & KC, 2016). This trend has been evident since at least 2005. Similarly, belt use rates for occupants 16 to 24 tend to be lower than the use rates of other age groups. In 2015, belt use was 90.8% for occupants 8 to 15, 86.3% for occupants 16 to 24, 88.6% for occupants 25 to 69, and 90.7% for those occupants 70 and older (Pickrell, Li, & KC, 2016). Since 2005, belt use rates for Black occupants have been lower than use rates for members of other races. In 2015, belt use for Black occupants was 82.3% compared to 88.3% among white occupants, and 94.0% among members of other races (Pickrell, Li, & KC, 2016). Additionally, NHTSA's 2015 National Occupant Protection Use Survey indicated belt use was lower for front seat passengers (86.8%) compared to drivers (89%), pick-up truck occupants (80.8%) compared to occupants of passenger cars (88.1%) and vans/SUVs (90.3%), and in rural areas (86.8%) compared to urban (89.4%) areas (Pickrell & Li, 2016). NHTSA's 2007 national Motor Vehicle Occupant Safety Survey (MVOSS) found the same patterns with males, young drivers, rural drivers, and pickup truck drivers-all reporting lower seat belt use (Boyle & Lampkin, 2008).

Most non-seat belt users report wearing seat belts at least some of the time. In NHTSA's 2007 national MVOSS, only 1% of drivers said they never used their belts and another 1% said they rarely used seat belts (Boyle & Lampkin, 2008). Backseat passengers are more frequently unbelted: 11% said they never use belts and another 6% said they rarely use them, while only 58% reported wearing belts all the time (Boyle & Lampkin, 2008). The most frequent reasons given by drivers for not wearing a belt were that they: were only driving a short distance (59%), forgot (52%), were in a rush (39%), or they found the belt uncomfortable (35%) (Boyle & Lampkin, 2008).

Use: Communications and outreach campaigns directed at low-belt-use groups are likely common, but no summary is available.

Effectiveness: Communications and outreach campaigns directed at low-belt-use groups have been demonstrated to be effective for targeted programs that support, and are supported by, enforcement. The effectiveness of stand-alone programs not supported by enforcement is unclear, though North Dakota has demonstrated success with its 2003 "Pick Up the Habit for Someone You Love" campaign.

High-visibility enforcement programs generally have been effective in increasing belt use (see Chapter 2, Section 2.1; Shults et al., 2004). Their publicity messages and placement can be directed at specific lower-belt-use groups. The 2013 *Click It or Ticket* campaign targeted 18- to 34-year old males and found they showed greater increases in awareness of seat belt enforcement activity and seat belt checkpoints than the general population (14% versus 10% for seat belt enforcement and 10% versus 7% for seat belt checkpoints, respectively).The target group did not show significant increases in awareness of the CIOT slogan (5%), messages to buckle up (6%), or perceived risk of a ticket (6%), while the general population showed significant increases in these indices (6%, 8%, and 5%, respectively). The small sample size for the target group may have contributed to not finding significant increases among this group for some indices. (Nichols et al., 2016).

Trauma Nurses Talk Tough, originally developed in Oregon in 1988, is a seat belt diversion program implemented by trauma nurses in a hospital setting that targets drivers who have been ticketed for not wearing a seat belt. The program was implemented in Robeson County, North Carolina, a diverse county whose seat belt rates were consistently lower than the rest of the State. Those who went through the program were more likely to have a positive outlook on the use of seat belts. Following the program, observed seat belt use increased significantly in the county at 8 survey locations (from 81% to 86%) and 2 additional sites (from 69% to 78%) (NHTSA, 2014c; Thomas, Blomberg, Fairchild, & Cosgrove, 2014).

The 5 States of NHTSA's Region 6 conducted a two-week *Buckle Up in Your Truck* paid advertising campaign immediately before their May 2004 *Click It or Ticket* campaign. The truck campaign's message complemented the *Click It or Ticket* message by focusing on the dangers of riding unrestrained in a truck and stressing the usefulness of belts in rollover crashes. The campaign spent nearly $600,000 for paid advertising in the 5 participating States. Surveys at the end of the campaign, before any enforcement-based *Click It or Ticke*t publicity, showed that belt use among pickup truck occupants increased by about 2 percentage points. Following the *Click It or Ticket* publicity, belt use among pickup truck occupants increased by another 6 percentage points (Solomon, Chaffe, et al., 2007).

In a November 2004 follow-up study, an intensive campaign using the same *Buckle Up in Your Truck* message was conducted in Amarillo, Texas. The campaign used paid advertising emphasizing belt law enforcement as well as earned media featuring local law enforcement officers. Belt use in pickup trucks increased by 12 percentage points in Amarillo and belt use in cars increased by 8 percentage points. At the same time, belt use in a comparison community increased by 5 percentage points for pickup truck occupants and by 4 percentage points for car occupants (Solomon, Chaffe, et al., 2007).

Iowa, Kansas, Missouri, and Nebraska (in NHTSA's Region 7) implemented a similar *Buckle Up in Your Truck* program in May 2006 and 2007. The campaign sought to increase seat belt use among pickup truck occupants by focusing on the dangers of riding unbuckled and increasing awareness of ongoing enforcement efforts. Following this campaign, these States also conducted statewide *Click It or Ticket* campaigns that included additional paid media and enforcement directed at occupants of all vehicle types. The *Buckle Up in Your Truck* campaign did increase the awareness of "buckle up in trucks" messages, but in terms of observed seat belt use, the *Click It or Ticket* campaign had the greater effect (Nichols, Tison, Solomon, Ledingham, Preusser, & Siegler, 2009).

NHTSA's Region 5 implemented a Rural Demonstration Program prior to the May 2005 *Click It or Ticket* mobilization. The goal of the Rural Demonstration Project was to evaluate strategies for increasing seat belt usage in rural areas. Paid media was used to notify rural residents that seat belt laws were being enforced. Active enforcement was included during the initial phase in 3 of the six Region 5 States (Illinois, Indiana, Ohio), but only the paid media component was implemented in the remaining three States (Minnesota, Michigan, Wisconsin). During the Demonstration Project phase, States that had intensified enforcement had significant increases in usage in their targeted rural areas. All six Region 5 States intensified enforcement during the *Click It or Ticket* mobilization, but States that had intensified enforcement during the Demonstration Project showed substantially greater overall statewide gains during the *Click It or Ticket* phase than did the States that had not intensified enforcement during the Rural Demonstration Program (Nichols, Ledingham, & Preusser, 2007).

Demonstration programs conducted in Kentucky, Mississippi, North Dakota, and Wyoming from 2004 to 2007 sought to increase seat belt use through a variety of innovative approaches. The primary method employed by Mississippi, North Dakota, and Wyoming was to target low- belt-use counties for additional enforcement and enforcement focused publicity. The seat belt laws in Kentucky and Mississippi were also upgraded from secondary to primary enforcement during the demonstration programs. All four States achieved significant statewide increases in belt use above baseline belt use rates (Blomberg, Thomas, & Cleven, 2009).

The North Dakota and Amarillo campaigns are well-documented examples of successful programs that target low-belt-use groups. They used all the characteristics of effective communications and outreach campaigns: good target audience research, effective and creative message development, and good message placement using both paid and earned media. The overall South Central Region campaign produced only modest gains, but Kentucky (67% to 76% statewide), Mississippi (58% to 65% in targeted counties), North Dakota (66% to 80% in targeted counties), and Wyoming (55% to 70% in targeted counties) were able to achieve significant increases in seat belt use through their programs (Blomberg, Thomas, & Cleven, 2009).

North Dakota's *Pick Up the Habit for Someone You Love* campaign in 2003 provides one of the few examples of a successful communications and outreach program not directly connected to enforcement. It was directed at male pickup drivers, whose pre-program belt use was 20 percentage-points lower than the statewide 63% rate. A survey of these drivers identified effective message goals (*choose* and *remember* to buckle up), message strategies (motivation through loved ones, sometimes using humor), and message placement (combining paid and earned radio and television, posters, and public relations events). The program increased observed belt use of male pickup drivers by 7 percentage points at a total cost of $295,000 (North Dakota DOT, 2004).

Costs: As with enforcement-related communications and outreach, costs vary depending on program quality and delivery. Paid advertising can be expensive.

Time to implement: A good media campaign will require 4 to 6 months to plan and implement.

Countermeasures Targeting Children and Youth

4. Child/Youth Occupant Restraint Laws

4.1 Strengthening Child/Youth Occupant Restraint Laws

Effectiveness: ★★★★★	Cost: $	Use: High	Time: Short

Beginning with Tennessee, every State from 1978 to 1985 passed laws requiring children traveling in motor vehicles to be restrained in child restraints appropriate for the child's age and size (Kahane, 1986). Today, State child restraint laws vary in terms of who is covered by the law, the types of restraints required, and whether children are required to ride in the rear seat. In some States, children as young as 5 may be restrained using the adult seat belt, while other State laws require children up to age 9 or 80 pounds or 57 inches tall to be restrained in a child restraint or booster seat (GHSA, 2016b; IIHS, 2016). Research has shown that laws requiring a child restraint or booster seat for children 4 to 7 are associated with a decrease in fatalities (Mannix et al., 2012).

In general, young children are usually covered by child restraint laws, while older children and adults are covered by seat belt laws. However, in 5 States some children under 16 are covered by neither law (IIHS, 2016). Most child passenger safety laws are primary; however, most seat belt laws start coverage before a child reaches 18, so older children and teens might be covered by a secondary enforcement seat belt law in some States. Research has found that teens living in a secondary enforcement State are less likely to report wearing their seat belt than teens living in primary enforcement States (Garcia-Espana, Winston, & Durbin, 2012). Strong occupant restraint use laws should be comprehensive, covering all seating positions equipped with a seat belt in all passenger vehicles (ACTS, 2001; NCUTLO, 2000; NHTSA, 2003b; NHTSA, 2006a). Such a law sends a clear and consistent message to the public. NHTSA and various partners have encouraged States to expand their child restraint laws to include "booster" provisions that cover children until they are big enough for the lap and shoulder belts to fit properly.

Use: As of July 2016, all but one State had enacted child restraint laws covering children through at least age 5 (South Dakota's law only covers children 4 and younger) (IIHS, 2016). However, a wide variation in age, height, and weight requirements exists among the laws of the various States (GHSA, 2016b; IIHS, 2016).

Effectiveness: Research conducted by Arbogast et al. (2009) found that transitioning children from child restraints with harnesses to belt-positioning booster seats instead of vehicle seat belts provides significant safety benefits for children at least through 8, and that belt-positioning booster seats lower the risk of injury to children in crashes by 45% compared to the use of vehicle seat belts alone. A number of studies evaluated the effect of booster provisions in States' laws on booster seat use (Gunn, Phillippi, & Cooper, 2007). Observational surveys conducted in Washington State before their booster seat law was expanded found that only 21% of children from 4 and 8 were using booster seats (Ebel, Koepsell, Bennett, & Rivara, 2003). Following a new law requiring booster seats for children weighing from 40 and 60 pounds or younger than 6 years old, observational surveys in Washington State found close to half of children 4 to 8 years old in a booster seat (Stehr & Lovrich, 2003). Similarly, an observational study of child restraint legislation in Canadian provinces found that provinces with newly passed legislation saw booster/front-facing restraint use increase to 54% from 26% previously (Simniceanu et al., 2014). However, during the same period, provinces with existing legislation saw no increase (31% vs. 30%). This suggests that legislation on its own may be insufficient, and that the outreach, education, and enforcement activities associated with new legislation play a vital role in increasing restraint use.

One study evaluated the effects of Tennessee's "booster" provisions that added new requirements for 4- to 8-year-olds in 2005 (Gunn et al., 2007). Pre- and post-law observational survey data revealed a significant increase in booster seat use among 4- to 8-year-olds from 29% to 39%. Decina et al. (2008) reported that an observational study conducted to evaluate a demonstration program found a 9-percentage-point increase in the use of child restraints, including booster seats, for children 4 to 8 following enactment of an enhanced child restraint law (booster seat law) in Wisconsin. Similarly, a second evaluation of Wisconsin's booster seat law found that while total booster seat use did increase, the law did not impact all children equally. Specifically, use of booster seats and proper use of booster seats varied among different racial and socioeconomic groups suggesting that further study is needed of the effects of booster seat legislation on all children (Brixey, Corden, Guse, & Layde, 2011).

Several research studies (Fell et al., 2005; Margolis, Bracken, & Stewart, 1996) have found restraint use levels among children and teens covered by restraint use laws are higher than those not covered, and that injury levels among children covered by child passenger safety laws are lower than children not covered.

Costs: The costs of expanding a restraint use law to include all seating positions in all passenger vehicles are minimal.

Time to implement: Expanded restraint use law coverage can be implemented as soon as the law is enacted and publicized.

5. Child Restraint/Booster Seat Law Enforcement

5.1 Short-Term High-Visibility Child Restraint/Booster Law Enforcement

Effectiveness: ★★★★★	Cost: $$$	Use: Medium	Time: Medium

As noted in Section 2.1, high-visibility short-duration belt law enforcement programs, such as *Click It or Ticket*, have proven to be the most effective countermeasure to date for increasing seat belt use. NHTSA typically includes child restraint and booster seat use and enforcement as a part of their *Click It or Ticket* campaigns. There is concern, however, that law enforcement officers are reluctant to enforce child restraint laws due to competing priorities within their departments and a lack of knowledge on the part of officers on the subject of child restraints (Decina, Lococo, Ashburn, Hall, & Rose, 2008; Decina, Temple, & Dorer, 1994; NHTSA, 1990). More recent research demonstrates that effective approaches for enforcing child restraint laws – in particular booster seat laws – are possible, but they depend on top management support and enforcement methods that are dedicated to booster seat and other child restraint laws (Decina, Hall, & Lococo, 2010).

As with high-visibility enforcement aimed at adult occupants (Section 3.1), enforcement of child restraint/booster laws should be coupled with high-visibility communications and outreach (Solomon et al., 2003). Paid advertising can be a critical part of the media strategy. Paid advertising brings with it the ability to control message content, timing, placement, and repetition (Milano et al., 2004).

Use: Most States currently conduct short-term, high-visibility child restraint/booster seat law enforcement programs in May of each year as part of national seat belt mobilizations (Solomon et al., 2004; Solomon, Chaffe, et al., 2007).

Effectiveness: In their systematic review of evidence of effectiveness for child restraint interventions, Zaza et al. (2001) determined that community-wide information plus enhanced enforcement campaigns were effective in increasing child restraint use.

Costs: High-visibility enforcement campaigns are expensive. They require extensive time from State highway safety offices, time from law enforcement officers to conduct the enforcement, and time from media staff and often from consultants to develop, produce, and distribute publicity. Paid advertising increases a campaign's effectiveness but can be quite expensive.

Time to implement: A high-visibility enforcement program requires 4 to 6 months to plan and implement.

Other issues:

- **Barriers to enhanced enforcement programs:** Decina et al. (2008) concluded that barriers to enhanced enforcement programs, especially as related to booster seats, include: low awareness of child restraint laws among parents/caregivers; low perception of risk to child passengers; lack of knowledge about the safety benefits of booster seats among the public; lack of knowledge about the safety benefits of booster seats among law enforcement officers and members of the courts; low threat of being ticketed for violations; and lack of commitment to child passenger safety by law enforcement top management.

- **Strategies to enhance enforcement programs**: Decina et al. (2010) found that the most effective approaches for enforcing booster seat laws depend on top management support to enforce these laws, having resources to support dedicated booster seat law enforcement programs, and enforcement methods that are dedicated to booster seat and other child restraint laws. These elements are in addition to other aspects that have typically been used to maximize the results of child restraint enforcement efforts (NHTSA, 1990). Specifically, effective program components that have worked over time include: media coverage of enforcement and public information activities by the local press and radio and television stations; training of law enforcement officers in the benefits of child passenger protection and methods of effective law enforcement; information activities aimed at target audiences; information activities coinciding with community events; a network of child restraint inspection stations; child restraint distribution programs; and public service announcements and other media coverage.

6. Communications and Outreach

6.1 Strategies for Older Children

Effectiveness: ★★★	Cost: Varies	Use: Unknown	Time: Medium

The number of older children killed in traffic fatalities has decreased substantially since 2006. For children 8 to 12, there has been a 33% decrease from 527 fatalities in 2006 to 353 fatalities in 2015 (NCSA, 2016b). Similarly, for children 13-14 there has been a 47% decrease from 368 fatalities in 2006 to 194 fatalities in 2015. While increased seat belt use has undoubtedly contributed to these improvements, there is still room to improve seat belt use within these age groups. The 2015 NSUBS found that 16% percent of children 8-12 were unrestrained, which represents an increased from 11% in the 2013 NSUBS (Li, Pickrell, & KC, 2016). Children who were unrestrained made up a higher proportion of deaths in fatal crashes (NCSA, 2016b). For children 8-12, 43% of the children killed were unrestrained, whereas only 16% of the children that survived were unrestrained. Similarly, for children 13-14, 60% of the children killed were unrestrained, whereas only 22% of the children that survived were unrestrained (FARS data).

As noted by Kuhn and Lam (2008a; 2008b), there is not a great deal of information on the factors influencing restraint use for children 8 to 15 years old. The few available studies have tended to focus on changing nonuse behaviors without investigating attitudinal or motivational factors that might be useful in developing additional strategies.

Use: There is beginning to be more of an emphasis on developing and implementing programs targeting children 8 to 14. In March 2015, NHTSA announced a new campaign focused on older children (ages 8-14), *Don't Give Up until They Buckle Up*. The campaign is targeted to parents and caregivers of "tweens", with material and resources for States and programs interested in targeting this age group. Some pilot programs have been implemented and evaluated that can be used as resources for program development. One extensive resource available is the report titled *Increasing Seat Belt Use Among 8- to 15-Year-Olds: Volumes I and II* (Kuhn & Lam, 2008a, 2008b).

Effectiveness: The few studies that have been conducted have produced encouraging results. The Avoiding Tween Tragedy Project was a comprehensive program aimed at increasing restraint use among 8- to 15-year-olds in Berks County, Pennsylvania. The program included education at elementary, middle, and high schools, law enforcement participation, earned and paid media, and participation in community events. Restraint use increased significantly following the program (13% at elementary schools, 17% at middle schools, and 20% at high schools). Among elementary school students, back seat positioning also increased. The authors recommend that future programs targeting this age group focus on high-visibility enforcement and education using materials designed for this age group. Because the behaviors of this age group are strongly influenced by others, a legislative focus on primary enforcement of restraint use for all occupants should be pursued if not already in place (Alonge et al., 2012).

The *Just Get It Across* program developed by the Rainbow Babies and Children's Hospital in Cleveland, Ohio targeted parents of 13- to 15-year-olds with a message encouraging parents to promote seat belt use among their teens (program description and implementation: University Hospitals Rainbow Babies & Children's Hospital Injury Prevention Center, 2014). The program demonstrated increases in knowledge of seat belt laws and teen-reported reminders to wear seat belts by parents. Observed seat belt use by parents and teens also increased in the target community; however, it is not clear what role the program had in this increase because seat belt use in the control community also increased (program evaluation: Zakrajsek, Eby, Molnar, St. Louis, & Zanier, 2014).

Colorado and Nevada implemented a Teen Seat Belt Demonstration Project in 2007-2008 consisting of publicity and enforcement. Each State held four enforcement waves focused in areas and times when teenagers were most likely to be driving. In addition to increases in teen awareness of seat belt messages and enforcement, teen belt use increased significantly in both States (5% in Colorado and 8% in Nevada) (Nichols, Haire, Solomon, Ellison-Potter, & Cosgrove, 2011).

The Automotive Coalition for Traffic Safety launched two pilot programs in 2005 targeting 8- to 15-year-olds, sometimes called "tweens." These brief school and community-based interventions targeted both children and their parents. Both programs were successful in changing knowledge and attitudes of the parents and children, but limited observations did not show significant changes in belt use among the targeted children (Jennings, Merzer, & Mitchell, 2006).

Costs: Program costs will depend on the size of the target audience and the components of the program.

Time to implement: Complete programs will require at least four months to plan and implement. School programs may require a full year.

6.2 Strategies for Child Restraint and Booster Seat Use

Effectiveness: ★★★	Cost: Varies	Use: Unknown	Time: Medium

Both the American Academy of Pediatrics and NHTSA recommend children stay rear-facing as long as possible until they outgrow the height or weight limits of the seat, and then use a forward-facing harness for as long as possible. However, observational data from the 2015 National Survey of the Use of Booster Seats (NSUBS) show that 9.2% of children under age 1 were moved to a forward-facing child restraint. Similarly, 23.0% of children 1 to 3 were not in a rear- or forward-facing child restraint but were instead in a booster seat, the seat belt alone, or were unrestrained (Li, Pickrell, & KC, 2016). Note however, that some 3 year olds may meet the requirement of a booster seat, so while it is not best practice, it also is not ‘misuse’.

Booster seats are recommended until the lap/shoulder combination belt fits properly on its own, typically when a child is 8 to 12 years old. However, 2015 NSUBS data show that children are moving into the seat belt much earlier than is recommended. In 2015, 25.8% of children 4 to 7 were restrained using the seat belt alone and 44.5% were using a booster seat. Only 9.1% of children 8 to 12 were using booster seats (Li, Pickrell, & KC, 2016). Due to differences in growth, children may meet the requirements for seat belts or booster seats earlier than their peers. If a child has grown to meet the requirements of a booster seat or a seat belt before reaching the recommended age group, it is not necessarily misuse.

Compared to the 2013 NSUBS, child restraint use in various age groups is either unchanged or slightly lower. In 2015, 9.4% of children 1 to 3 were rear-facing, slightly less than 10.3% in 2013. However, a greater number of children 1 to 3 were prematurely moved to booster seats (13.6% in 2015 compared to 9.3% in 2013). There were also fewer children 4 to 7 were riding in car seats or booster seats compared with 2013 (62.4% versus 66.6%) (Li, Pickrell, & KC, 2016).

Use: Communications and outreach campaigns directed at booster-seat-age children are likely common, but no summary is available.

Effectiveness: The effectiveness of communication and outreach strategies has been examined in various ways. Will, Sabo, and Porter (2009) used a threat-based message to increase booster seat use among attendees of two large daycare/after school programs in Eastern Virginia. The intervention included a video made with images to invoke emotions, crash test footage, well-respected experts, and personal stories to convey a message of high-threat consequences without using gore. The study found significant increases in overall restraint use and booster seat use following exposure to the intervention and concluded that applying messages of high-threat consequences (without gore) to booster seat interventions is a promising approach. Similarly, a number of studies have also used a different threat-based message (“No Regrets”) with some success (Bryant-Stephens, Garcia-Espana, & Winston, 2013; Winston, Erkoboni, & Xie, 2007). Another study found that the strongest predictors of booster seat use among Canadian parents of 4- to 9-year-olds was the parents’ knowledge of the purpose and benefit of booster seat use as well as perceived community norms (Bruce et al., 2011).

The Strike Out Child Passenger Injury program used community sports programs to promote booster seat use among 4- to 7-year-olds in 20 rural communities across four States Alabama, Arkansas, Illinois, and Indiana (Aitken et al., 2013). In the intervention communities, information about proper restraint use was shared in conjunction with T-ball season. In addition to information, parents were given the opportunity to meet with a CPS Technician during a T-ball event in order to get a personal assessment and recommendation for proper restraint use. Child restraints and booster seats were provided to families in need and baseball themed prizes were provided to participants. Control communities received only an informational brochure. Following the short program, proper restraint use increased in intervention communities in 3 of 4 States. This study demonstrated that tailoring a program to fit in an established community event can have a short term impact on restraint use in a rural community where resources are limited.

Costs: As with enforcement-related communications and outreach, costs vary depending on program quality and delivery.

Time to implement: A good educational campaign will require 4 to 6 months to plan and implement.

7. Other Strategies

7.1 School Programs

Effectiveness: ★★★	Cost: Varies	Use: Unknown	Time: Varies

Schools provide well-defined and somewhat controlled audiences for seat belt use programs. Education and other communications strategies can be tailored to a specific audience. While these programs are often well received in the community, there is limited information on their effectiveness.

Use: There are no data on the number of school programs operating currently.

Effectiveness: School programs have been shown to increase belt use in the few evaluations of school programs that have been conducted. Williams, Wells, and Ferguson (1997) conducted a pilot program to increase restraint use and rear seating position among elementary schools and day care centers. The programs, held in conjunction with an ongoing statewide *Click It or Ticket* program, included letters and pamphlets sent to parents, proper restraint use demonstrations, assemblies emphasizing proper restraint use (at the schools), and enforcement checkpoints. Proper use increased substantially at elementary schools (36% to 64%; 49% to 71%) with smaller increases at the daycare centers (71% to 76%; 60% to 75%). The researchers concluded also that enforcement is a key ingredient of programs even among school age children.

See Section 6.1 Communications and Outreach Strategies for Older Children for additional information about programs targeting school-aged children.

Costs: Program costs will depend on the size of the target audience and the components of the program.

Time to implement: School policies can be implemented immediately. Complete programs will require at least 4 months to plan and implement and may require a full year.

7.2 Inspection Stations

Effectiveness: ★★★	Cost: $$	Use: High	Time: Short

The misuse of child restraints has been a concern for many years. A number of programs have been implemented to provide parents and other caregivers with "hands-on" assistance with the installation and use of child restraints in an effort to combat widespread misuse. Child passenger safety (CPS) inspection stations, sometimes called "fitting stations" are places or events where parents and caregivers can receive this assistance from certified CPS technicians. Information on how to market an inspection station campaign is available through Parents Central (www.safercar.gov/parents/CarSeats/TRS-carseats/toolkit.htm). Certification courses for child safety seat checks are available through the National Child Passenger Safety Certification program (http://cert.safekids.org).

Inspection stations in urban communites may be effective in reaching households that improperly use child restraints. One study conducted in Los Angeles that reached out to parents and caregivers using advertisements found that vehicles visiting the inspection stations had a rate of child restrain misuse of 96.2% (Bachman et al., 2016). While this rate was substantially higher than the 46% misuse rate observed in the nationally representative NCRUSS sample (Greenwell, 2015), some of this difference likely reflects a broader definition of misuse in the Los Angeles study as the determination of misuse was based on American Academy of Pediatrics (AAP) best practice recommendations. It is also possible that the households targeted in this community study had particularly high misuse rates. The Los Angeles inspection station study found that factors such as child age, child weight, and vehicle year led to systematic insatnces of child restraint misuse and should be considered when conducitng inspections and addressing deficiencies in restraint use (Bachman et al., 2016).

Use: Child restraint inspection stations have become common components of State and local child passenger safety programs. As of December 2016, there are over 4,900 inspection stations registered with NHTSA (see www.safercar.gov/cpsApp/cps/index.htm for locations).

Effectiveness: One study found that Safe Kids child restraint inspection events held at car dealerships, hospitals, retail outlets and other community locations positively changed parents' behavior and increased their knowledge over a 6-week follow-up period: children arriving at the second event were restrained more safely and more appropriately than they were at the first (Dukehart, Walker, Lococo, Decina, & Staplin, 2007). Another small study found that attending inspection stations may be more effective for increasing restraint use in children older than 4 (Kroeker, Teddy, & Macy, 2015). Specifically, children in this age range were more likely to depart the inspection in a restraint configuration that was more appropriate for their size and weight than prior to the inspection.

Another study evaluated whether a "hands-on" educational intervention makes a difference in whether or not parents correctly use their child restraints. All study participants received a free child restraint and education, but the experimental group also received a hands-on demonstration of correct installation and use of the child restraint in their own vehicles. Parents who received this demonstration were also required to demonstrate in return that they could correctly install the restraint. Follow-up observations found that the intervention group was four times more likely to correctly use their child restraints than was the control group (Tessier, 2010).

An evaluation of the child restraint fitting station network in New South Wales, Australia, found that children whose parents attended a fitting station were significantly more likely to be properly restrained than children whose parents had not visited a fitting station. While specific to Australia, these results suggest similar benefits are possible in the United States (Brown, Finch, Hatfield, & Bilston, 2011).

Costs: Program costs will depend on the size of the target audience, the components of the program, and the level of services offered.

Time to implement: Complete programs typically require several months to plan and implement.

Other issues:

- **Programs to make child seats available at low cost:** One of the issues identified when child passenger safety laws were being considered was the costs associated with obtaining child restraints. Because of this, many State and local organizations initiated programs to make child restraints available at low or no cost to parents though child restraint loan or rental programs (Zaza et al., 2001). Since then, the popularity of these programs has decreased significantly as child restraints have become more readily available and funding for such programs scarce. Much of the research on this topic is quite old. Zaza et al. (2001) conducted a systematic review of evidence of effectiveness for five interventions, including child restraint distribution programs. Evidence suggests child restraint distribution coupled with education can be effective. However, the studies evaluated were mostly from the 1980s when child passenger safety laws were first being passed and the availability and costs of child restraints were much different. It is not clear how the results of this research apply to today. Louis and Lewis (1997) conducted a project to increase child restraint use in low-income minority families. Families in the program were divided into two study groups with both groups receiving free child restraints. One group also received education regarding child restraint use. The results of the study indicated that distributing child restraints resulted in increased long-term use among a low-use population.

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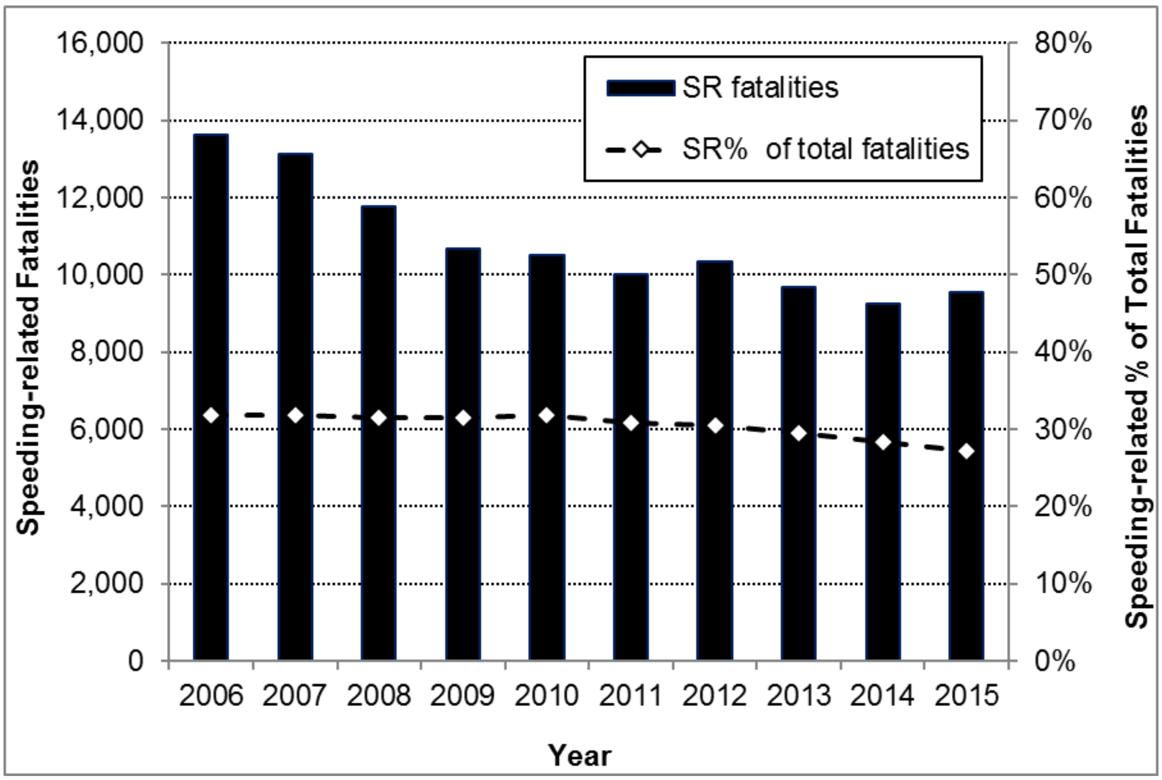
3. Speeding and Speed Management

Overview

Characteristics and problem size: Speeding. NHTSA defines a crash to be speeding-related if any driver involved in the crash is charged with a speeding-related offense or if a police officer indicates that racing, driving too fast for conditions, or exceeding the posted speed limit was a contributing factor in the crash. Speeding-related fatalities have generally reflected nearly one-third of all fatalities, with a general downward trend since 2006, as shown in the figure below. In 2015, there were 9,557 speeding-related fatalities, an increase of 3% from the 9,283 fatalities in 2014 (NCSA, 2017). Speeding is a contributing factor for 27% of fatalities in motor vehicle traffic crashes in U.S. (NCSA, 2017), a percentage that decreased from 32% since 2006.



Source: NCSA (2017)

Younger drivers, particularly young males, continued to be the most likely to be identified as speeding in fatal crashes in 2015. Thirty-two percent (32%) of male drivers 15 to 20 and 21 to 24 involved in fatal crashes were speeding. Other risk factors associated with speeding in 2015 included driver alcohol use, lack of seat belt usage, driver not being properly licensed, nighttime hours, and wet and icy road surfaces at the time of the crash. In addition, motorcycle riders were overrepresented in fatal crashes involving speeding (33%) compared to passenger car drivers (19%) and light truck drivers (15%) (NCSA, 2017).

Speeding is legally defined by States and municipalities in terms of a "basic speed rule" and statutory maximum speed limits. The basic speed rule generally requires drivers to operate a vehicle at a speed that is reasonable and prudent for roadway conditions. Making a determination to take enforcement action is at the law enforcement officer's discretion, which may be impacted by weather, surface conditions, traffic volume, and special locations (e.g., work zones, school zones, or other environmental conditions). Statutory speed limits set maximum limits for different types of roads, and generally apply to all roads of that type even when the limits are not posted. These limits can be superseded by limits posted for specific roadway segments, usually determined by an engineering study. Special Report 254 of the Transportation Research Board, which reviewed much of the past research regarding the effects of speed and speed limits on crashes, describes the reasons for setting speed limits and other actions for managing travel speeds (TRB, 1998). The TRB guide contains much valuable information that is still very relevant for setting limits and managing speeds.

A more recent document prepared by the Global Road Safety Partnership (Howard, Mooren, Nilsson, Quimby, & Vadeby, 2008) with input from U.S. experts, updates speed management guidance based on more recent knowledge, and describes the evolution of practices used by countries with a zero deaths vision and framework. For example, practices used in such countries no longer rely on the 85th percentile or other operating speed distributions, but set limits according to injury minimization principles. A detailed description and comparison of these and other methods is provided in *Methods and Practices for Setting Speed Limits: An Informational Report* (Forbes, Gardner, McGee, & Srinivasan, 2012), prepared by the Institute of Transportation Engineers in cooperation with FHWA. In the U.S., Vision Zero is primarily an initiative targeting local jurisdictions to get them to adopt speed-management policies and roadway design practices that encourage driving at speeds that are less likely to result in serious injuries or fatalities. As of 2017, more than twenty cities had adopted policies from this initiative (Vision Zero Network, 2017).

Speeding can be dangerous on all types of roads. In 2015, 19% of speeding-related fatalities occurred on Interstate highways and other expressways, with 17% occurring on local streets, 17% on non-interstate collectors, and 40% on non-interstate principal and minor arterials combined (NCSA, 2017).

Speeding is also common. A 2007 nationally representative observational survey for NHTSA estimated that, in free-flowing traffic, 48% of drivers on limited access highways were exceeding the speed limit, 60% were exceeding speed limits on other major arterials, and 61% were exceeding speed limits on minor arterials and collectors. Many drivers were exceeding the posted speed limit by more than 10 mph on all of these road types, including 16% on limited access roads, 14% on major arterials, and 15% on minor arterials and collectors (Huey, De Leonardis, Shapiro, & Freedman, 2012). The survey was repeated in 2009, and found that free-flow speeds on limited access highways increased by 6 mph as compared with 2007. The percentage of drivers exceeding the speed limit by more than 10 mph increased from 16% in 2007 to 19% in 2009 on limited access highways. There was little change in speeds on major and minor arterials from 2007 to 2009. Slight declines (0.3 to 0.5 mph) in mean speeds were observed for major arterials, with slight increases (0.2 to 0.4 mph) on minor arterials and collectors. The percentage of drivers exceeding the speed limit by more than 10 mph increased on minor arterials and collectors (from 15% to 16%) from 2007 to 2009 (Huey, De Leonardis, & Freedman, 2012.) Traffic Tech summaries are available for both studies (NHTSA, 2012a; NHTSA, 2012b).

Drivers themselves also report a high percentage of speeding. The most recent nationally representative survey of drivers conducted for NHTSA suggests that some trends in driver attitudes and speeding behaviors may be improving (Schroeder, Kostyniuk, & Mack, 2012). In 1997, 31% of surveyed drivers reported passing other cars more often than other cars passed them. In 2011 about 27% of surveyed drivers indicated passing other drivers more often. The percentage of drivers who reported that they enjoy the feeling of driving fast also declined, from 40% in 1997 to 27% in 2011. In addition, the percentage who thought the faster they drive, the more alert they are decreased (from 29% in 1997 to 15% in 2011), as did the percentage who reported that they try to get where they are going as fast as they can (from 30% in 1997 to 21% in 2011). A few trends did not improve: Driver impatience with slower drivers was about the same in 2011 (61%) as in 1997 (60%). In addition, the proportion of drivers stopped by police for speeding was fairly similar over these different survey periods. Other driver beliefs were sometimes at odds with each other. For example, two-thirds of drivers agreed strongly that "It is unacceptable to exceed the limits by more than 20 mph," and 91% agreed that "Everyone should obey the speed limit because it's the law." Yet 82% agreed that "People should keep up with the flow of traffic," and 51% agreed that speeding tickets have more to do with raising money than they do with reducing speeding.

Drivers in the 2011 survey were grouped (by analysis) into three clusters or categories according to their responses on six questions about speeding behavior (Schroeder, Kostyniuk, & Mack, 2012). Of the sample, 30% were classified as "frequent" speeders. Forty percent of the sample of drivers was classified as "sometime" speeders, and 30% as "non-speeders" or drivers who rarely speed. The vast majority of speeders reported that they often pass others, speed by at least 15 mph on multi-lane divided highways and two-lane highways and by at least 10 mph on residential streets, and were five times more likely to have been stopped for speeding in the past 12 months than non-speeders. Unfortunately, speeders also reported taking other risky actions more often than non-speeders and sometime speeders. Speeders reported talking on the phone or texting more often, using seat belts less often, and drinking before driving slightly more often than the other groups. Speeders also tended to be younger compared to non-speeders and sometime speeders, and to view the need to do something about speeding as less important. Across all drivers, however, 87% of surveyed drivers thought it was very important (48%) or somewhat important (39%) that something is done to reduce speeding.

Another recent study characterized motivations and types of speeders using naturalistic driving data (Richard et al., 2012, for a summary of findings; also see Richard et al., 2013a, 2013b). Speeders were classified into four general patterns based on the percentage of trips with speeding and the average amount of speeding per trip. The four patterns were: (1) incidental or infrequent speeders (few trips with speeding and little speeding on those trips); (2) situational speeders (few trips with speeding but a lot of speeding on those trips); (3) casual speeders (many trips with speeding but only small amounts of speeding on those trips trip); and (4) habitual speeders (speeding on most trips with a lot of speeding on those trips). Young males and young females in urban settings and young males in rural settings were more likely than older drivers to have trips with speeding. Follow-up focus groups revealed some interesting differences between speeding drivers and those that did not speed. Particularly interesting was the drivers' perception of the meaning of posted speed limits. Drivers that sped a lot considered posted limits to be guidelines rather than strict limits, while the non-speeders considered speed limits to be firm limits not to be exceeded.

A follow-up analysis using the naturalistic driving data described above found evidence for a specific type of speeding behavior that had more aggressive characteristics, such as high maximum speeds and high speed variability, in comparison to other types of speeding behaviors (Richard, Divekar, & Brown, 2016). Moreover, drivers that engaged in this type of aggressive speeding differed from other drivers in terms of self-reported measures. In general, these drivers were significantly more likely to report engaging in other risky behaviors such as tailgating, taking risks when in a hurry, and cutting off other drivers. Taken together, this analysis based on naturalistic driving behaviors suggests that aggressive driving may arise from persistent driver attitudes and personality traits.

The legal definitions of speeding include exceeding the posted speed limit, driving too fast for existing conditions, and racing. Speeding becomes an element of aggressive driving when a vehicle's speed substantially exceeds the prevailing travel speeds of other vehicles, and other driving behaviors contribute to unsafe conditions, e.g., tailgating, weaving, and rapid lane changes. Speeding is a more clearly defined problem than aggressive driving, and strategies to reduce speeding (and other serious traffic law violations) may provide a means to address the problem of aggressive driving. However, speeding is among the most complex traffic safety issues to address and requires a multi-disciplinary approach to effectively manage. Enforcement is an important element in developing a strategy to address speeding, as are considerations of engineering issues and public education and communications efforts.

Characteristics and problem size: Aggressive and risky driving. Aggressive and risky driving actions are also perceived to be common, although they are difficult to measure accurately. In NHTSA's 2002 survey of speeding and unsafe driving behaviors, 40% of drivers reported that they sometimes enter an intersection "just as the light turned from yellow to red," and 11% said they often did this. In the same survey, 10% reported sometimes cutting in front of another driver, and 2% said they often did this (NHTSA, 2004). About one-third (34%) of drivers reported that they feel threatened by other drivers at least several times monthly (NHTSA, 2004). The 2011 National Survey of Speeding Attitudes and Behaviors did not ask about these other risky behaviors. NHTSA has estimated that two-thirds of traffic fatalities involve behaviors commonly associated with aggressive driving such as speeding, red-light running, and improper lane changes (NHTSA, 2001). Similarly, the AAA Foundation for Traffic Safety estimated that 56% of fatal crashes involved one or more driver actions typically associated with aggressive driving, the most common being excessive speed (AAA Foundation for Traffic Safety, 2009).

Aggressive driving is generally understood to mean driving actions that markedly exceed the norms of safe driving behavior and that directly affect other road users by placing them in unnecessary danger. Aggressive driving may involve driver anger, attempts to gain an advantage over other drivers, and deliberate violations and deviations from normal traffic speeds (Neuman et al., 2003). It has proven challenging to arrive at a consensus for a theoretical definition of aggressive driving, and hence to come up with a working definition. Not every moving violation is considered to be aggressive driving. However, multiple violations that encroach on others' safe space, such as driving much faster than prevailing speeds, following too closely, making unsafe lane changes, and running red lights, either on one occasion or over a period of time, may indicate a pattern of aggressive driving. Although some States have passed laws criminalizing aggressive driving, it should not be confused with road rage, which is an intentional assault by a driver or passenger with a motor vehicle or a weapon that occurs on the roadway or is precipitated by an incident on the roadway.

Causes of aggressive driving can include both personal influences, such as peer or social pressures, and environmental triggers. A predisposal to styles or habits of driving that frequently puts others at risk might be the norm for a small proportion of drivers, while others may be provoked to drive aggressively, at least occasionally, by exceptional congestion, work zone delays, poorly timed traffic signals, being late, and other frustrating conditions. Other drivers' actions are also sources of irritation for "reactive" style drivers. More than half of drivers in one study reported that they would react aggressively, particularly to being impeded, by others' reckless driving or actions perceived as directly hostile (Björklund, 2008). Other life stressors, such as combat deployments, may also contribute to aggressive driving (Sarkar, 2009). Driving actions are, however, ultimately under individual drivers' control. Behavioral countermeasures for speeding and aggressive driving must reinforce and help teach such control.

Strategies to Reduce Speeding and Aggressive Driving

Speeding and aggressive driving actions, such as red-light running, involve traffic law violations. Therefore, deterrence through traffic law enforcement is the basic behavioral strategy that has been used to control them. This strategy involves the same components used to deter alcohol-impaired driving or seat belt nonuse: highly publicized and highly visible enforcement of practical, sound, and broadly accepted laws. Another important strategy involves setting appropriate speed limits using engineering practices that take into consideration the road segment's design, vulnerable users, traffic operations, land use and environmental conditions (Speed Management, 2008). Information on different speed limit setting approaches is described in *Methods and Practices for Setting Speed Limits*, a report sponsored by FHWA and ITE. Additionally, the *NCHRP Guide for Addressing Aggressive-Driving Collisions* (Neuman et al., 2003) suggests that successful anti- aggressive driving programs place an emphasis on enforcing all traffic laws. Such a strategy increases respect for all laws and the public's expectation that traffic laws should be obeyed.

Speeding is a traffic safety problem that is national in scope, but requires local decision making and action to be managed effectively. Local communities are in the best position to make judgments in balancing risk against mobility, and are encouraged to use all of the tools that are available to make determinations regarding speed management.

Speed enforcement is among the most common traffic enforcement activities conducted by law enforcement across the country. Sustained enforcement of all traffic laws is strongly encouraged, including speeding violations. The enforcement of traffic laws and attentiveness to traffic safety should be a core value and practice among law enforcement agencies in order to achieve results that contribute to the quality of life in communities that are impacted by the movement of traffic.

Specific action and decision making with respect to taking enforcement generally falls to the discretion of the law enforcement officer engaged with the traffic violator. While enforcement action is not always indicated, it does reinforce the concept of consequences for unsafe driving and creates a perception of risk for drivers operating a vehicle unsafely. Enforcement actions for speeding violations should be fair, consistent with local or State statutes, and taken in the interest of preventing traffic crashes. Correspondingly, enforcement activity in locations with a demonstrable speeding/crash issue are ideally recommended for focused enforcement activities.

To support fair, defensible, and reasonable enforcement of speed, speed limits should be established through appropriate engineering practices. Roadway design can take many forms and can manage the smooth and efficient movement of traffic based on the nature of the roadway. These practices include making determinations about appropriate and reasonable speed limits.

Engineering measures may include the application of traffic calming roadway design, such as roadway diets, using devices, markings, and structures to slow traffic to increase safety, or support safety efforts near schools, parks, and other areas, particularly on collector and neighborhood roads (Speed Management, 2008; TRB, 1998; also see *FHWA*, 2009). “Self-enforcing” roadways is a related concept where roadways are designed in such a way as to encourage drivers to intuitively adopt a speed appropriate for the roadway without the need for posted speed limit signs (Neuman et al., 2009). This approach relies on geometric features and visual cues to shape driver speed selection towards speeds that feel safe and comfortable.

Although such measures must be carefully implemented so as not to shift speeding or safety problems to other locations, they can be useful on both local streets and transition areas such as State highways that pass through towns or rural villages (Bagdade et al., 2012). Roundabout intersection designs and road diets also reduce speed and crashes and can, at the same time, improve traffic flows in some situations (Rodegerdts et al., 2007; Harkey et al., 2008; Srinivasan et al.,2011). Well-timed and coordinated traffic signals can improve traffic flow and reduce red-light running and are potentially useful for managing speeds. Adequately designed turn bays and entrance and exit ramps can reduce improper merging and driving on the shoulder (Neuman et al., 2003, Strategy B1). Advance warnings of congestion or delays and well-designed and managed work zones may also decrease unexpected frustration. Intelligent Transportation System technologies such as real-time transit information, variable speed limits, variable message signs, traffic control warning devices and other systems that respond to changing traffic and environmental conditions and provide motorists with timely information, also hold promise for improving mobility and safety by mitigating causes of delay and warning of hazardous conditions that require lower speeds. Company policies, backed up with speed monitors and logs or even speed regulators, can reduce commercial vehicle speeding. A variety of measures to reduce congestion, such as mass-transit, ride-sharing, or bicycle riding, can also diminish driver frustration that leads to aggressive driving (Shinar & Compton, 2004).

Vehicle technologies that interact with the environment, such as adaptive cruise control and intelligent speed adaptation, hold promise. Adaptive cruise control works similarly to standard cruise control, except that, in addition to maintaining a speed set by the driver, a radar system in the front of the vehicle detects and responds to other vehicles in the lane ahead to maintain a safe following distance. Intelligent Speed Adaptation, or ISA, involves in-vehicle devices that “know” the speed limit through accurate speed limit mapping and vehicle location data, and provide a warning or active controls to help prevent speeding above limits (see Sections 2.3 and 3.1). These environmental and vehicular strategies are generally not included in this guide because State Highway Safety Offices (SHSOs) have little or no direct authority or responsibility for them. However, in partnership with other groups, such strategies may be encouraged through Highway Safety Plans.

Any measures that can achieve reductions in average operating speeds, including lower speed limits, enhanced enforcement, and communications campaigns, as well as engineering measures, are expected to reduce fatal and injury crashes (AASHTO, 2010). Small changes in average speed are predicted to have a substantial impact. For example, a reduction of 3 mph in average operating speed on a road with a baseline average operating speed of 30 mph is expected to produce a reduction of 27% in injury crashes and 49% in fatal crashes (AASHTO, 2010; p. 3-57, Table 3E-2). The effects on injury and fatal crashes of changes in average roadway operating speed are also greater, as a percentage, at lower initial average speeds than at higher speeds. The table below reproduces Table 3E-2 from the Highway Safety Manual and shows crash modification factors (CMFs) for fatal and injury crash reductions. To determine the expected crash reductions for different changes in average speed, subtract the CMF from 1. In the example described above – a 3 mph reduction from an initial average operating speed of 30 mph – the CMF is .73, so 1 – .73 is .27, or a 27% reduction in injury crashes. Actual effects may vary depending on the type of countermeasure and other factors. No single strategy will be appropriate for all locations, and combinations of treatments may be needed to obtain speed limit compliance and achieve crash reduction goals.

Expected injury and fatal crash modifications by change in average operating speed*

Change in avg. speed	Baseline average operating speed in mph					
	30	40	50	60	70	80
Injury Crashes						
-5	0.57	0.66	0.71	0.75	0.78	0.81
-4	0.64	0.72	0.77	0.8	0.83	0.85
-3	0.73	0.79	0.83	0.85	0.87	0.88
-2	0.81	0.86	0.88	0.9	0.91	0.92
-1	0.9	0.93	0.94	0.95	0.96	0.96
0	1	1	1	1	1	1
1	1.1	1.07	1.06	1.05	1.04	1.04
2	1.2	1.15	1.12	1.1	1.09	1.08
3	1.31	1.22	1.18	1.15	1.13	1.12
4	1.43	1.3	1.24	1.2	1.18	1.16
5	1.54	1.38	1.3	1.26	1.22	1.2
Fatal Crashes						
-5	0.22	0.36	0.48	0.58	0.67	0.75
-4	0.36	0.48	0.58	0.66	0.73	0.8
-3	0.51	0.61	0.68	0.74	0.8	0.85
-2	0.66	0.73	0.79	0.83	0.86	0.9
-1	0.83	0.86	0.89	0.91	0.93	0.95
0	1	1	1	1	1	1
1	1.18	1.14	1.11	1.09	1.07	1.05
2	1.38	1.28	1.22	1.18	1.14	1.1
3	1.59	1.43	1.34	1.27	1.21	1.16
4	1.81	1.59	1.46	1.36	1.28	1.21
5	2.04	1.75	1.58	1.46	1.36	1.27

NOTE: Although data used to develop these CMFs are international, the results apply to North American conditions.

*This table can be used to estimate expected changes in injury and fatal crashes (if no Crash Modification Factors are available) for treatments reducing average travel speeds of a road by the amounts listed.
Source: Reproduced from AASHTO (2010), p. 3-57; Table 3E-2. Crash Modification Factors for Changes in Average Operating Speed from Highway Safety Manual.

Speed management and the setting of appropriate speed limits requires a coordinated effort among State and local highway safety offices, engineering offices, and law enforcement agencies. A collaborative effort using a multi-disciplinary approach will support better informed and enforceable speed limits likely to have public and political support. Neuman et al. (2009) and other guides in the NCHRP report 500 series provide more detailed information and steps to develop comprehensive safety plans. For example, a comprehensive strategy may begin with data analysis to prioritize corridors, intersections or other areas with crash problems related to speeding or aggressive driving. Analyses may require, at a minimum, crash data and roadway inventory data, both of which are typically maintained and analyzed by State DOTs. Next steps should include identifying other important partners, establishing crash reduction goals, and performing additional diagnosis such as through interdisciplinary, roadway safety audits to identify the specific problems and potential solutions. Next, program developers should conduct economic and feasibility analyses to prioritize among alternate solutions and develop implementation plans. Finally, partners cooperate to implement engineering, enforcement and communications strategies to achieve the desired behaviors and target crash reductions. Combining appropriate countermeasures may achieve greater effects. Communications strategies are important to support enforcement and some types of engineering countermeasures. See Neuman et al. (2003) for specific examples of cooperative strategies on aggressive driving, and Neuman et al. (2009) for more information on speed limit setting, roadway design, traffic enforcement, and public information and educational strategies to reduce speeding-related crashes. State highway safety offices can also promote dissemination of effective practices through the types of safety projects recommended and funded.

The same cooperative methods can be useful in addressing local speeding or aggressive driving concerns, for example, in a neighborhood or on a road segment or corridor. Public safety, local public works or engineering departments, the State DOT, and potentially other partners including community leaders and concerned citizens should be involved at an early stage in the speed management process. An interdisciplinary speed management working group may help to foster long-term commitment, cooperation, and improvement over time (Bagdade et al. 2012).

The recent national *Speed Management Program Plan* updated the national speed management goals and actions for the U.S. Department of Transportation. This Plan emphasizes the importance of comprehensive and cooperative efforts, and outlines the national role in helping States and local agencies reduce speeding-related crashes, injuries and fatalities using the traditional approaches of engineering, enforcement, education and evaluation (NHTSA, FHWA, and FMCSA, 2014). This national plan has several goals and objectives for the DOT related to developing knowledge about the relationships between travel speed and speed limits on crash risk, causes and types of speeding, and developing and testing innovation measures such as variable speed limits combined with automated enforcement and other new technologies. The plan also aims to provide leadership for public policy decision-making, and technical assistance and tools to help agencies develop speed management strategies that meet local needs. The Plan promotes the development of data driven models that target enforcement resources where they are most needed to achieve the greatest safety benefits.

The national efforts to address dangerous speeding and aggressive driving include better understanding of speeding in relation to road designs and environments, and the motivations and choices of drivers. More comprehensive or different types of measures may be needed to address certain types of speeders, including flagrant and repeat offenders, than are generally employed. As part of a comprehensive road safety strategy, the United Kingdom has embarked upon an ambitious research program known as High UnSafe Speed Accident Reduction (HUSSAR) to understand the human, psychological, and emotional factors in speeding and other dangerous driver behaviors so that interventions may better target barriers to speed compliance (Fuller et al., 2008a; Fuller et al., 2008b; Stradling et al., 2008; and others). As already mentioned, several recent U.S. studies have also begun to characterize speeding motivations and attitudes and types of speeding behaviors that may warrant different types of strategies.

A significant body of research has also emerged in the past few years shedding light on characteristics of angry and aggressive drivers and risk-taking tendencies such as impulsiveness or even genetic predispositions. A few pilot studies have noted glimmers of success in helping some of these drivers achieve better control. As examples, a group in Estonia pilot tested an intervention with promising results (Paaver et al., 2013). The intervention was provided by trained psychologists and focused on teaching driving students about impulsive personality and information processing styles, different types of impulsivity and how to recognize such tendencies in oneself, and potential situational triggers that may induce subjects to behave impulsively and take risks. The test group had half as many speeding violations over a year following the intervention as a control group of students from the same driving schools. Another effort in the United Kingdom developed and trialed an intensive personal intervention to target attitudes, skills, and knowledge relating to crash risk among young men with a number of social and behavioral risk factors and high levels of road traffic collisions (Tapp, Pressley, Baugh, & White, 2013). The intervention sought to teach "smoothness and control." The study measured positive and long-lasting impacts among the men who completed the program. One of the challenges, however, was achieving recruitment and completion among this cohort.

A small study pilot tested a work-related driver behavior modification program using feedback and goal setting, as well as a social-norming branding (Newman, Lewis, & Warmerdam, 2014). This trial showed at least short-term improvement in drivers' compliance with speed limits. These and other research efforts may ultimately lead to changes in education, training, and enforcement interventions that will have more beneficial effects on safety than most driver interventions to date.

Resources

As mentioned in the introduction, this document is restricted to behavioral countermeasures that are typically under the direct authority of SHSOs. But a comprehensive, multifaceted approach that incorporates assessing and addressing engineering and environmental issues as well as enforcement, legislative, and program evaluation needs, is essential to most effectively reduce speeding-related crashes and injuries.

Other resources and links:

- National Highway Traffic Safety Administration
  - Speeding – www.nhtsa.gov/risky-driving/speeding; one.nhtsa.gov/Driving-Safety/Aggressive-Driving
  - Enforcement and Justice Services – one.nhtsa.gov/Driving-Safety/Enforcement-&-Justice-Services
  - Research and Evaluation – www.nhtsa.gov/Driving+Safety/Research+&+Evaluation
  - Behavioral Safety Research Reports – ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- FHWA Safety Office, Speed Management Safety page and links: safety.fhwa.dot.gov/speedmgt/
  - Speed Concepts: Informational Guide – http://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa10001/

    - Methods and Practices for Setting Speed Limits- http://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa12004/
- AASHTO Highway Safety Manual: www.highwaysafetymanual.org/
    - AASHTO Strategic Highway Safety Plan, including the NCHRP Report 500 series guides on reducing crashes: www.trb.org/Main/Blurbs/152868.aspx
- Centers for Disease Control, Community Speed Reduction and Public Health. Health Resources In Action resources: www.cdc.gov/healthyplaces/healthtopics/transportation/practice.htm
- Crash Modification Factors Clearinghouse: www.cmfclearinghouse.org/
- NCHRP Report 504, Design Speed, Operating Speed, and Posted Speed Practices: onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_504.pdf
- NCHRP Report 622, *Effectiveness of Behavioral Highway Safety Countermeasures*: www.nap.edu/openbook.php?record_id=14195
- Transportation Research Board Special Report 254, *Managing Speed: Review of Current Practice for Setting and Enforcing Speed Limits*: http://onlinepubs.trb.org/onlinepubs/sr/sr254.pdf
- Global Road Safety Partnership, *Speed Management: Road Safety Manual for Decision-makers and Practitioners*: www.who.int/roadsafety/projects/manuals/speed_manual/en/
- Transportation Research International Documentation (TRID) database – bibliographic database of transportation-related research: trid.trb.org

Speeding and Speed Management Countermeasures

Countermeasures to reduce aggressive driving and speeding are listed in the table below. The table is intended to provide a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. Effectiveness is shown using a five-star rating system:

- Countermeasures that receive ★★★★ or ★★★★★ have been determined to be effective.
- Countermeasures that receive ★★★ are considered promising, and likely to be effective.
- Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States, communities and other organizations are encouraged to use ★★★, and especially ★★★★ or ★★★★★, countermeasures. They should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

Further details about the symbols and terms used are included after the table. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate.

Each countermeasure to reduce aggressive driving and speeding is discussed individually in this chapter. Full descriptions are included for ★★★, ★★★★ and ★★★★★ countermeasures. Brief descriptions are included for ☆ and ☆☆ countermeasures. Further details about the ☆ and ☆☆ countermeasures are included in Appendix A3 to this report.

1. Laws

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Speed Limits	★★★★★†	$	High	Short
1.2 Aggressive Driving and Other Laws	☆	$	Low	Short

† When enforced and obeyed

2. Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Automated Enforcement	★★★★★	$$$†	Medium	Medium
2.2 High-Visibility Enforcement	☆☆	$$$	Low††	Medium
2.3 Other Enforcement Methods	☆☆	Varies	Unknown	Varies

† Can be covered by income from citations

†† For aggressive driving, but use of short-term, high-visibility enforcement campaigns for speeding is more widespread

3. Penalties and Adjudication

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Penalty Types and Levels	☆☆	Varies	High	Low
3.2 Diversion and Plea Agreement Restrictions, Traffic Violator School	☆	Varies	Unknown	Varies

4. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Communications and Outreach Supporting Enforcement	★★★	Varies	Medium	Medium

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, or equipment, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, and/or facilities
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than 1 year

Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Laws

1.1 Speed Limits

Effectiveness: ★★★★★†	Cost: $	Use: High	Time: Short

† When enforced and obeyed

Speed limits are only one part of the system that attempts to control driving speeds. Well-established speed limits based on the use of appropriate engineering practices form the basis for roadway design and operations. Active enforcement and supportive adjudication are also essential to support established limits (NHTSA, FHWA, & FMCSA, 2014).

Speed limits are set both by legislation and by administrative action. General speed limits apply to all roads in a class, such as rural interstates or local streets. They are set by State, municipal, or even at times by Federal law based on tradeoffs between safety, travel efficiency, and community concerns, taking into account the design characteristics of each road class. Speed zones apply to road segments where the general speed limit is thought to be inappropriate. Speed limits in these zones usually are set by administrative action based on the road segment's free-flowing travel speeds, crash experience, road and land use conditions, and other factors (TRB, 1998).

The effects of maximum speed limits on speeds, crashes, and casualties have been studied extensively over the past 40 years. However, recent actions by States raising maximum limits, as well as changes in road design, hardware, vehicles, and drivers suggest that new studies may be needed. In 1974, the 55 mph National Maximum Speed Limit (NMSL) was enacted to conserve fuel. Travel decreased, speeds decreased on roads where the speed limit was lowered to 55 mph, and total traffic fatalities decreased by 9,100 from 1973. The slower and more uniform speeds due to the 55-mph limit are judged to have saved between 3,000 and 5,000 lives in 1974 (TRB, 1984). As fuel became plentiful again, travel increased and compliance with the 55-mph limit decreased markedly (TRB, 1984). In 1987, Congress allowed States to raise speed limits to 65 mph on rural interstate highways. States that raised their limits generally saw increases of about 4 mph in average speeds and 85th percentile speeds and statistically significant increases in traffic fatalities on these roads (TRB, 1998). In 1995, Congress repealed the NMSL and returned full authority to set speed limits back to the States. Again, increased speed limits produced modest increases in both average and 85th percentile speeds as well as increases in traffic fatalities (TRB, 1998; for the most recent analysis, see TRB, 2006). Speed limit increases from 75 to 80 mph on rural Texas interstates in 2006 also resulted in increased speeds relative to a comparison highway where the limit wasn't changed (Retting & Cheung, 2008).

Relatively few studies have examined the safety effects of speed limit changes on lower-speed roads. Earlier studies found little effect on driving speeds or crash rates when speed limits were raised to near the 85th percentile travel speed or lowered to near the 35th percentile speed, either on rural roads or on urban and suburban arterials (TRB, 1998, p. 6). However, a recent study from Edmonton, Alberta, Canada, found that speeds on residential streets decreased significantly when limits were lowered and supported with enforcement or other measures. Specifically, this study found significant speed reductions (3.9 to 4.9 km/h [2.4 to 3.0 mph], three and six months after treatment, respectively) when posted speed limits in residential areas were reduced from 50 km/h (31 mph) to 40 km/h (25 mph). Changes in posted limits were accompanied by education and enforcement measures, but no changes were made to the roadway. Speeds were reduced on both collector and local road types, in all types of communities, for light and heavy vehicles, for different times of day and on weekends and weekdays. Compliance improved over time up to six months post-implementation (Islam, El-Basyouny, & Ibrahim, 2013). Following the lowering of urban default maximum speed limits from 60 km/hr (37.3 mph) to 50 km/h (31.1 mph) in 2003 in Adelaide (South Australia), low speed roads showed a significant reduction in mean speed from 46.9 km/h (29.1 mph) to 44.8 km/h (27.8 mph) (Kloeden & Woolley, 2010). From 2003 to 2010, yearly mean speeds have remained lower than before the limits were changed, fluctuating between a high of 44.8 km/h (27.8 mph) and a low of 43.3 km/h (26.9 mph).

When urban speed limits were increased from 50 to 70 km/h (from 31 to 43 mph) or from 70 to 80 km/h (from 43 to 50 mph) on 19 urban road segments in Hong Kong, crashes increased by 20 to 30% (Wong, Sze, Lo, Hung, & Loo, 2005).

A systematic evaluation of changed speed limits on rural roads and motorways in Sweden also found fairly consistent increases in travel speeds on all types of rural roads when limits were raised and decreases on roads where limits were lowered. Increases of the posted speed limit by 10 km/hr (6.2 mph) led to increases in speeds on the order of about 3 to 3.6 km/h (1.9 to 2.2 mph) in mean speeds (weighted for segments length and volume, and including all vehicles on a section for a given time period, not just free flow speeds). Decreases of the posted speed limit of 10 km/hr (6.2 mph) led to decreases of about 2 to 3.3 km/hr (1.2 to 2 mph) for most road types (Vadeby & Forsman, 2014). These findings are generally in line with those of earlier studies of the effects of changing limits by 5 or more mph (TRB, 1998).

Use: A speed limit is in effect on all road segments in all States. For summaries of each State's maximum speed limits see the Governors Highway Safety Association (GHSA, 2015c) and the Insurance Institute for Highway Safety (IIHS, 2015b) websites. NHTSA (2011) provides a publication with each State's complete speed limit laws.

Effectiveness: Lower maximum speed limits definitely reduce crashes and casualties when lower limits result in reduced speeds. In general, speeds tend to decrease, but to a lower degree than the reduction in limits. Similarly, when limits are raised, speeds tend to increase by a smaller amount than the change in limits. The same holds true on any road: if a lower speed limit yields reduced operating speeds, crashes and injuries are expected to decrease (AASHTO, 2010). A more comprehensive effort that includes changes to the roadway and/or enhanced enforcement may be required to reduce travel speeds by the desired amount, especially if the road design does not reflect the desired speed limit and operating speeds (TRB, 1998). The State of Victoria, Australia implemented a comprehensive effort to reduce speeds that combined review and adjustment of speed limits, covert and overt forms of enforcement, a media campaign, penalty restructuring, and other efforts. An evaluation found these combined elements reduced injury crashes by 10% and fatal crashes by 27% (D'Elia, Newstead, & Cameron, 2007).

Costs: The immediate costs of changing speed limits are for new signage and for publicizing the new limit. Enforcing the new limit may involve substantial costs.

Time to implement: Speed limit changes can be implemented quickly, as soon as signage is in place and the new limits are publicized.

Other issues:

- **Public acceptance, roadway characteristics, enforcement, and publicity:** Lowering speed limits can reduce average driving speeds, but it is generally difficult to enforce and obtain broad compliance with a lower speed limit on a roadway designed for much higher speeds (TRB, 1998). Thus, speed limits must be considered as part of a system including roadway design and other characteristics, active enforcement, and publicity (TRB, 1998).
- **Rational speed limits:** Speed limits on many road segments are frequently not obeyed, and average travel speeds on these segments substantially exceed the speed limit. One strategy that has been proposed to increase overall safety is to carefully set and enforce credible speed limits for homogeneous road segments. Once credible, also called rational, speed limits are established, aggressive enforcement is used to enforce close to the actual limit. The goal of this strategy is to increase the public's overall acceptance of speed limits while reducing the number of people driving at speeds considerably higher than the limit. Evidence suggests that drivers' perceptions of safe speed are in fact influenced by their expectation of what speed above the limit would trigger a ticket (Mannering, 2009). Therefore, lower tolerances would help to increase the perception of the risk of exceeding limits by even small amounts. Although consistency in speed limit setting practices should provide better information about appropriate speeds to drivers, the safety effects of combining rational speed limit setting (with limits raised to between the 50th and 85th percentile free flow operating speed) with enhanced enforcement close to the new limit are uncertain. Reviews of the evidence suggest that it can be difficult to implement or sustain enhanced levels of enforcement. In general, higher speed limits are very likely to lead to higher average speeds if nothing is done to the road or enhanced enforcement is not maintained (Hauer, 2009). Higher average speeds are predicted to lead to an increase in fatal and injury crashes (ASHTO, 2010). When testing the effects of raising speed limits, followed by enhanced enforcement in Mississippi and Virginia, average speeds increased in both locations. In Virginia, average speeds tended to increase about 2 mph at locations where the limit was raised by 5 mph and by 3 to 4 mph where it was raised by 15 mph (Freedman, De Leonardis, Polson, Levi, & Burkhardt, 2007). In Virginia, average speed increased by a statistically significant 3 to 4 mph when the limit was raised from 55 to 65 mph on two rural Virginia highways (Fontain, Park, & Son, 2007). Speed variance did not increase and compliance overall was improved in Virginia, which supplemented stricter enforcement with enhanced roadside signs, media publicity, and brochures (Fontain et al., 2007). Average speeds as well as speed variance increased in Mississippi, where limits were increased on different sections of one route by 5 to 15 mph and the number of extreme speeders were not reduced, except on sections where limits were increased by 15 mph (Freedman et al., 2007). Mississippi chose to enforce only flagrant violators (at least 5 mph above the limit). Crash effects were inconclusive over both of these fairly short term evaluations (1 to 1.5 years), although crashes were higher during the Mississippi trial compared to a prior three-year period. A test in Minnesota yielded more promising, though inconclusive crash trends (Harder & Bloomfield, 2007). The Minnesota campaign, which used speeding and crash histories to help target enforcement, effectively reduced mean speeds and especially excessive speeding (speeds of 70 mph

and more), but the study period was insufficient to assess crash trends. Extensive radio publicity supplemented by earned media was used in the Minnesota campaign, but it was unclear if these efforts were successful at reaching the target audience.

- **Variable speed limits**: Speed limits that may adjust to adverse or changing environmental conditions are considered by FHWA to have promise in restoring credibility of speed limits on some highways. Variable speed limits (VSLs) have long been used on European freeways to manage speed and traffic flows. As of 2013, five metropolitan areas in the United States are employing enforceable, variable speed limits on freeways (posted on changeable message signs) (Office of the Assistant Secretary for Research and Technology, 2013). Variable speed limits are also being used in work zones by 11 agencies including Utah DOT, Minnesota DOT, and Texas DOT (Office of the Assistant Secretary for Research and Technology, 2013; National Work Zone Safety Information Clearinghouse, 2016). A high-quality study of safety effects of variable limits deployed on freeways in the St. Louis area reported crash reductions of 8%. The congestion relief benefits were not as high as the public and agencies had hoped, however, leading to somewhat equivocal support for the measure (Bham et al., 2010). No other quality evaluations are available at present. Preliminary investigation of a Wyoming freeway VSL system showed speed reductions from 0.47 to 0.75 mph for every mph reduction in speed limit (Buddemeyer, Young, & Dorsey-Spitz, 2010). Other States that have used VSL systems to alter speed limits for weather conditions include Alabama, Delaware, and Washington (Katz et al., 2012). Automated speed enforcement could potentially be linked to variable limits to increase compliance.
- **Work Zone speed limits:** If drivers perceive that limits are too low, workers are not present, and other changes to the roadway do not seem to justify the lower limits, they may not comply, and extensive enforcement may be needed to enforce the limit (Ullman et al., 2013).
- **Setting Speed Limits at High-Risk Locations:** A project by Jurewicz, Phillips, Tiotis, and Turner (2014) provided guidelines for setting speed limits at high-risk locations in Australia based on the road category/function and the presence of a severe crash risk (i.e., severe crash rate per 100 million vehicle kilometers traveled), types of road use and users, road features, and speeds. The recommendations incorporate other considerations that affect crash risk such as the presences of high-numbers of pedestrians and cyclists, access point density, AADT, among other factors.

1.2 Aggressive Driving and Other Laws

Effectiveness: ☆	Cost: $	Use: Low	Time: Short

This approach targets aggressive drivers who violate traffic laws repeatedly or whose violations lead to crashes producing serious injury or death. Aggressive driving actions are covered by specific traffic laws, such as the laws regarding speeding, improper lane changes, and following too closely, or by general laws, such as those that target reckless driving. The primary traffic law strategy to address aggressive driving is to assure that more severe penalties are available for repeat offenders and for violations causing death or serious injuries.

Effectiveness Concerns: *There is currently no evidence that aggressive driving laws in general, or increased penalties in particular, affect aggressive driving and related crashes.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A3, Section 1.2.

2. Enforcement

2.1 Automated Enforcement

Effectiveness: ★★★★★	Cost: $$$†	Use: Medium	Time: Medium

† Can be covered by income from citations

The use of automated enforcement systems to address speeding and red-light running are in use across the United States. Many States have prohibitions in their laws to prevent the use of automated enforcement technology; others have enabling legislation and/or parameters on the use of the technology; and others still have no legislation that addresses the technology's use.

Automated speed enforcement (commonly referred to as "photo radar") and red light camera systems should be used as a component of a broader traffic safety and speed management program supported by a demonstrated need through problem identification. These systems should be used to support traditional enforcement efforts, or be deployed in locations where enforcement may be unsafe or impractical for law enforcement officers to make traffic stops.

Automated enforcement systems function by capturing violations, recording relevant data about the violations, and recording image(s) of the violator vehicle. Red light camera systems employ sensors linked to a camera and data collection equipment. Vehicles that enter an intersection against a red signal light are detected; the camera captures a series of images (and with some systems, video) to depict the violation. Sensors provide additional violation data, such as the vehicle speed, the time the light had been red at the point the vehicle entered the intersection, and temporal information. Images and violation data is reviewed at a later time, and when appropriate- a traffic citation is issued and mailed to the registered owner of the vehicle. Some States involve driver liability to determine responsibility for violations. This approach requires a more involved process in which approaching and receding images are captured, and include an image of the driver. Review and processing of citations in such States is more intensive in nature, and places a higher burden on the State to identify the driver for a conviction or finding of responsibility. Many States operating in this manner apply penalty points against the license of the driver.

Other jurisdictions use a registered owner liability approach to enforcement. The processes for this approach are generally more limited and are not reliant on charging the actual driver of the vehicle. This approach places the burden on the registered owner, regardless of who was driving the vehicle to resolve the citation. In many cases, the only defenses would be in cases where it can be demonstrated the vehicle had changed ownership, was stolen, or an error occurred in processing the citation.

Guidance documents have been produced by the Federal Highway Administration and the National Highway Traffic Safety Administration for the use of red light camera systems and automated speed enforcement. Red- Light Camera Systems Operational Guidelines (FHWA, 2005) provides information on red-light camera program costs, effectiveness, implementation, and other issues, Eccles, Fiedler, Persaud, Lyon, and Hansen (2012), and NHTSA and FHWA (2008) released automated enforcement program and operational guides with information on identifying problems and setting up and maintaining an effective and transparent, community-supported enforcement program using speed or red light cameras.

Use: Red-light camera systems are used extensively in other industrialized countries and were first employed in the United Sates in 1993 (NCSRLR, 2002).). As of November 2017, red-light camera systems were being used in 421 communities in 24 States, the District of Columbia, and the U.S. Virgin Islands. Speed cameras were being used in approximately 142 jurisdictions in 12 States, the District of Columbia, and the U.S. Virgin Islands, including four statewide work zone automated enforcement programs (in Illinois, Maryland, Oregon, and Washington) (GHSA, 2017; IIHS, 2017). Speed cameras also are used extensively in other countries (WHO, 2004).

Effectiveness: The effectiveness of red light camera systems has been studied previously and mixed results with respect to crash type and experience were found. The presence of a red light camera system has reflected increased numbers of lower impact rear end crashes at intersections where the systems are installed. Research has also found a reduction in more dangerous offset and right angle crashes at intersections with red light cameras (Aeron-Thomas & Hess, 2006; Decina, Thomas, Srinivasan, & Staplin, 2007; MacCubbin, Staples, & Salwin, 2001; McGee & Eccles, 2003; Retting, Ferguson, & Hakkert, 2003; Washington & Shin, 2005; WHO, 2004). The best-controlled studies have found that intersections with high total volumes, higher entering volumes on the main road, longer green (through) cycle lengths, protected left turn phases, and higher publicity may also increase the safety and cost benefits of red light camera enforcement (Council, Persaud, Eccles, Lyon, & Griffith, 2005; Washington & Shin, 2005).

It should be noted that red light camera technology does not cause traffic crashes. Additional studies may provide greater insight into whether or not such crashes persist where the technology is in place for longer periods of time. The effect of warning signs, public education, and familiarity with the presence of the system in the fullness of time is not clear.

The use of warning signs for drivers to indicate the presence of automated enforcement systems within the community, and in the approaches where the technology is deployed, is highly recommended. These signs enable drivers to come into compliance before a crash or enforcement event occurs, and provides fair warning to drivers of potential enforcement action in general. Washington and Shin (2005) also caution that less expensive engineering solutions should be sought before implementing camera programs.

The use of speed cameras can contribute to reductions in speed and crash experience. Decina et al. (2007) reviewed 13 safety impact studies of automated speed enforcement internationally, including one study from a U.S. jurisdiction. The best-controlled studies suggest injury crash reductions relating to the introduction of speed cameras are likely to be in the range of 20 to 25% at conspicuous, fixed camera sites. Covert, mobile enforcement programs also result in significant crash reductions area-wide (Thomas, Srinivasan, Decina, & Staplin, 2008). Recent crash-based studies from the United States have reported positive safety benefits of crash and speed reductions from mobile camera enforcement on 14 urban arterials in Charlotte, North Carolina (Cunningham Hummer, & Moon, 2008), and from fixed camera enforcement on an urban Arizona freeway (Shin, Washington, & van Schalkwyk, 2009).

The Shin et al. (2009) study examined effects of a fixed camera enforcement program applied to a 6.5-mile urban freeway section through Scottsdale, Arizona. The speed limit on the enforced freeway was 65 mph; the enforcement trigger was set to 76 mph. Total *target* crashes were reduced by an estimated 44 to 54%, injury crashes by 28 to 48%, and property damage only crashes by 46 to 56% during the 9-month program period. Since analyses found low speeding detection rates during peak travel times, the target crashes (speeding-related crashes) were considered to be those that occurred during non-peak flow periods (weekends, holidays, and non-peak weekdays hours). In addition to the crash reductions, average speed was decreased by about 9 mph and speed variance also decreased around the enforced zones. Another positive finding from this study was that all types of crashes appeared to be reduced, with the possible exception of rear-end crashes, for which effects were non-significant. Thus, there were no obvious trade-offs of decreases in some crash types at the expense of increases in others. The program effects should be considered short-term. There was also very limited examination of spillover effects, including the possibility of traffic or crash diversion to other routes.

Speed cameras were also installed on Interstate 10, west of central Phoenix, and were supported by mobile speed camera units (vehicle mounted). In 2009/2010, a political determination was made to discontinue the speed camera program. Among the factors impacting the decision was the fatal shooting of the operator of a mobile speed camera operator in his vehicle that created concerns for the safety of personnel in the field. Additionally, a change in administration in the State shifted the view of automated enforcement in general, and on the freeways around Phoenix, in particular. However, there are a number of local jurisdictions in Arizona that have retained their automated enforcement systems, and continue to operate speed enforcement and red light camera programs.

Pilot project evaluations of speed camera use in the United States have also obtained promising speed reductions from fixed speed cameras in low-speed, school zones in Portland, Oregon (Freedman et al., 2006), and low-speed limit residential streets and school zones in Montgomery County, Maryland (Retting, Farmer, & McCartt, 2008). In the latter case, speed reductions attributed to spillover from the automated enforcement program were also observed on unenforced comparison streets (Retting et al., 2008). In an update to the original study by Retting et al. (2008), Hu and McCartt (2015) evaluated speed data from 18 of the 20 original speed cameras and data from nine of the 10 control sites. Between the six months before and seven and a half years after the start of the speed camera program, mean speeds decreased by 13% at the camera sites, 5% at the spillover sites, and by 4% at the unenforced comparison sites. The percentage of vehicles exceeding the speed limit by more than 10 mph decreased by 64% at camera sites, by 39% at spillover sites, and by 43% at unenforced comparison sites.

The percentage of speeders was also substantially reduced when police-operated photo radar enforcement vans were present in a work zone on a non-interstate highway in Portland, Oregon, but there was no carry-over when the enforcement was not present (Joerger, 2010). Given that there was no evidence of any accompanying signs or publicity, there was, however, no reason to expect carry-over outside of the enforced periods. Crash and injury outcomes were not evaluated in these studies.

The use of fixed speed cameras has also been evaluated internationally, specifically in Norway. Hoye (2015) investigated the effects of speed cameras on injury crashes and the number killed or severely injured (KSI) on short, medium, and long road lengths downstream of camera sites from 2000 to 2010. Short road lengths were 100 m upstream to 100 m downstream of the camera site, medium road lengths were 100 m upstream to 1 km downstream of the camera site, and long road lengths were 100 m upstream to 3 km downstream of the camera site. There was a 22% reduction in injury crashes on road sections of medium length, but no significant reductions for short or long road lengths. Additional speed cameras installed in 2004 or later furthered the reduction in injury crashes and KSI with 9% and 39% reductions respectively on long road lengths, and 32% and 49% reductions respectively on medium road lengths.

Costs: Costs will be based on equipment choices, operational and administrative characteristics of the program, and specific negotiations with vendors. Cameras may be purchased, leased, or installed and maintained by contractors for a negotiated fee (NHTSA & Federal Highway Administration, 2008). Most jurisdictions contract with private vendors to install and maintain the cameras and, to process images and violations. A substantial portion of the fines from red-light citations is generally used to cover program costs (Washington & Shin, 2005). Operating costs of automated enforcement systems vary based on the nature of the system, administrative costs, and negotiated fees to vendors providing services to a jurisdiction. Many systems are “turnkey” operations, in which a vendor provides all of the equipment, vehicles, and support services necessary to collect violation data and issue a citation. The cost for this service may be based on a fixed monthly fee, or on a negotiated fee for issued or paid citations.

Costs to communities or States for the installation of fixed equipment can vary based on the type of system, the number of devices in use, and the type of sensors being employed to collect violation data. Jurisdictions must make the return on investment decisions for accepting these costs based on their determination of need, risk vs mobility assessment, and budgetary projections and constraints.

Fixed speed camera costs may not be similar to those for red-light camera programs, based on volume of activity and violations they generate. An economic analysis estimated the total cost savings of the Scottsdale freeway fixed speed enforcement were from $16.5 to $17.1 million per year, considering only camera installation and operational cost estimates and crash cost impacts (other potential economic impacts were not considered) (Shin, Washington, & van Schalkwyk, 2009). Chen (2005) provides an extensive analysis of the costs and benefits of the British Columbia, Canada, mobile speed camera program and estimated a societal savings of C$114 million and a savings of over C$38 million for the Insurance Corporation of British Columbia (ICBC) that funded the program. Gains, Heydecker, Shrewsbury, and Robertson (2004) reported a 4:1 overall societal cost to benefit ratio of operating the national (fixed) speed camera program in the U.K. based on 33% reductions in personal injury crashes at camera sites and a 40% reduction in the number of people killed and seriously injured.

Time to implement: Once any necessary legislation is enacted, automated enforcement programs generally require up to nine months to plan, publicize, and implement.

Other issues:

- **Laws:** Many jurisdictions using automated enforcement are in States with laws authorizing its use. Some States permit automated enforcement without a specific State law. Others prohibit or restrict some forms of automated enforcement (GHSA, 2015b; IIHS, 2015a). In yet others, there is no specific statute, and it cannot be inferred from case law whether the State allows automated enforcement. As of February 2010, 9 States had statutes specifically authorizing the use of automated speed enforcement, three implicitly allowed automated speed enforcement (but had no specific authorizing statute), and 6 had statutes allowing specific or limited automated speed enforcement (NHTSA, 2011). See NCUTLO (2000) for a model automated enforcement law.
- **Public acceptance:** Public surveys typically show strong support for red-light cameras and somewhat weaker support for speed cameras (NHTSA, 2004). A 2011 nationally representative survey of drivers found that 86% thought automated speed cameras would be acceptable to enforce speed limits in school zones. Significant majorities also thought they would be acceptable at high-crash locations (84%), in construction zones (74%), and in areas that would be hazardous for police officers to stop vehicles (70%) or would cause congestion (63%). Thirty-five percent thought automated camera enforcement of speeds is acceptable on all roads (Schroeder, Kostyniuk, & Mack, 2012). Support appears highest in jurisdictions that have implemented red-light or speed cameras. A survey of District of Columbia residents found 76% favored speed cameras, with even higher support among non-drivers (Cicchino, Wells, & McCartt, 2014). A larger majority of 87% favored the use of red light cameras. Interestingly, support was lower for measures not currently in use, including photo-enforcement of stop signs (50%) and yielding at crosswalks (47%). Again, support was higher among non-drivers for these measures (Cicchino et al., 2014). However, efforts to institute automated enforcement often are opposed by people who believe that speed or red-light cameras intrude on individual privacy or are an inappropriate extension of law enforcement authority. They also may be opposed if they are viewed as revenue generators rather than methods for improving safety. Drivers responding to the NHTSA survey, although indicating support generally for automated enforcement in certain types of locations or conditions, were also more likely to somewhat agree or strongly agree with the statement that speed cameras are used to generate revenue (70%) than with the statement that speed cameras are used to prevent accidents (55%) (Schroeder et al., 2012). Such concerns should be carefully and openly addressed in any automated enforcement program. FHWA recommends, for example, that per citation payment arrangements to private contractors should be avoided to reduce the appearance of conflicts of interest (FHWA, 2005). A case study from Portland Oregon's RLC program indicates that the vendor payment structure is a blended contract. The vendor receives a fixed amount per intersection to install and operate the cameras (the city picks the sites) and a monthly amount based on the number of citations that are issued (Eccles, Fiedler, Persaud, Lyon, & Hansen, 2012). The marginal amount decreases with more citations issued. The current payment structure is $27 per citation for the first 500 paid citations in a month, $20 for citations 501-700, and $18 for each paid citation over 700. A couple of research papers have discussed how Australia and the United Kingdom have dealt with the opponents of and controversies associated with speed cameras and expanded programs at the same time (Delaney, Diamantopoulou, & Cameron, 2003; Delaney, Ward, Cameron, & Williams, 2005). Also see Eccles, Fiedler,

Persaud, Lyon, & Hansen (2012) for more in-depth description of best practices for speed camera programs and case study examples of sustained programs.

- **Legality:** State courts have consistently supported the constitutionality of automated enforcement (Poole, 2012).
- **Covert versus overt enforcement:** Covert, mobile speed camera enforcement programs may provide a more generalized deterrent effect and may have the added benefit that drivers are less likely to know precisely when and where cameras are operating. Drivers may therefore be less likely to adapt to cameras by taking alternate routes or speeding up after passing cameras, but data is lacking to confirm this idea (Thomas et al., 2008). Public acceptance may be somewhat harder to gain with more covert forms of enforcement (NHTSA & FHWA, 2008). Fixed, or signed, conspicuous mobile enforcement may also be more noticeable and achieve more rapid site-specific speed and crash reductions at high crash locations. However, the use of general signs in jurisdictions with automated enforcement (not at specifically enforced zones), media, and other program publicity about the need for speed enforcement may help to overcome the idea that covert enforcement is unfair, and promote the perception that enforcement is widespread, enhancing deterrence effects. Based on lessons learned abroad, a mix of conspicuous and covert forms of enforcement may be most effective. See Belin, Tillgren, Vedung, Cameron, & Tingvall (2010) for a comparison of Australian covert and Swedish fixed, overt systems. NHTSA and FHWA's operational guidelines document outlines other considerations of overt and covert speed enforcement and signing strategies (NHTSA & FHWA, 2008).
- **Halo effects:** More research is needed to shed light on spillover effects (positive or negative) of automated speed enforcement programs of varying characteristics. While fixed cameras may yield more dramatic decreases in crashes at the treated sites (which, however, are often sites with high crash frequencies that are likely to decrease in subsequent years) than mobile enforcement, there is little reason to expect that there would be a significant positive spillover effect. In fact, some studies have detected crash migration related to conspicuous, fixed camera enforcement (Decina et al., 2007). There is also a possibility of negative spillover resulting from mobile camera enforcement, but signing and random deployment practices may reduce that possibility (Thomas, Srinivasan, et al., 2008).
- **Average speed (over distance) enforcement:** A review of the evidence to date suggests that enforcement (using multiple cameras and camera sites) of average motorist speed over distance is associated with reductions in average and 85th percentile speeds, and the proportion of speeding vehicles. Such systems have the potential to reduce speed variability and improve traffic flow characteristics, and may help to avoid negative halo effects such as crash migration to downstream sites that fixed or overt mobile enforcement sometimes experience (Soole, Watson, and Fleiter, 2013).
- **Enforcement threshold:** Victoria, Australia has had success with a program that tightened enforcement tolerances as part of an overall speed management package that included automated and other enforcement, publicity, and penalty restructuring (D'Elia, Newstead, & Cameron, 2007). A recent experiment in Finland also found that lowering the enforcement threshold of fixed, speed camera enforcement on a rural, two-lane road from 20 km/h (12.4 mph) above the limit to 4 km/h (2.5 mph) above the limit (advertised as zero tolerance) and publicity of the measure reduced mean speeds by 2.5 km/h (1.6

mph) and speed variance by 1.1 km/h (0.7 mph) in comparison with a similar, camera-enforced corridor where the threshold was not reduced (Luoma, Rajamäki, & Malvivuo, 2012). The percentage of vehicles exceeding the speed limit was reduced from 23% to 10%, so deterrence of speeding was increased without increasing the processed citations (police or administrative burden). The speed effect of the reduced threshold was within the range of effect of the initial implementation of the automated camera enforcement.

- **Implementation Considerations:** The Province of Ontario, Canada offers suggestions for municipalities that are considering initiating a red light camera program based on the lessons learned during 13 years of red light camera program operations. As of 2014, there were over 190 camera operating sites in South and Central Ontario, spanning seven municipalities (Solomon, Izadpanah, Brady, & Hadayeghi, 2014). Solomon et al., (2014) offer multiple suggestions for improving the effectiveness of these programs, which cover aspects related to planning, implementation, performance, evaluation, and supporting policy.

2.2 High-Visibility Enforcement

Effectiveness: ☆☆	Cost: $$$	Use: Low-Medium†	Time: Medium

† Use is low for aggressive driving, but use of short-term, high-visibility enforcement campaigns for speeding is more widespread

High-visibility enforcement campaigns have been used to deter speeding and aggressive driving through specific and general deterrence. In the high-visibility enforcement model, law enforcement target certain high-crash or high-violation geographical areas using either expanded regular patrols or designated aggressive driving patrols. The objective is to convince the public that speeding and aggressive driving actions are likely to be detected and that offenders will be arrested and punished.

Effectiveness Concerns: *This countermeasure has been examined in several research studies. Overall, the findings regarding countermeasure effectiveness are inconclusive. While some studies suggest that high-visibility, anti-speeding and aggressive driving enforcement campaigns produce some safety-related benefits, other comparable studies show no benefits or even negative outcomes.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A3, 2.2.

2.3 Other Enforcement Methods

Effectiveness: ☆☆	Cost: Varies	Use: Unknown	Time: Varies

Several technologies have been recommended to address speeding and aggressive driving, and law enforcement agencies around the country have conducted innovative and effective aggressive driving enforcement programs. These include several different types of infrastructure-based and in-vehicle technologies, such as speed trailers, drone radar, and intelligent speed adaptation (see Appendix A3, Section 2.3 for more details).

Effectiveness Concerns*:* *In general, these technological measures have not been adequately studied to reliably determine their effectiveness.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A3, Section 2.3.

3. Penalties and Adjudication

3.1 Penalty Types and Levels

Effectiveness: ☆☆†	Cost: Varies	Use: High	Time: Low

† For general traffic offenses

This countermeasure involves implementing progressive penalty types and levels for speeding and the various traffic offenses included under aggressive driving as part of each State's overall driver control system.

Effectiveness Concerns: *This countermeasure is widely used. Its effectiveness has been examined in several research studies. The balance of the evidence suggests that these types of countermeasures are ineffective in the long term.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A3, Section 3.1.

3.2 Diversion and Plea Agreement Restrictions; Traffic Violator School

Effectiveness: ☆	Cost: Varies	Use: Unknown	Time: Varies

In this countermeasure, drivers who have accumulated a specific number of demerit points on their driver's licenses are given the option of attending Traffic Violator School in order to reduce their punishment.

Effectiveness Concerns: *Although there is some research examining the effectiveness of this countermeasure, there is insufficient evidence to conclude that the positive effects outweigh the negative effects that have also been observed.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A3, Section 3.2.

4. Communications and Outreach

4.1 Communications and Outreach Supporting Enforcement

Effectiveness: ★★★	Cost: Varies	Use: Medium	Time: Medium

Effective, high-visibility communications and outreach are an essential part of successful speed and aggressive-driving enforcement programs (Neuman et al., 2003; NHTSA, 2000). All of the examples discussed in Chapter 3, Sections 2.2, High-visibility Enforcement, and 2.3, Other Enforcement Methods, used extensive communications campaigns to support their enforcement efforts. Most campaigns to date have not used paid advertising. The success of paid advertising in seat belt use campaigns (Chapter 2, Section 3.1) suggests that it is worth considering for speed and aggressive driving enforcement campaigns.

The objective should be to provide information about the program, including expected safety benefits, and to persuade motorists that detection and punishment for violations is likely. See also Neuman et al. (2003, Strategy A2). Communications and outreach programs urging drivers to behave courteously or not to speed are unlikely to have any effect unless they are tied to vigorous enforcement (Neuman et al., 2003, Strategy A2). Campaign messages that are pre-tested to ensure they are relevant to the target audience and that reach the audience with sufficient intensity and duration to be perceived and noticed are most likely to be effective (Preusser et al., 2008). Other State and community partners may also help leverage resources and achieve a wider reach if they have common goals and concerns (GHSA, 2004).

A recent assessment report prepared for the Governor's Highway Safety Association also recommends raising the priority of speed enforcement as a traffic safety priority among law enforcement agencies, the general public and the courts (Sprattler, 2012). Such an effort may require careful framing of the message that speed enforcement is a public injury prevention strategy. Health Resources in Action developed community resources for the Centers for Disease Control and Prevention highlighting injury-reduction and public health and community livability issues in relation to speed and speed management (Health Resources in Action, 2013; and other resources available at www.cdc.gov/healthyplaces/healthtopics/transportation/practice.htm.)

Use: Most aggressive driving and speed enforcement programs have a communications and outreach component. At least half the States have a named public awareness campaign (Sprattler, 2012).

Effectiveness: A recent meta-analysis of 67 worldwide studies of the effect of road safety campaigns on crashes suggests a general campaign effect of 9%; however, anti-drunk-driving campaigns were considerably more effective than anti-speeding campaigns (Phillips, Ulleberg, & Vaa, 2011). Other evidence comes from publicity associated with automated enforcement programs. Reductions in crashes in Victoria, Australia, have been attributed to a television advertising campaign that supported, but did not relate directly, to automated speed enforcement initiatives (Bobevski, Hosking, Oxley, & Cameron, 2007). A study from Charlotte, NC also found that publicity from an aggressive media outreach campaign and on-going publicity related to automated enforcement was responsible for an 8 to 9% reduction in crashes. Effects carried over for several months after the program ended before gradually returning to pre-intervention levels (Moon & Hummer, 2010). Earlier evidence from Australia also suggested that paid media advertising could enhance the effectiveness of automated speed enforcement (Cameron, Cavallo, & Gilbert, 1992). The evidence from seat belt (Chapter 2, Sections 2.1, 2.2, and 3.1) and alcohol-impaired driving (Chapter 1, Sections 2.1 and 2.2) enforcement programs also strongly suggests that good communications and outreach are essential to a successful enforcement program.

Costs: Good media campaigns can be expensive. See Chapter 2, Section 3.1.

Time to implement: An effective media campaign requires 4 to 6 months to plan and implement.

Other issues:

- **Effective campaign characteristics:** The Phillips et al. (2011) meta-analysis of publicity campaigns attempted to identify factors associated with successful campaigns. The researchers caution that they could not assess factors that were not reported on frequently, or had little variation, and also could not assess important program aspects such as the degree of publicity achieved, whether a campaign addressed the social norm, or whether behavioral change was achieved. As mentioned above, they found that speed-based campaigns were generally less effective than alcohol-themed ones. In addition, results suggested that the type of message delivery had an effect. Messages delivered through personal communications or at the roadside (such as variable and mixed message signs, etc.) were independently associated with greater effectiveness than campaigns that used mass media. Roadside delivery may provide the message in a context-relevant way that is more proximal to the potentially negative behaviors (such as speeding), while personal communications may improve processing of the message and message uptake compared with mass media delivery (Phillips et al., 2011). However, the authors emphasized that the potential target reach of mass media suggests it still be considered a viable method of delivery.
- As found in Philadelphia's *Heed the Speed* campaign, getting message penetration through signs, flyers and other community outreach is a challenge in a large urban setting (Blomberg, Thomas, & Marziani, 2012).

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4. Distracted and Drowsy Driving

Overview

Distracted driving and drowsy driving are common, though both are difficult to define, measure, and sometimes observe. Both distracted and drowsy driving result in large part from lifestyle patterns and choices. For these reasons, few behavioral highway safety countermeasures have been shown to reduce distracted or drowsy driving, although a number of new countermeasures are currently being developed and evaluated.

Distracted driving has received a great deal of attention in recent years. The U.S. Department of Transportation held two distracted driving summits in Washington, D.C., developed a *Blueprint for Ending Distracted Driving* (NHTSA, 2012). Although much of the attention and research has concentrated on cell phones and texting, this is just one of many potential distractions behind the wheel. For example, NHTSA hosted a technical meeting in 2015 to discuss cognitive distraction or mind-wandering. Until recently, attention and research on drowsiness has primarily concentrated on commercial truck drivers, but the problem is far more widespread. NHTSA initiated a new effort to address drowsy driving by hosting a forum in 2015 and releasing the ‘Drowsy Driving Research and Program Plan” in 2016.

A related issue that is emerging as a growing safety concern is distracted pedestrians using cell phones and electronic devices in the roadway environment. A recent literature review from NHTSA found that, based on the limited amount of research done on pedestrian distraction, distraction is associated with a small but statistically significant decrease in pedestrian safety (Scopatz & Zhou, 2016). This issue is discussed in more detail in Chapter 8.

Problem size and characteristics: distracted driving. Distraction occurs when a driver’s attention is diverted away from driving to some other activity. A distraction can be produced by something a driver sees or hears, some physical task not directly involved in driving such as eating or operating the car radio, or mental activities such as conversations on a cell phone (Goodwin et al., 2005, Section III).

It is clear that the public perceives driver distraction to be a serious traffic safety issues. In 2013, AAA Foundation surveyed 3,103 U.S. residents and found that 9 in 10 (88%) say distracted driving is a “somewhat” or “much bigger” problem today compared to three years ago, and 89% believe drivers talking on cell phones are a “somewhat” or “very serious” threat to their personal safety (AAA Foundation, 2013). In 2015, AAA Foundation repeated this survey with 2,442 U.S. residents and found that almost the same number proportion or percentage (85%) say distracted driving is a “somewhat” or “much bigger” problem today compared to three years ago, and 86% believe drivers talking on cell phones are a “somewhat” or “very serious” threat to their personal safety (AAA Foundation, 2016). Similarly, in 2012 NHTSA conducted 6,016 telephone interviews and asked respondents how safe they would feel in a variety of situations in which they are passengers in vehicles operated by drivers who are engaged in other activities while driving. NHTSA found that about two-thirds (66%) would feel “somewhat” or “very” unsafe if the driver was to “talk on a cell phone while holding the phone” and almost all (95%) would feel “somewhat” or “very” unsafe if the driver was to “read e-mails or text messages” or “send text messages or emails (Schroeder, Meyers, & Kostyniuk, 2013).

Although people are concerned about distracted driving, they frequently admit to engaging in such behaviors behind the wheel. In the 2013 AAA Foundation survey, two-thirds (67%) of respondents admitted to talking on the phone while driving during the past 30 days (AAA Foundation, 2013). A third (35%) admitted to reading text messages while driving, and a fourth (26%) had sent text messages. The AAA Foundation conducted another survey in 2015 and found that more than two-thirds (69.9%) of respondents admitted to talking on the phone while driving during the past 30 days (AAA Foundation, 2016). Two in five drivers (42.3%) admitted to reading text messages while driving in the past 30 days, and nearly one-third (31.5%) had sent text messages. These findings show that the problem has worsened since the 2013 survey. The AAA Foundation summarized their findings by observing that a substantial number of drivers have a “Do as I say, not as I do” attitude with regard to distracted driving – they view these behaviors as dangerous, but engage in them nevertheless. The 2012 NHTSA survey also asked about a variety of behaviors related to distracted driving (Schroeder, Meyers, & Kostyniuk, 2013). Among the behaviors that drivers reported doing at least sometimes:

- 80% talking to other passengers;
- 68% adjusting the car radio;
- 47% eating or drinking;
- 40% making or accepting phone calls;
- 36% interacting with children in the back seat;
- 35% using a navigational system;
- 25% changing CDs, DVDs, or tapes;
- 20% using a smartphone for driving directions;
- 14% reading e-mail or text messages;
- 10% sending text messages or email;
- 9% personal grooming.

The role of distraction in crashes can be difficult to determine because pre-crash distractions often leave no evidence for law enforcement officers or crash investigators to observe and drivers are understandably reluctant to admit to having been distracted during a crash. According to NHTSA’s NCSA, there were 3,179 fatalities in distraction-affected crashes in 2014 (NCSA, 2016). This represents an increase of 8.8% from the 3,197 fatalities in 2014. Ten percent (3,196) of all fatal crashes are distraction-affected crashes (NCSA, 2017). Distracted-affected crashes is a new measure that focuses on distractions that are most likely to affect crash involvement such as distraction by dialing a cell phone or texting and distraction by an outside person/event (NHTSA, 2015).

The risks posed by specific distracted driving behaviors are beginning to be understood thanks to naturalistic driving studies that use onboard sensors and cameras to capture data right before crashes as well as during normal driving situations. The recently completed Second Strategic Highway Research Program Naturalistic Driving Study (SHRP 2 NDS) included 3,500 participants, 35 million miles of continuous driving data, and 905 injury and property damage only (PDO) crashes. As such, it provided the first opportunity to perform a direct analysis of the crash risk associated with various observable distractions compared to regular driving (Dingus et al., 2016). In the table below, a change in risk greater than 1 represents an increase in crash risk due to the secondary task, while a change in risk less than 1 represents a decrease in crash risk. For example, interacting with a handheld cell phone increases the risk of a crash 3.6 times compared to model driving. The table also shows baseline prevalence of the distraction in terms of the percentage of time drivers engaged in a distracting task while driving.

Type of Distraction	Change in Risk (Odds Ratio)	Baseline Prevalence
Total cell (handheld)	*3.6*	*6.4%*
Cell dial (handheld)	12.2	0.1%
Cell text (handheld)	6.1	1.9%
Cell reach	4.8	0.6%
Cell browse	2.7	0.7%
Cell talk	2.2	3.2%
Total in-vehicle device	*2.5*	*3.5%*
In-vehicle device (other, e.g. touchscreen)	4.6	0.8%
In-vehicle climate control	2.3	0.6%
In-vehicle radio	1.9	2.2%
Reading/writing (including tablet)	9.9	0.1%
Reaching for object (other than cell phone)	9.1	1.1%
Looking at outside object	7.1	0.9%
Eating	1.8	1.9%

Note: All odds ratios statistically different from 1 at the 0.05 level of significance.
Source: Dingus et al. (2016).

Klauer et al. (2014) used a naturalistic study to examine distracted behaviors and their effects on the risk of being involved in a crash or near crash among 42 newly licensed (novice) drivers. Some of the findings are shown in the table below. Novices were eight times more likely to be involved in a crash or near crash when dialing a cell phone and seven times more likely to be involved in a crash or near crash when reaching for a cell phone. While the novice driver study had far fewer participants than the SHRP 2 NDS study above, it demonstrated that the risks posed by various types of distraction are problematic for young drivers just as they are for the general driving population.

Estimated Change in Crash Risk When Engaging in Secondary Tasks, Newly Licensed (Novice) Drivers

Type of secondary task	Change in risk
Using a cell phone	
Dialing	8.3
Reaching for phone	7.1
Texting	3.9
Reaching for object (other than cell phone)	8.0
Looking at outside object	3.9
Eating	3.0

Note: All odds ratios statistically different from 1 at the 0.05 level of significance.
Source: Klauer et al. (2014).

Given the possible visual, manual, and cognitive attention changes caused by secondary tasks while driving, none of the distractions listed in the tables above is easily addressed. Moreover, it is important to note that many of the studies on distracted driving and its consequences were conducted prior to the proliferation of smart phones, navigation apps and devices, and built-in technologies. Consequently, it is possible that distraction-related crashes will escalate as the prevalence, diversity, and use of new technologies continues to increase.

Problem size and characteristics: drowsy driving.
Drowsy driving shares some characteristics with distracted driving in that it can cause drivers to be less responsive to the driving events in a way that potentially increases the risk of crashing. In addition, drowsy driving is another behavior that almost everyone acknowledges is potentially dangerous, but in which many drivers still engage. However, an important difference between these behaviors is that drivers may not realize they are drowsy are until it's too late (i.e., because of medicine or health issue), whereas by deliberately engaging distracting actions, drivers know they are being unsafe. Several studies across the past two decades have estimated the portion of the population who have fallen asleep at the wheel through self-reporting. A 2010 survey of 2,000 U.S. residents found 41% of drivers reported having ever fallen asleep or nodding off while driving (AAA Foundation, 2010). Four percent of drivers reported falling asleep while driving in the past month, while 11% had done so within the past year. A similar, more recent study found that nearly all drivers (97%) believe it is unacceptable to drive while excessively drowsy, yet 32% admitted to having driven while too tired to easily keep their eyes open in the past 30 days (AAA Foundation, 2016). A Centers for Disease Control and Prevention survey of over 90,000 U.S. residents found that 4% reported having fallen asleep while driving at least once in the past 30 days (Wheaton, Chapman, Presley-Cantrell, Croft, & Roehler, 2014). NHTSA surveyed 4,010 drivers in spring 2002 and found 11% reported that they had nodded off while driving during the past year (Royal, 2003). Of those who nodded off, 66% said they had 6 or fewer hours of sleep the previous night.

These surveys provide additional useful information about drowsy driving. Three of the studies found that young drivers and male drivers were more likely than older drivers and female drivers to have dozed off at the wheel (AAA Foundation, 2010; Wheaton et al, 2014; Royal, 2003). Moreover, driving while drowsy does not just occur late at night. About one-quarter of those drivers who admit to nodding off say the most recent incident occurred in the afternoon (noon to 5 p.m.), which might be attributable to circadian rhythms (Royal, 2003). Drowsy driving is also not limited to long trips – roughly half of the drivers who nodded off had been driving for an hour or less.

It's often difficult to determine whether drowsy driving contributed to a crash. Similar to distracted driving, drivers may be reluctant to admit they dozed off following a crash. Current estimates range from 2% to 20% of annual traffic deaths attributable to driver drowsiness, according to the NHTSA Drowsy Driving Research and Program Plan (NHTSA 2016). Annually from 2009 to 2013, there were on average over 72,000 police-reported crashes involving drowsy drivers, injuring more than an estimated 41,000 people, and killing more than 800, as measured by NHTSA's Fatality Analysis Reporting System (FARS) and National Automotive Sampling System (NASS) General Estimates System (GES). However, researchers have inferred the existence of additional drowsy-driving crashes by looking for correlations with related factors such as the number of passengers in the vehicle, crash time and day of week, driver sex, and crash type. A study by the AAA Foundation using data from 1999 to 2013 found that driver drowsiness may have contributed to 6% of all crashes and 21% of fatal crashes (Tefft, 2014). This estimate suggests that more than 6,000 people died in drowsy-driving-related motor vehicle crashes across the United States last year.

Strategies to Reduce Distracted and Drowsy Driving

The seemingly easy way to reduce distracted or drowsy driving crashes is to convince or require drivers to pay attention to their driving and to get enough sleep. However, these are very difficult goals. Many drivers consider some distractions, such as eating or drinking, listening to the radio, or talking on a cell phone, to be important and common activities and are unlikely to give them up. Drowsy driving may result from lifestyles that include insufficient or irregular sleep (shift workers, for instance) or from medical problems – issues beyond a driver's immediate control. Moreover, studies indicate that drivers themselves are poor judges of the performance decrements that result from distracting activities and from drowsiness (Horrey, Lesch, & Garabet, 2008; Powell & Chau 2010).

Behavioral strategies for distracted and drowsy driving focus on removing some of the underlying causes or promoting awareness of the risks. Currently, few studies have examined whether the standard behavioral countermeasures of laws, enforcement, and sanctions (which are used successfully for alcohol impairment, seat belt use, aggressive driving, and speeding) are effective for distracted or drowsy drivers. However, pilot studies focused on high-visibility enforcement combined with paid and earned media suggest that these elements show promise in reducing the use of hand-held phones and texting (Cosgrove, Chaudhary, & Reagan, 2011). Additionally, standard behavioral countermeasures have been studied with young drivers: some graduated driver licensing provisions help reduce distracted and drowsy driving by limiting the number of passengers, prohibiting nighttime driving, and restricting cell phone use (see Chapter 6, Sections 1.3 to 1.5).

Distracted or drowsy driving that is related to a driver's job may be reduced through employer policies and programs. Links to employer-based resources are available from the Network of Employers for Traffic Safety through trafficsafety.org. The National Safety Council also provides resources to employers, including an online distracted driving course at nsc.org/learn/NSC-Initiatives/Pages/distracted-driving. Drowsy driving caused by medical conditions such as sleep apnea or by drugs or medications may be addressed through policies, communications, and outreach. Similarly, communications and outreach may be useful in raising awareness of specific distraction or drowsiness issues among certain high-risk populations. However, it is unknown if any of these strategies have been evaluated.

There are a variety of environmental and vehicular strategies to address distracted and drowsy driving. Rumble strips, both on the shoulder and the centerline, have demonstrated their effectiveness in preventing crashes associated with inattention or drowsiness (Persaud, Lyon, Eccles, & Soika, 2016). Other roadway improvements, such as wide and visible edge lines, more easily visible road signs, and better lighting at night can help drivers who are not fully alert. Vehicular strategies also can address driver distraction and drowsiness. Collision avoidance technologies such as lane departure warning, crash-imminent braking, and forward collision warning; and vehicle-to-vehicle and vehicle-to-infrastructure communications technologies hold promise for reducing crashes among drivers who are drowsy or inattentive (IIHS, 2012; IIHS, 2014c). Such technologies, once available only in luxury brands, are now offered in many new vehicles. Additionally, in-vehicle technology in the future may be able to detect driver distraction or drowsiness, by monitoring driver performance and then alerting drivers (Donmez, Boyle, & Lee, 2007; May & Baldwin, 2009; Papadelis et al., 2007; Sahayadhas, Sundaraj, & Murugappan, 2012; Brown, Lee, Schwarz, Fiorentino, & McDonald, 2014). On the other hand, built-in technologies such as navigation and entertainment systems in vehicles may create more potential distractions. NHTSA developed Visual-Manual Driver Distraction Guidelines for In-Vehicle Electronic devices pertaining to original equipment in-vehicle electronic devices (78 Fed. Reg. 24,817, 2013). Although voluntary, the Guidelines encourage automobile manufactures to design in-vehicle devices so that potentially distracting tasks are limited while driving. This chapter only addresses behavioral strategies. It does not include environmental, vehicular, and engineering countermeasures because State Highway Safety Offices do not have authority or responsibility in these areas.

Driver drowsiness is a critical issue for commercial drivers. The Federal Motor Carrier Safety Administration regulates drowsiness in commercial drivers through Hours of Service regulations, driver logs and inspections (see for example FMCSA, 2008). FMCSA has an extensive drowsy driver research program focused on commercial drivers (FMCSA, 2005). Additionally, NHTSA recently published a Drowsy Driving Research and Program Plan that describes multiple projects related to quantifying the problem, building public awareness and education, policy development, high-risk populations, vehicle technology, and infrastructure (NHTSA 2016). NHTSA has also developed a prototype Drowsy Driver Warning System that appears promising in reducing drowsiness among drivers of heavy vehicles (Blanco et al., 2009; see also Brown et al., 2014). As with the environmental and vehicular countermeasures mentioned above, commercial driver countermeasures are not discussed in this guide because they do not fall under SHSO jurisdiction.

Resources

The agencies and organizations listed below can provide more information on distracted and drowsy driving and links to numerous other resources.

- U.S. Department of Transportation website on distracted driving: www.distraction.gov
- National Highway Traffic Safety Administration:
    - Research and Evaluation – one.nhtsa.gov/Driving-Safety/Research-&-Evaluation
    - Distracted Driving – www.nhtsa.gov/risky-driving/distracted-driving
    - Drowsy Driving – www.nhtsa.gov/risky-driving/drowsy-driving; one.nhtsa.gov/Driving-Safety/Drowsy-Driving
    - Behavioral Safety Research Reports – ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Governors Highway Safety Association: www.ghsa.org
- National Safety Council: www.nsc.org/learn/NSC-Initiatives/Pages/distracted-driving.aspx
- National Conference of State Legislatures: www.ncsl.org/research/transportation/spotlight-distracted-driving

- National Sleep Foundation: www.sleepfoundation.org
- Insurance Institute for Highway Safety: www.iihs.org
- AAA Foundation for Traffic Safety: www.aaafoundation.org
- Network of Employers for Traffic Safety: trafficsafety.org

For overviews of distracted driving prevalence, risks, legislation, research, and recommended strategies, see:

- NHTSA's Understanding the Effects of Distracted Driving and Developing Strategies to Reduce Resulting Deaths and Injuries: A Report to Congress – DOT HS 812 053 (Vegega, Jones, & Monk, 2013).
- NHTSA's Driver Distraction: A Review of the Current State-of-Knowledge – DOT HS 810 787 (Ranney, 2008).
- Overview of the National Highway Traffic Safety Administration's Driver Distraction Program – DOT HS 811 299 (NHTSA, 2010).
- GHSA's Distracted Driving: What Research Shows and What States Can Do (GHSA, 2011).
- World Health Organization's Mobile Phone Use: A Growing Problem of Driver Distraction (WHO/NHTSA, 2011).
- NHTSA's Blueprint for Ending Distracted Driving – DOT HS 811 629 (NHTSA, 2012).

For overviews on drowsy driving, see:

- GHSA's Wake Up Call! Understanding Drowsy Driving and What States Can Do (GHSA, 2016c).
- NHTSA Drowsy Driving Research and Program Plan – DOT HS 812 252 (NHTSA, 2016a).
- NHTSA's Asleep at the Wheel: A Nation of Drowsy Drivers Forum (NHTSA, 2016b).

Key terms

- GDL: Graduated driver licensing, a three-phase system for beginning drivers consisting of a learner's permit, a provisional license, and a full license. A learner's permit allows driving only while supervised by a fully licensed driver. A provisional license allows unsupervised driving under certain restrictions.
- NCSDR: National Center for Sleep Disorders Research
- NSF: National Sleep Foundation.

Distracted and Drowsy Driving Countermeasures

Countermeasures to reduce distracted and drowsy driving are listed in the table below. The table is intended to provide a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. Effectiveness is shown using a five-star rating system:

- Countermeasures that receive ★★★★ or ★★★★★ have been determined to be effective.
- Countermeasures that receive ★★★ are considered promising, and likely to be effective.
- Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States, communities and other organizations are encouraged to use ★★★, and especially ★★★★ or ★★★★★, countermeasures. They should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

Further details about the symbols and terms used are included after the table. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate.

Each countermeasure to reduce distracted and drowsy driving is discussed individually in this chapter. Full descriptions are included for ★★★, ★★★★ and ★★★★★ countermeasures. Brief descriptions are included for ☆ and ☆☆ countermeasures. Further details about the ☆ and ☆☆ countermeasures are included in Appendix A4 to this report.

1. Laws and Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
1.1 GDL Requirements for Beginning Drivers	★★★★★†	$	High	Medium
1.2 Cell Phone and Text Messaging Laws	☆☆	$	Medium	Short
1.3 High-Visibility Cell Phone/Text Messaging Enforcement	★★★★	$$$	Low	Medium
1.4 General Drowsiness and Distraction Laws	☆	Varies	High††	Short

† Effectiveness demonstrated for nighttime and passenger restrictions
†† Included under reckless driving; use of explicit drowsiness and distraction laws is low

2. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Communications and Outreach on Drowsy Driving	☆	$$	Unknown	Medium
2.2 Communications and Outreach on Distracted Driving	☆	$$	High	Medium

3. Other Countermeasures

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Employer Programs	☆☆	$	Unknown	Short
3.2 Education Regarding Medical Conditions and Medications	☆	Variable	Unknown	Medium

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities

Unknown: data not available

Time to implement:
Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Laws and Enforcement

1.1 Graduated Driver Licensing Requirements for Beginning Drivers

Effectiveness: ★★★★★†	Cost: $	Use: High	Time: Medium

† Effectiveness demonstrated for nighttime and passenger restrictions

Studies suggest teenagers and adults are similar in terms of how often they engage in potentially distracting activities while driving (Foss & Goodwin, 2014; Klauer et al., 2014). However, as mentioned in the introduction, teens are at higher risk for a crash when engaged in distracting activities compared to adults (Klauer et al., 2014). Teens are less experienced at the task of driving, so driving requires more of their attention than is the case for experienced drivers (Lansdown, 2002). Moreover, key areas of the brain are still developing during adolescence, making it difficult for teens to manage potential distractions (Keating, 2007). A number of studies also suggest that drivers 16 to 24 are somewhat more likely than other age groups to drive while drowsy (AAA Foundation, 2012; Royal, 2003; Wheaton et al., 2014).

Several elements of graduated driver licensing (GDL) reduce the likelihood of drowsiness and distractions for newly licensed drivers. For example, nighttime driving is typically restricted under GDL. Driving at night is associated with higher fatal crash risk than during the day for teen drivers (McCartt & Teoh, 2015), and also may pose greater risks of drowsy driving. In addition, GDL systems usually include a passenger restriction. Passengers, especially teenage passengers, are a major source of distraction for young, beginning drivers (Foss & Goodwin, 2014). Cell phones can also distract drivers (see Appendix A4, Section 1.2), so they are often restricted under GDL. The NCHRP guide for reducing crashes involving young drivers describes the key provisions of GDL laws (Goodwin, Foss, Sohn, & Mayhew, 2007). The Insurance Institute for Highway Safety (IIHS, 2015) and the Governors Highway Safety Association (GHSA, 2016a) summarize State GDL laws. These summaries are updated monthly. See Chapter 6, Sections 1.1 and Appendix A6, Section 1.7, for a complete discussion of GDL for beginning young drivers.

Use: As of November 2016 all 50 States and the District of Columbia had some GDL components in place. The laws in 49 States and the District of Columbia do not allow driving during certain nighttime hours. Laws in 46 States and the District of Columbia limit the number of passengers allowed with a driver with a provisional license (GHSA, 2016a; IIHS, 2015). Thirty-Seven States and the District of Columbia prohibit the use of cell phones, both hand-held and hands-free, by drivers with learner's permits or provisional licenses or by drivers under 18 (IIHS, 2016).

Effectiveness: Several studies document that nighttime and passenger GDL restrictions reduce teenage driver crashes and injuries (Hedlund & Compton, 2005; Goodwin, Foss, Sohn, & Mayhew, 2007; Williams, 2007); however, an evaluation of a GDL cell phone restriction suggests cell phone restrictions may have little effect on teenage drivers' cell phone use (Foss, Goodwin, McCartt, & Hellinga, 2009; Goodwin, O'Brien, & Foss, 2012). This finding is consistent with McCartt, Kidd, & Teoh (2014) who determined that cell phone laws in general have little effect on teenagers' use of cell phones while driving.

One factor that may undermine the effectiveness of GDL restrictions on cell phone use in teen drivers is the perception that the risk of penalty from not complying with the law is low. In particular, a study of GDL violations in Washington State and North Carolina found low overall enforcement of the GDL requirement laws, particularly the cell phone use requirement in both States (AAA Foundation, 2014). The authors cite that one possible explanation for low enforcement of cell phone requirements is that it may be difficult for officers to discern whether a particular cell phone activity is a banned task or one that is allowed. The most frequently charged violation was violation of passenger restrictions. In an analysis of naturalistic driving data, the most frequently seen driving behavior leading up to a teen crash was attending to passengers (Carney, McGeHee, Harland, Weiss, & Raby, 2015). AAA Foundation (2014) also found that a high proportion of citations were dismissed by the courts, which “may very well be detrimental to the overall effectiveness of GDL programs.”

Costs: Publicity for GDL restriction changes can be delivered directly by the Department of Motor Vehicles to young drivers as they apply for their learner’s permits and provisional licenses, so costs can be minimal. Information about GDL restrictions can also be provided through driver education courses.

Time to implement: GDL nighttime, passenger, or cell phone restriction changes require several months to implement for drivers receiving a provisional license. They then will take one or two years before all provisionally licensed drivers are subject to the new restrictions.

1.2 Cell Phone and Text Messaging Laws

Effectiveness: ☆☆	Cost: $	Use: Medium	Time: Short

This countermeasure involves legislation to curtail distracted driving or driver cell phone use. It has been implemented at both the State and local level throughout the country. Bans on texting are more common than bans on hand-held cell phone use. Fourteen States and the District of Columbia have laws banning hand-held cell phones while driving, but at present no State restricts *hands-free* phone use for all drivers (GHSA, 2016b; IIHS, 2016). Forty-Six States have banned text messaging for all drivers (GHSA, 2016b; IIHS, 2016).

Effectiveness Concerns: *The effectiveness of laws banning cell phone use has been examined in several research studies. The results across types of phone use are inconsistent. Specifically, research examining prohibitions on hands-free phone use and texting have yielded mixed results in terms of reductions in phone use while driving and reduced crashes. There is some evidence that banning hand-held cellphone use leads to long-term reductions in this behavior; however, it is unknown if drivers are simply switching to hands-free use. At this time, there is insufficient consensus across research findings to determine that this countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A4, Section 1.2.

1.3 High-Visibility Cell Phone and Text Messaging Enforcement

Effectiveness: ★★★★	Cost: $$$	Use: Low	Time: Medium

Numerous studies demonstrate that high-visibility enforcement (HVE) can be effective in curbing alcohol-impaired driving and increasing seat belt use among drivers (see Chapter 1, Section 2.1 and Chapter 2, Section 2.1). Recently, NHTSA has examined whether the HVE model could be effective in reducing hand-held cell phone use and texting among drivers.

Similar to sobriety checkpoints, the objective is to deter cell phone use by increasing the perceived risk of a ticket. The HVE model combines dedicated law enforcement with paid and earned media supporting the enforcement activity. Enforcement officers actively seek out cell phone users through special roving patrols or through a variety of enforcement techniques such as the spotter technique where a stationary officer will radio ahead to another officer when a driver using a cell phone is detected. Officers report that higher vantage points, SUVs, and unmarked vehicles are strategies useful in identifying violators (Chaudhary, Casanova-Powell, Cosgrove, Reagan, & Williams, 2014). Both earned and paid media are critical to ensure the general public is aware of the enforcement activity, and to increase the perception that being caught is likely.

NHTSA conducted a high-visibility enforcement demonstration project aimed at reducing cell phone use among drivers. The message of the program was: "Phone in one hand. Ticket in the other." Pilot programs were tested in Hartford, Connecticut, and Syracuse, New York, from April 2010 to April 2011. Law enforcement officers conducted four waves of enforcement during the course of the year. Approximately 100 to 200 citations were issued per 10,000 population during each enforcement wave. Paid media (TV, radio, and online advertisements and billboards) and earned media (e.g., press events and news releases) supported the enforcement activity. For more details about the program, see Chaudhary et al. (2014).

To examine the effectiveness of high-visibility enforcement in larger jurisdictions, NHTSA proceeded to implement an HVE campaign in Delaware and in nine California counties in the Sacramento area. Three waves of enforcement were conducted from November 2012 to June 2013. Paid and earned media were similar to that in Hartford and Syracuse. See Schick, Vegega, and Chaudhary (2014) and Chaudhary, Connolly, Tison, Solomon, & Elliott (2015) for more information.

Observations from the previous demonstration projects in Hartford/Syracuse and California/Delaware indicated that relatively few citations were issued for texting while driving. Moreover, feedback from law enforcement officers suggested that enforcing laws prohibiting texting while driving was difficult. In 2012 NHTSA undertook a third demonstration program to determine the enforceability of texting laws and to test methods for enforcing these laws. Law enforcement agencies in Connecticut and Massachusetts participated in the program. Four waves of enforcement were conducted in each State over 2013 and 2014. The evaluation suggested that having a strong set of distracted driving laws helps with enforcement of texting laws (See Retting, Sprattler, Rothenberg, & Sexton, 2017).

Use: To date, only a handful of States have implemented high-visibility enforcement programs to address talking and texting among drivers.

Effectiveness: Results from the NHTSA HVE program suggest hand-held cell phone use among drivers dropped 57% in Hartford and 32% in Syracuse (Chaudhary et al., 2014). The percentage of drivers observed manipulating a phone (e.g., texting or dialing) also declined. Public awareness of distracted driving was already high before the program, but surveys suggest awareness of the program and enforcement activity increased in both Hartford and Syracuse. Surveys also showed most motorists supported the enforcement activity. In California and Delaware, similar reductions in cell phone use were observed following the campaign, although decreases were also noted in comparison communities (Schick et al., 2014). Although these results are encouraging, the effect of HVE campaigns on crashes is not certain. An analysis of crash data from before and after the enforcement period found no effects of HVE on the incidence of distraction-related crashes (Chaudhary et al., 2015). Note that the evidence for effectiveness is based on community and smaller statewide programs that targeted hand-held cell phone use. There is no evidence available that HVE programs targeting texting will be as effective.

Costs: High-visibility enforcement campaigns are expensive. They require time from law enforcement officers to conduct the enforcement. In addition, time is needed from State highway safety office and media staff and often from consultants to develop, produce, and distribute advertising, educational materials, and other communications tools. In the NHTSA demonstration program, both Connecticut and New York received $200,000 to implement and evaluate the program, and each State contributed an additional $100,000 to the Federal funds. Paid media costs for the program in the two States were over $500,000.

Time to implement: A high-visibility enforcement program requires 4 to 6 months to plan and implement.

1.4 General Driver Drowsiness and Distraction Laws

Effectiveness: ☆	Cost: Varies	Use: High†	Time: Short

† Included under reckless driving; use of explicit drowsiness and distraction laws is low

This countermeasure involves laws that specifically target the issue of drowsy and/or distracted drivers. With regard to drowsy driving, this type of law would permit drivers to be prosecuted for vehicular homicide if they have not slept in 24 hours and they cause a crash in which someone is killed. With regard to distracted driving, this type of law would permit drivers who are involved in a crash or who commit an infraction to be cited for distracted driving if a police officer believes distraction to be the underlying cause. Distraction is defined as an activity not necessary to the operation of the vehicle that impairs, or could impair, the ability to drive safely (GHSA, 2011).

Effectiveness Concerns: *Laws that specifically target drowsy and/or distracted drivers are not widely used, and this countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A4, Section 1.4.

2. Communications and Outreach

2.1 Communications and Outreach on Drowsy Driving

Effectiveness: ☆	Cost: $$	Use: Unknown	Time: Medium

This countermeasure involves drowsy driving communications and outreach campaigns directed to the general public (Stutts, Knipling, Pfefer, Neuman, Slack, & Hardy, 2005, Strategy C1; NSF, 2004). Campaign goals usually include:

- raising awareness of the dangers of drowsy driving;
- motivating drivers to take action to reduce drowsy driving; and
- providing information on what drivers can do, either before they start out on a trip or if they become drowsy while driving.

These campaigns can be conducted by States and national organizations such as the National Sleep Foundation.

Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A4, Section 2.1.

2.2 Communications and Outreach on Distracted Driving

Effectiveness: ☆	Cost: $$	Use: High	Time: Medium

This countermeasure involves distracted driving communications and outreach campaigns directed to the general public. Since distracted driving is a particular concern among teenage drivers (Foss & Goodwin, 2014; NHTSA, 2012), distracted driving campaigns may specifically target teen drivers. Some campaigns carry a general "pay attention" message, while others are directed at specific behaviors such as cell phone use.

Effectiveness Concerns: *Based on NCHRP research, there are no studies of any campaign's effects on driver knowledge, attitudes, or behavior (Stutts, Knipling, Pfefer, Neuman, Slack, & Hardy, 2005, Strategies C1 and D2).*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A4, Section 2.2.

3. Other Countermeasures

3.1 Employer Programs

Effectiveness: ☆☆	Cost: $	Use: Unknown	Time: Short

This countermeasure involves employer-based programs targeting workers that are at higher risk of drowsy-driving crashes. These groups include shift workers who work long or irregular hours or who work at night, including many law enforcement officers (Stutts, Knipling, Pfefer, Neuman, Slack, & Hardy, 2005, Strategy D6). Another at-risk group for drowsy driving crashes is medical interns and emergency responders (such as EMS), who frequently work extended shifts of 24 hours or more. Education program for shift workers can include information on sleep habits in general and drowsy driving in particular. Employer programs can also include medical condition testing/education.

Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A4, Section 3.1.

3.2 Education Regarding Medical Conditions and Medications

Effectiveness: ☆	Cost: Variable	Use: Unknown	Time: Medium

This countermeasure involves providing education about a number of chronic medical conditions and sleep disorders that may compromise sleep and lead to drowsy driving or falling asleep at the wheel. These conditions include insomnia, sleep apnea, and narcolepsy.

The principal countermeasures to address these conditions are:

1. Communications and outreach on sleep disorders to increase overall awareness of their symptoms, consequences, and treatment.
2. Efforts with driver licensing medical advisory boards to increase their awareness of these conditions as they review driver fitness for licensing.
3. Efforts with physicians to increase their awareness of these conditions and their potential effects on driving, to treatment for these conditions as appropriate, and to counsel their patients to take steps to reduce the risk of drowsy driving.

Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A4, Section 3.2.

Distracted and Drowsy Driving References

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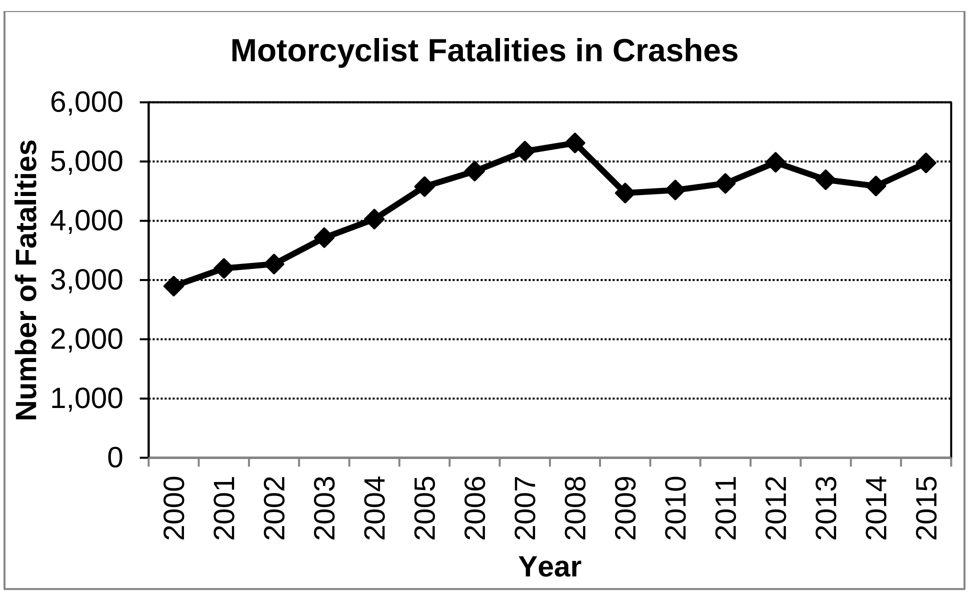
5. Motorcycle Safety

Overview

A motorcycle is inherently more difficult to operate than a passenger vehicle because it requires more physical skill and strength. The relationship of motorcycle speed and stability is also a critical consideration when riding a motorcycle, as the stability of a motorcycle is relative to speed. As speed increases, the motorcycle becomes more stable, requiring less effort from the operator to maintain its balance, even as it becomes less maneuverable. At very low speeds, the motorcycle becomes less stable, requiring greater effort from the operator to balance it.

A motorcycle offers the rider little protection in a crash. Crash data confirm this observation. NHTSA estimates that per vehicle mile traveled, motorcyclists are about 29 times more likely than passenger car occupants to die in traffic crashes. Motorcyclists are killed at a rate of 25.38 per 100 million vehicle miles traveled (VMT) as compared to 0.89 fatalities per 100 million VMT for passenger cars (NCSA, 2017).

Trends. Motorcycling has become increasingly popular over the last 10 years even as total vehicle miles traveled has declined. Along with this growth in popularity is a corresponding increase in crashes and fatalities involving motorcyclists. From 2000 to 2008, the crash data show the number of motorcyclists killed in crashes increased by 83% and the number of injured increased by 66%. In 2008, motorcyclist fatalities increased for the 11th consecutive year to 5,312, a level not seen since 1980 (NHTSA, 2009). After 2008, motorcyclist fatalities decreased substantially to 4,469 in 2009. The most recent data show that in 2015, there were 4,976 fatalities, an 8% increase from the 4,594 motorcyclists killed in 2014 (NCSA, 2017). Motorcyclists accounted for 14% of total motor vehicle related fatalities during 2015 (NCSA, 2017).



Source data: NCSA (2017)

In 2015, 41% of motorcyclist fatalities and almost half of all motorcyclist injured occurred in single-vehicle crashes (NCSA, 2017). About half (52%) of all fatalities occurred on weekdays, and 57% of fatalities occurred during daylight hours (NCSA, 2017). Ninety-one percent of motorcyclists killed and 85% of those injured were males, and passengers comprised 6% of motorcycle fatalities (NCSA, 2016).

One trend that is emerging is an increase in fatalities and injuries among older motorcyclists over the past 10 years. In 2015, 71% of the motorcyclists killed in crashes were 30 or older and 54% were 40 or older, compared to 2006, when 68% of the motorcyclists killed were 30 or older and 47% were 40 or older (NCSA, 2017). Similarly, while the number of motorcyclists involved in injury crashes has increased among all age groups, injuries among motorcyclists 50 and older have increased at the fastest rate. Motorcyclists 50 and older were estimated to account for 29% to 30% of motorcyclists injured nationally during 2014 and 2015, compared with 19% during 1998 and 1999 (FARS data).

Speeding is more prevalent in fatal crashes involving motorcycle operators than among other types of motor vehicle operators. Thirty-three percent of all motorcycle riders involved in fatal crashes in 2015 were speeding, compared to 19% of passenger car drivers (NCSA, 2017). Motorcyclists involved in fatal crashes had worse prior driving records than other passenger vehicle drivers, including more DWI convictions, speeding convictions, and suspensions or revocations (NCSA, 2017). Additionally, 27% of the motorcycle riders involved in crashes in 2015 did not have valid motorcycle operator licenses (NCSA, 2017). In 2015, 27% of the motorcycle riders killed in crashes had BACs of .08 g/dL or higher (NCSA, 2017). Forty percent of fatally injured motorcyclists were not wearing helmets (NCSA, 2017), although the percentage varies from State to State.

Other trends in motorcycle safety relate to the types of motorcycles being produced and purchased. While the number of registrations for all types of motorcycles increased from 2000 to 2005, registrations for supersport motorcycles, which are built on racing bike frames and reach speeds of nearly 190 mph, have climbed even faster. Whereas combined registrations for all motorcycle styles were 51% higher in 2005 than in 2000, supersport registrations were 83% higher (IIHS, 2007). Fatalities are three to four times higher among registered supersport owners as well (IIHS, 2007; Teoh & Campbell, 2010). Fatally injured supersport-style motorcycle riders were about twice as likely as standard/cruiser riders to have been speeding and half as likely to have been alcohol-impaired, after accounting for rider age and gender. These results suggest that the types of risks taken may vary in association with the style of bike chosen (Teoh & Campbell, 2010). Supersport riders also tend to be younger. In 2005, the average age was 27 among those fatally injured while riding these bikes, compared to an average age of 44 for cruiser and standard motorcycles (IIHS, 2007).

Another emerging trend is the increased use of low-powered cycles such as mopeds, electric-assist bicycles, and scooters. State laws defining and regulating these vehicles vary, making it difficult to track trends. While these are different vehicles in terms of their speed and power capabilities (most States classify these vehicles based on multiple criteria including maximum speed, generally 20 to 30 mph), countermeasures aimed at motorcycles are likely to also apply to low-powered cycles. However, it should be noted that riders of low-powered cycles may face different safety problems than motorcycle riders.

Strategies to Improve Motorcycle Safety

There are various existing strategies to improve motorcycle safety but few have been extensively reviewed in published research. Some of the strategies that have been identified are that all motorcycle riders should wear motorcycle helmets that meet Federal Motor Vehicle Safety Standard (FMVSS) 218 and clothing that provides both protection and visibility. Motorcycle riders should be properly trained and licensed. They should be alert and aware of the risks they face while riding; in particular, they should not be impaired by alcohol or drugs. These and other strategies are discussed in the National Agenda for Motorcycle Safety (NAMS), a comprehensive, collaborative, and multidisciplinary blueprint for motorcycle safety (NHTSA, 2000a). The recommendations of the NAMS were prioritized in 2013 (NHTSA, 2013). See also the NAMS Implementation Guide (NHTSA, 2006a), NHTSA's Motorcycle Safety Program Plan (NHTSA, 2006b), the U.S. DOT Action Plan to Reduce Motorcycle Fatalities (U.S. DOT, 2007), and the Centers for Disease Control and Prevention's Motorcycle Safety Guide (CDC, 2011). In addition, a review of State Motorcycle Safety Program Technical Assessments summarizes program recommendations, implementations, and barriers to implementation from nine State motorcycle safety program technical assessments conducted by NHTSA (Baer & Skemer, 2009).

The most demonstrable objectives for improving motorcycle safety are to increase helmet use and reduce alcohol-impaired motorcycle riding. These objectives are difficult to accomplish. Universal helmet laws are highly effective in assuring that virtually all motorcycle riders use helmets, but they also are politically difficult to enact and retain. Strategies based only on communications and outreach to promote helmet use and reduce impaired motorcycling appear to be no more successful with motorcycle riders than with other drivers.

Another objective is to increase other motorists' awareness of motorcyclists by increasing the visibility of motorcyclists and educating drivers on the importance of sharing the road with motorcycles. Daytime running lights for motorcycles improve motorcycle conspicuity. Most motorcycles on the road have headlights that turn on automatically when the engines are started (Raborn et al., 2008, Strategy 11.1 D2). In addition, 23 States require daytime headlight use for all motorcycles manufactured since 1980 (and Pennsylvania requires daytime headlight use for motorcycles manufactured since 1986; MSF, 2014). Modulating headlights, which cause the headlight to move from high- to low beam rapidly, also increase motorcycle visibility (Olson, Halstead-Nussloch, & Sivak, 1979), but integration of these devices into the motorcycle fleet has been slow.

A similar way to increase improve motorcycle conspicuity is to manipulate the front-light configuration. In a 2012 study by Cavallo and Pinto, results showed that daytime running lights on cars create "visual noise" that interferes with the lighting of motorcycles and affects their visual conspicuity. As a potential solution, Pinto, Cavallo, and Saint-Pierre (2014) tested three front-light configurations in a daytime environment that included cars using day running lights. They found that while adding more lights to the configuration did not improve conspicuity over a typical single front-light configuration, changing the color of that light from white to yellow resulted in significantly higher detection (74% vs. 54%).These findings suggest that lighting has a role promoting motorcycle conspicuity.

Vehicle technologies such as antilock brakes also have the potential to enhance motorcycle safety (Bayly, Regan, & Hosking, 2006). For example, two studies by IIHS found that motorcycles with antilock brakes had a lower fatal crash involvement than motorcycles without antilock brakes (Teoh, 2011, 2013).

Resources

Many environmental factors can also affect motorcycle safety. Slippery roadway surfaces and markings, surface irregularities and debris, unpaved shoulders, and unforgiving roadway barriers all can be dangerous. These issues are not included in this guide because State Highway Safety Offices have little or no authority or responsibility for them. Also, this guide does not include administrative or management countermeasures such as traffic safety data systems and analyses, program planning and assessments, State and community task forces, or comprehensive multi-pronged community traffic safety strategies. See National Cooperative Highway Safety Research Report 500, Volume 22 Guide for Addressing Collisions Involving Motorcycles, for a thorough discussion of environmental and other strategies: www.trb.org/Publications/Public/Blurbs/A_Guide_for_Addressing_Collisions_Involving_Motorc_160626.aspx

For a broad set of resources for State safety agencies and on-going research efforts:
- Government Accountability Office’s Report to Congressional Committees – www.gao.gov/assets/660/650037.pdf
- The Community Guide’s Motorcycle Helmets: Universal Helmet Laws – www.thecommunityguide.org/findings/motor-vehicle-injury-motorcycle-helmets-universal-helmet-laws

NHTSA’s web pages:
- Motorcycles – www.nhtsa.gov/road-safety/motorcycles; one.nhtsa.gov/Safety/Motorcycles
- Research and Evaluation – www.nhtsa.gov/research-data; one.nhtsa.gov/Research/Behavioral-Research
- Behavioral Safety Research Reports – ntlsearch.bts.gov/tris/ntlc/nhtsa/index.shtm

Motorcycle Safety Countermeasures

Countermeasures to improve motorcycle safety are listed in the table below. The table is intended to provide a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. Effectiveness is shown using a five-star rating system:

- Countermeasures that receive ★★★★ or ★★★★★ have been determined to be effective.
- Countermeasures that receive ★★★ are considered promising, and likely to be effective.
- Countermeasures that receive ☆ or ☆☆ have <u>NOT</u> been determined to be effective, either because there is limited or no high quality evidence (☆) or because effectiveness is undetermined based on current evidence (☆☆).

States, communities and other organizations are encouraged to use ★★★, and especially ★★★★ or ★★★★★, countermeasures, and to exercise caution when selecting ☆ or ☆☆ countermeasures, as these countermeasures do not have conclusive evidence on their effectiveness. When deploying a new or emerging countermeasure with unproven effectiveness, it is valuable to include an evaluation of the countermeasure in connection with its use.

Further details about the symbols and terms used are included after the table. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate.

Each countermeasure to improve motorcycle safety is discussed individually in this chapter. Full descriptions are included for ★★★, ★★★★ and ★★★★★ countermeasures. Brief descriptions are included for ☆ and ☆☆ countermeasures. Further details about the ☆ and ☆☆ countermeasures are included in Appendix A5 to this report.

1. Motorcycle Helmets

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Universal Coverage State Motorcycle Helmet Use Laws	★★★★★	$	Medium	Short
1.2 Motorcycle Helmet Use Promotion Programs	☆	Varies	Low to Medium	Varies
1.3 Motorcycle Helmet Law Enforcement: Noncompliant Helmets	☆	$	Unknown	Medium

2. Alcohol Impairment

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Alcohol-Impaired Motorcyclists: Detection, Enforcement, and Sanctions	★★★	Varies	Unknown	Varies
2.2 Alcohol-Impaired Motorcyclists: Communications	☆	$$	Medium	Medium

3. Motorcycle Rider Licensing and Training

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Motorcycle Rider Licensing	☆	$	High	Medium
3.2 Motorcycle Rider Training	☆☆	$$	High	Varies

4. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Conspicuity and Protective Clothing	☆	Varies	High	Medium
4.2 Motorist Awareness of Motorcyclists	☆	Varies	High	Medium

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources.

☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources

$$: requires some additional staff time, equipment, facilities, and/or publicity

$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: from one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Motorcycle Helmets

1.1 Universal Coverage State Motorcycle Helmet Use Laws

Effectiveness: ★★★★★	Cost: $	Use: Medium	Time: Short

Motorcycle helmets are highly effective in protecting motorcycle riders' heads in a crash. Research indicates that helmets reduce motorcycle rider fatalities by 22 to 42% and brain injuries by 41 to 69% (Coben, Steiner, & Miller, 2007; Cummings, Rivara, Olson, & Smith, 2006; Deuterman, 2004; Liu, Ivers, Norton, Blows, & Lo, 2008; NHTSA, 2003; NHTSA, 2006a). A Cochrane Collaboration review of 61 studies concluded that risk reductions were on the high end of the ranges mentioned above, with higher quality studies indicating that the protective effect of helmets was about a 42% reduction in risk of fatality in a crash and 69% for risk of a head injury in a crash. This review found that there was insufficient evidence to determine the effect on neck or facial injuries, or the effects of various types of FMVSS 218 compliant helmets on injury outcomes (Liu et al., 2008). Others have found no evidence that helmets increase the risk of neck injuries (Brewer et al., 2013; Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2008, Strategy E1; NHTSA, 2000a; Philip et al., 2013; Ulmer & Preusser, 2003).

State universal coverage helmet-use laws are effective at increasing helmet use. In 2013, observed compliant helmet use was 89% across States with universal helmet laws that cover all riders, and 48% across States with no law or laws covering only young riders (Pickrell & Choi, 2015). A systematic review of U.S. motorcycle helmet laws found that States with universal coverage laws: (1) had motorcycle helmet use rates 53 percentage points higher than States with partial coverage or no law; (2) had 29% fewer deaths; and (3) had lower fatality rates per registered motorcycle and per vehicle mile traveled (Guide to Community Preventive Services, 2013).

Nationally in 2015, DOT-compliant helmet use was 61% (Pickrell & Li, 2016). Use of noncompliant helmets increased from 5% in 2014 to 11% in 2015, while helmet non-use decreased slightly from 31% in 2014 to 29% in 2015 (Pickrell & Li, 2016).

Use: The first universal helmet law was enacted in 1966. Universal laws were in effect in 47 States and the District of Columbia by 1975. After Federal penalties were eliminated in 1975 for States failing to have a universal law, about half the States repealed their laws. Several States have enacted or repealed helmet laws since then. The IIHS (2016) summarizes the helmet law history in each State.

As of 2016, 19 States, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and Northern Mariana Islands that had helmet laws covering all riders (GHSA, 2016; IIHS, 2016). Three States (Illinois, Iowa, and New Hampshire) did not have motorcycle helmet laws. Guam and most other States had laws covering only riders under a specified age, typically 18 or 21 (GHSA, 2016; IIHS, 2016). The motorcycle helmet laws of 23 States also apply to all low-powered cycles. Twenty-Five States and the District of Columbia have motorcycle helmet laws that cover some low-powered cycles, typically those with engine displacements under 50cc (IIHS, 2016).

Effectiveness: Studies of helmet use among motorcyclists indicate that universal helmet use laws are effective in increasing helmet use, which reduces injuries, decreases hospital admissions and treatment costs, and lowers insurance claims. Studies in States that enacted universal helmet laws observed use rates of 90% or higher immediately after the laws became effective, compared to 50% or lower before the laws (Ulmer & Preusser, 2003, Section II). States that repealed universal helmet laws observed the opposite effect, as use rates dropped from above 90% to about 50% (Kyrychenko & McCartt, 2006; Preusser, Hedlund, & Ulmer, 2000, Section V; Ulmer & Preusser, 2003, Sections IV and V). Reenactment of a universal law in Louisiana (after a cycle of repeals and reenactments since 1968) resulted in an increase in use among riders involved in crashes, from 42% before reenactment to 87% following (Gilbert, Chaudhary, Solomon, Preusser, & Cosgrove, 2008).

The Community Preventive Services Task Force conducted a systematic review of 69 studies (through August 2012) evaluating motorcycle helmet laws in the United States. It found that universal coverage motorcycle helmet laws consistently increased helmet use and decreased injuries and deaths associated with motorcycling. The Task Force concluded that universal coverage laws were substantially more effective than partial coverage laws or no law (Guide to Community Preventive Services, 2013).

The U.S. General Accountability Office (GAO) reviewed 46 methodologically sound studies of State helmet laws published before 1990. GAO concluded that motorcycle rider fatality rates were 20 to 40% lower with universal helmet laws (GAO, 1991; Ulmer & Preusser, 2003, Section II). Studies since 1990 confirm these results (Cummings et al., 2006; Houston & Richardson, 2008; Kyrychenko & McCartt, 2006; Morris, 2006; Ulmer & Northrup, 2005; Ulmer & Preusser, 2003, Section II).

Some States have helmet laws that only cover young riders. Helmet use is generally low in these States (GAO, 1991), and non-comprehensive laws do not translate into meaningful reductions in young rider fatalities rates (Brooks et al., 2010; Houston, 2007). Additionally, Weiss, Agimi, and Steiner (2010) compared the risk of traumatic brain injury among youth in States with limited-age helmet laws and States with universal helmet laws. They found a 37% increase in risk of traumatic brain injury requiring hospitalization for youth in States with partial coverage helmet laws compared to States with universal helmet laws. A reduction in fatality rates among all ages was estimated for partial coverage laws compared to no law by Houston & Richardson (2008), but the effect was much smaller (7% to 8%) than that for universal coverage (22% to 33%). Moreover, when Florida eliminated the requirement that all motorcycle riders 21 and older wear helmets, there was an 81% increase in motorcyclist fatalities (Ulmer & Northrup, 2005). Fatalities even increased among riders under 21 who were still covered by the helmet law.

Hospital admissions and treatment costs have also increased following repeal of universal helmet laws (Derrick & Faucher, 2009; GAO, 1991). Almost half of all motorcyclists admitted to hospitals lacked sufficient health care insurance or were covered by government services, so the public ultimately shares many of these costs, as well as a greater long-term burden of care (Derrick & Faucher, 2009; GAO, 1991). In addition, an analysis of insurance claims data found that when Michigan’s helmet law was amended from a universal coverage law to a partial coverage law, claims increased by more than 22% compared with control States (HLDI, 2013). The Community Preventive Services Task Force found in their systematic review of 22 studies that universal coverage motorcycle helmet laws resulted in significant economic benefits (Guide to Community Preventive Services, 2013). The studies show that universal coverage laws provide greater safety and cost benefits than laws that cover only a specific age group or riders having a certain amount of insurance.

Costs: Once legislation requiring universal helmet use has been enacted, implementation costs are minimal. The inevitable controversy surrounding the legislation will help to publicize the new law extensively. Motorcycle helmet laws can be enforced during regular traffic patrol operations because helmet use is easily observed.

Time to implement: Although a universal helmet use law can be implemented as soon as the law is enacted, enacting such a law is a complex and time-consuming process, and may require the involvement of a "champion."

Other issues:

- **Opposition to motorcycle helmet laws:** Any effort to enact a universal helmet law can expect immediate, well-coordinated, and highly political opposition (NHTSA, 2003). Helmet law opponents claim that helmet laws impinge on individual rights. They also claim that helmets interfere with motorcycle riders' vision or hearing, though research shows that these effects are minimal (NHTSA, 1996). See Jones and Bayer (2007) for a history of opposition to helmet laws in the United States. Derrick and Faucher (2009) also discuss national policy, organized opposition, and helmet law changes over the past four decades.
- **Noncompliant helmets:** Some riders in States with universal helmet laws wear helmets that do not comply with FMVSS 218 (Pickrell & Liu, 2014). See the discussion in Appendix A5, Section 1.3.

1.2 Motorcycle Helmet Use Promotion Programs

Effectiveness: ☆	Cost: Varies	Use: Unknown	Time: Varies

A few States with or without universal motorcycle helmet-use laws promote helmet use through communications and outreach campaigns. NHTSA has developed helmet use promotion brochures, flyers, and public service announcements suitable for television and radio that are available online. Raborn et al. (2008) describes elements that should be included in a campaign should one be undertaken.

Effectiveness Concerns: *There appear to be no formal evaluations of the effect of helmet use promotion programs in States without universal helmet laws (Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2008).*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A5, Section 1.2.

1.3 Motorcycle Helmet Law Enforcement: Noncompliant Helmets

Effectiveness: ☆	Cost: $	Use: Unknown	Time: Medium

This countermeasure involves legislation and enforcement of laws that require motorcyclists to wear helmets that comply with FMVSS 218. For compliant helmet laws to be effective, they must be enforced, publicized, and adequately funded. NHTSA prepared a video clip for motorcyclists and law enforcement demonstrating how to identify compliant and noncompliant helmets, and how to choose a helmet that fits properly (NHTSA, 2006b). NHTSA also produced a brochure on how to identify noncompliant helmets (NHTSA, 2004). States have access to this video for their own outreach campaigns.

Effectiveness Concern: *The effectiveness of an enforcement program on noncompliant helmet use has not been evaluated.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A5, Section 1.3.

2. Alcohol Impairment

2.1 Alcohol-Impaired Motorcyclists: Detection, Enforcement, and Sanctions

Effectiveness: ★★★	Cost: Varies	Use: Unknown	Time: Varies

Alcohol impairment is a substantial problem for motorcyclists, even more than for drivers of other motor vehicles. In 2015, 27% of motorcycle riders involved in fatal crashes had BACs of .08 or higher, which is higher than the rate for passenger car drivers (21%) and light-truck drivers (20%) (NCSA, 2017). By age, the proportion of riders who had BACs of .08 or higher was higher among fatally injured 35- to 49-year-old riders (37% for riders 35 to 39, 34% for riders 40 to 44, 36% for riders 45 to 49; NCSA, 2017). An additional 7% of motorcycle riders in fatal crashes had at least some measurable level of alcohol in their blood (BAC .01 to .07 g/dL). Fatally injured motorcycle riders with BAC levels .08 g/dL or higher were less likely to wear helmets than were sober riders – 51% vs. 65%, respectively (NCSA, 2017). In 2015, 42% of riders killed in single-vehicle crashes had BACs of .08 or above, and on weekend nights, this figure climbed to 63% (NCSA, 2017). The 2013-2014 National Roadside Survey similarly found that 5.0% of motorcycle riders on weekend nights had BACs of .08 or above, as compared to 1.4% of passenger vehicle drivers (Ramirez et al., 2016).

Motorcyclists are included in and affected by the comprehensive strategies to reduce alcohol-impaired driving discussed in detail in Chapter 1. However, some law enforcement and sanction strategies may be especially useful for motorcyclists, while others may be less effective.

Law enforcement officers on traffic patrol use characteristic driving behaviors, or cues, to identify drivers who may be impaired by alcohol. Some of the cues for motorcycle riders, such as trouble maintaining balance at a stop, are different from those for cars and trucks. Stuster (1993) identified and validated 14 cues useful for identifying alcohol-impaired motorcycle riders. NHTSA prepared a brochure, a law enforcement training video, and a pocket detection guide discussing the cues (NHTSA, 2000b). The cues for motorcycle riders are part of the SFSTs training given to all law enforcement officers.

Vehicle impoundment or forfeiture can be an effective deterrent to drinking and driving for all drivers (see Chapter 1, Section 4.3). It may be even more effective for motorcyclists. Research by Becker, McKnight, Nelkin, and Piper (2003) confirmed earlier findings that many motorcyclists do not find traditional impaired-driving sanctions such as fines and license suspension to be effective deterrents (although self-reported beliefs may not reflect actual effectiveness of these other sanctions). However, motorcyclists tended to be highly concerned for the safety and security of their motorcycles.

These findings suggest a potentially effective strategy to reduce alcohol-impaired motorcycling: high-visibility enforcement using officers trained in identifying impaired motorcycle riders and other motor vehicle drivers, with offender sanctions including vehicle impoundment or forfeiture. This strategy would treat motorcyclists on an equal footing with other vehicle drivers in impaired-driving enforcement and publicity, but it may be controversial and therefore difficult to enact or enforce. However, a Washington State law that allows officers to impound motorcycles for impaired riding was not found to cause unforeseen problems with law enforcement officers or with towing companies (McKnight, Billheimer, & Tippets, 2013).

Use: Thirty-two of 43 responding States reported that they have programs for law enforcement on how to detect impaired motorcyclists or enforce laws related to operating motorcycles while impaired (Baer et al., 2010). NHTSA (2006a) provides resources for law enforcement and State programs on the detection of impaired riding, including examples of State programs that distribute the NHTSA cue cards and brochures to law enforcement (Illinois), provide a web-based seminar for officers (Minnesota), and regularly establish high-visibility law enforcement presence at major rider events (Ohio, Wisconsin).

Effectiveness: Some agencies have reported some success in using the cues for identifying alcohol-impaired motorcycle riders, but no evaluation data on the extent of their use are available (Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2008, Strategy B3). Although there is limited evidence of the effects of enforcement and sanctions on impaired motorcycle riding, sobriety checkpoints and saturation patrols have demonstrated effectiveness in reducing impaired driving and crashes generally. See Chapter 1 for more information on enforcement strategies and other tools.

Costs: Law enforcement training costs are low and training material is available. Enforcement itself can be carried out during regular traffic patrol and as part of all impaired-driving enforcement programs. A major campaign including alcohol-impaired motorcyclists may require additional costs for publicity.

Time to implement: Law enforcement training can be conducted quickly. A major campaign will require 4 to 6 months to plan and implement.

Other issues:

- **BAC limits:** BAC levels as low as .05 g/dL caused some detectable levels of impairment, primarily in reaction time, among experienced riders in tests on controlled courses (Creaser et al., 2007). Puerto Rico passed a law in 2007 lowering the BAC limit for motorcyclists to .02.
- **Drugs other than alcohol:** Drugs other than alcohol can impair motorcycle riders. Potentially impairing drugs include over-the-counter and prescription medications as well as illegal drugs. The 2007 National Roadside Survey reported that 31.9% of nighttime weekend motorcycle riders who provided oral fluid and/or blood samples tested positive for drugs (illegal drugs or medications), as compared to 16.5% of passenger car drivers (Lacey et al., 2009b). The extent to which various drugs impair driving performance or contribute to crashes is not well understood, however, for either four-wheeled vehicles or for motorcycles. Furthermore, individual differences in metabolism of drugs and level of impairment, as well as multiple-drug use complicate the understanding of drug impairment on motor vehicle drivers (Compton, Vegega, & Smither, 2009). (See Compton et al.’s 2009 Report to Congress on drug-impaired driving for a discussion of current knowledge and recommendations for improving States data and records systems and statutes.) Law enforcement should consider drugs as potential impairing agents for

motorcycle riders just as for other vehicle operators. See also Chapter 1, Section 7 on drug-impaired driving.

- **Targeted enforcement:** As with other crash problems, better identification of problem areas (either impaired riding or impaired riding crashes) and targeting enforcement to such locations, events, or times could improve enforcement effectiveness.

2.2 Alcohol-Impaired Motorcyclists: Communications and Outreach

Effectiveness: ☆	Cost: $$	Use: Medium	Time: Medium

This countermeasure involves communications and outreach campaigns directed at drinking and riding. Although States typically implement these campaigns, they can also be conducted by local riding groups.

Effectiveness Concerns: *A literature search found no evaluations of the safety effectiveness of any drinking and riding campaigns.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A5, Section 2.2.

3. Motorcycle Rider Licensing and Training

3.1 Motorcycle Rider Licensing

Effectiveness: ☆	Cost: $	Use: High	Time: Medium

The goal of licensing is to ensure that motorcycle riders have the minimum skills needed to operate motorcycles safely (NHTSA, 2000a). All 50 States, the District of Columbia, and Puerto Rico require motorcycle riders to obtain a motorcycle operator license or endorsement before they ride on public highways (MSF, 2012). Most States will waive the skills test, and sometimes the knowledge test, for motorcyclists who have completed approved motorcycle rider training courses, if the student passes the knowledge and skills tests administered at the conclusion of the course.

Effectiveness Concerns: *Although this countermeasure is widely used, the effectiveness of current licensing and testing on crashes and safety has not been evaluated.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A5, Section 3.1.

3.2 Motorcycle Rider Training

Effectiveness: ☆☆	Cost: $$	Use: High	Time: Varies

This countermeasure involves rider education and training courses provided by States, rider organizations (for example, some ABATE and Gold Wing groups), manufacturers (Harley-Davidson), the U.S. Military, and others. This training can be required for all motorcycle operators or those under a specified age.

Effectiveness Concerns: *This countermeasure is widely used. Its effectiveness has been examined in several research studies. Although there have been some positive research findings, the balance of evidence regarding countermeasure effectiveness remains inconclusive.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A5, Section 3.2.

4. Communications and Outreach

4.1 Communications and Outreach: Conspicuity and Protective Clothing

Effectiveness: ☆	Cost: Varies	Use: High	Time: Medium

This countermeasure involves communications and outreach campaigns promoting the use of protective clothing and measures that increase rider conspicuity, such as clothing and auxiliary devices. Measures that may increase rider conspicuity include wearing brightly colored clothing, clothing that incorporates retro-reflective materials, and/or white- or bright- colored helmets (for increased visibility during day or night). Additional solutions include the use of continuous headlights, auxiliary head and brake lights, and flashing headlights.

Effectiveness Concerns: *This countermeasure is widely used, but it has not been extensively studied. There is some evidence that certain approaches may lead to limited positive outcomes; however, there is insufficient evaluation data to determine the extent of effectiveness.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A5, Section 4.1.

4.2 Communications and Outreach: Motorist Awareness of Motorcyclists

Effectiveness: ☆	Cost: Varies	Use: High	Time: Medium

This countermeasure involves communications and outreach campaigns to increase other drivers' awareness of motorcyclists. Typical themes are "Share the Road" or "Watch for Motorcyclists." Some States build campaigns around "Motorcycle Awareness Month," often in May, early in the summer riding season. Many motorcyclist organizations, including MSF, SMSA, the Gold Wing Road Riders Association, and State and local rider groups, have driver awareness material available. Some organizations also make presentations on driver awareness of motorcyclists to driver education classes.

Effectiveness: *Although this countermeasure is widely used, no evaluations of the effectiveness of campaigns to increase driver awareness of motorcyclists are available.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A5, Section 4.2.

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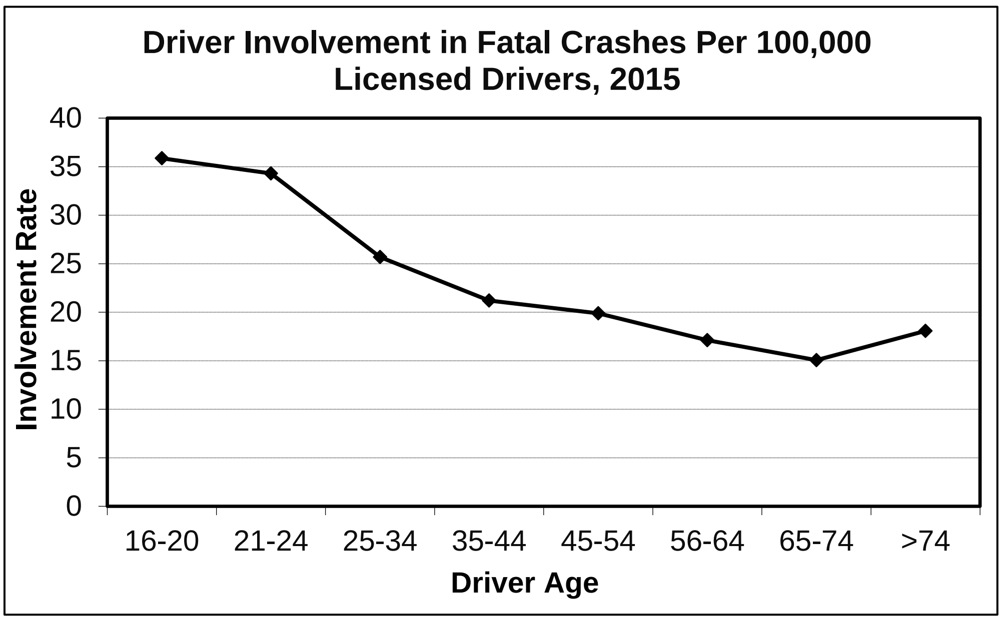
6. Young Drivers

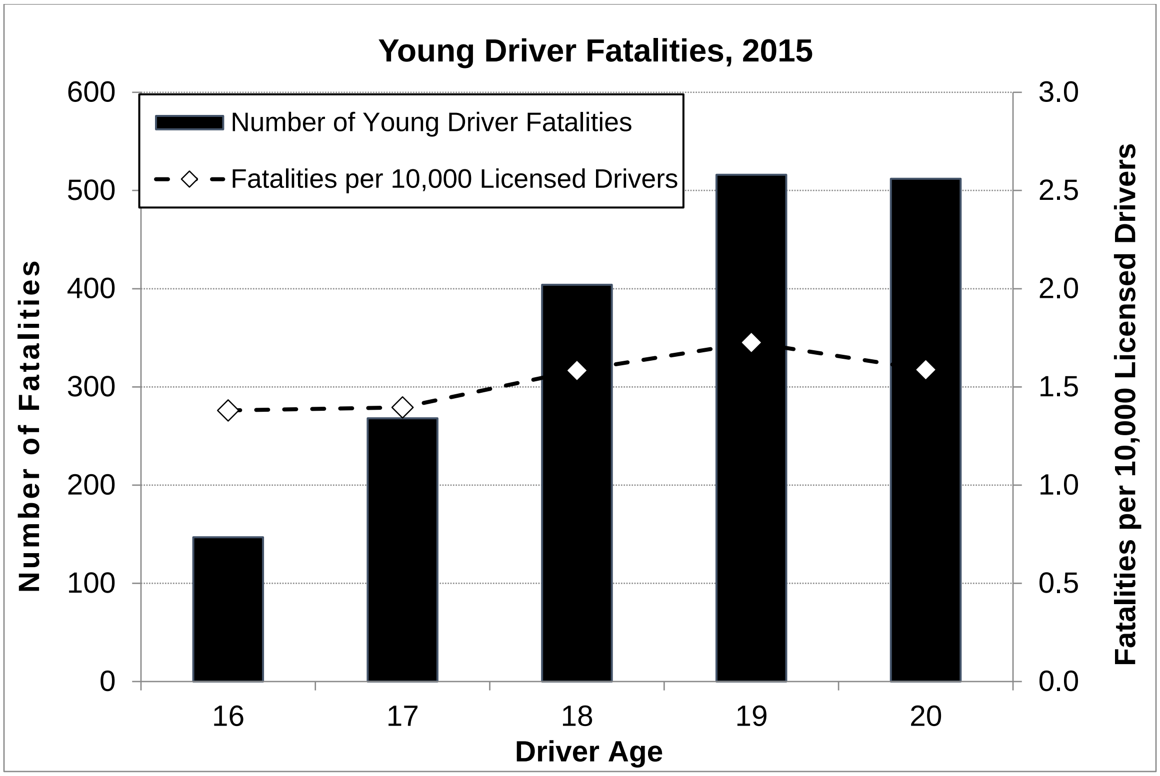
Overview

Motor vehicle crashes are the leading cause of death for teenagers in the United States. In 2015, 1,886 drivers 15 to 20 years old were killed and an estimated 195,000 were injured in motor vehicle crashes (NCSA, 2017). In comparison with adult drivers, young drivers are substantially over-involved in crashes. In 2015, drivers 15 to 20 made up 5.4% of licensed drivers in the United States, yet they made up 9% of total drivers in fatal crashes, and 12% of drivers in all crashes (NCSA, 2017). As shown in the figure below, drivers 16 to 20 years old have the highest involvement in fatal crashes of any age group.



Source: NHTSA (2017), Table 62

As shown in the figure below, young driver involvement in fatal crashes increases with age. However, the rate of young driver fatalities per 10,000 licensed drivers is relatively stable - between 1.0 and 1.6.



Sources: NCSA (2017), FHWA (2016)

Per mile driven, young drivers are even more over-involved than older drivers. In 2008 drivers 16 to 19 years old were involved in 4.6 fatal crashes per 100 million miles of travel, compared to 3.8 for drivers 20 to 24 and 1.2 for drivers 30 to 59 years old (McCartt & Teoh, 2014). Only 37% of the people killed in young driver crashes are the teen driver themselves; the majority of fatalities in young driver crashes (63%) are passengers of the teen driver, occupants of other vehicles, or nonmotorists (Shults & Ali, 2010).

Trends. From 2006 to 2015 there was a 43% decrease in the number of young drivers (aged 15 to 20) involved in fatal crashes, compared to a 16% decrease in all drivers involved during the same period (NCSA, 2017). The number of young drivers involved in police reported crashes decreased 13% from 2006 to 2015 (NCSA, 2008; NCSA, 2015). The reasons for the reductions in fatal and police-reported crashes among young drivers are not entirely known; however, it is noteworthy that most States implemented new, multi-stage licensing systems during this time period.

Young-driver characteristics. Young drivers have high crash risks for two main reasons, as documented by extensive research summarized in Hedlund, Shults, and Compton (2003). First, they are inexperienced, just learning to drive. The mechanics of driving require much of their attention, so safety considerations frequently are secondary. They do not have experience in recognizing potentially risky situations or in reacting appropriately and controlling their vehicles in these situations. Second, normal adolescent development involves an increase in novelty seeking and risk taking behaviors (Kelley, Schochet, & Landry, 2004). In fact, research on adolescent development suggests that key areas of the brain involved in judgments and decision making are not fully developed until the mid-20s (Dahl, 2008; Keating, 2007; Steinberg, 2007).

Inexperience makes certain circumstances more dangerous for younger drivers. In addition, immaturity increases the likelihood of young drivers putting themselves in risky circumstances. NHTSA has identified five areas of concern in relation to younger drivers:

- Nighttime Driving: Driving is more difficult and dangerous at night for everyone, but particularly for teenagers. Young drivers have less experience driving at night than during the day, and drowsiness and alcohol may be more of a factor at night (Lin & Fearn, 2003; Williams, 2003).
- Drinking and Driving: Young drivers' inexperience with both driving and drinking means that they have a higher crash risk at all BAC levels than older drivers (Voas, Torres, Romano, & Lacey, 2012; Williams, 2003).
- Passenger Interactions: Teenage passengers can distract young drivers and encourage them to take risks (Foss & Goodwin, 2014; Lin & Fearn, 2003; Williams, 2003).
- Belt Use: Seat belts reduce the risk of injury or fatality in a crash (see Chapter 2, Overview), but teenage drivers and passengers have slightly lower belt use rates than older drivers and passengers (Ferguson, 2003).
- Cell Phone Use: All drivers are at higher risk when talking or texting (see Appendix A4, Section 1.2); however, young drivers have more difficulty handling distractions (Lee, 2007).

Strategies to Reduce Crashes Involving Young Drivers

Graduated driver licensing (GDL) addresses both the inexperience and immaturity of young drivers. GDL provides a structure in which beginning drivers gain substantial driving experience in less- risky situations. GDL raises the minimum age of full licensure and helps parents manage their teenage drivers. GDL's effectiveness in reducing young driver crashes has been demonstrated many times (Masten, Foss, & Marshall, 2013; Russell, Vandermeer, & Hartling, 2011; Shope, 2007; Simpson, 2003; Williams, Tefft, & Grabowski, 2012).

Driver education was developed to teach both driving skills and safe driving practices. Based on evaluations to date, driver education for beginning drivers does a good job at teaching driving skills, but has not definitively been shown to reduce the number of crashes or crash rate. Rather, some research has suggested that it lowers the age at which teenagers become licensed, and therefore increases exposure, so its overall effect is to *increase* the number of crashes (Roberts et al., 2006; Thomas, Blomberg, & Fisher, 2012a; Vernick et al., 1999). Current research is investigating ways to integrate driver education with GDL and is developing second-level programs for drivers who have acquired basic driving skills and have been, or are nearing, licensure. Driver education must be combined with an effective GDL program that does not allow a lower licensing age. Many States have completed NHTSA-sponsored driver education assessments in an effort to strengthen their programs and align with national standards.

Parents play a key role in their teenagers' driving. In many States a parent or guardian must sign the driver's license application for a teenager under 18 and parents can withdraw their approval at any time. Parents can set limits on their teenagers' driving. In addition, parents can be involved explicitly and formally through GDL requirements such as minimum hours of supervised driving practice, or they can be involved voluntarily and informally. Several parent-teen driving guide programs can provide assistance. At least one driving guide program has successfully encouraged parents to impose more driving restrictions on their teens (Simons-Morton, 2007). Recently, technologies have become available to assist parents in monitoring their newly licensed teen driver. When combined with a comprehensive system for providing feedback to parents and teens, these technologies have been promising in reducing the incidence of risky driving behaviors among teens (Carney, McGehee, Lee, Reyes, & Raby, 2010; Farah et al., 2014; McGehee, Raby, Carney, Lee, & Reyes, 2007; Simons-Morton et al., 2013). Finally, several States are now requiring parent involvement in driver education, usually in the form of a mandatory parent orientation class. All of these approaches are promising, though none have been shown as of yet to reduce young driver crashes or fatalities.

Young drivers are subject to several traffic laws that apply only to them. GDL systems have been adopted by all 50 States to help novices gain experience in safe settings. Minimum legal drinking age (MLDA) and zero-tolerance BAC laws apply specifically to persons under 21, and are discussed in Chapter 1. In addition, a number of States have restrictions on cell phone use and texting that apply only to young drivers (see Appendix A4, Section 1.2). With all of these, enforcement is critical if the laws are to have any effect. The law enforcement system faces several problems when dealing with young drivers. In deciding whether to make a traffic stop, it can be difficult for law enforcement officers to determine a person's age to know whether GDL and zero-tolerance laws apply. It has been suggested that a vehicle decal identifying a driver as "young" and subject to GDL requirements, may be beneficial for enforcement reasons. New Jersey is the first State to pass legislation requiring young drivers subject to GDL restrictions to be identified via a vehicle decal. Recent studies examining the effectiveness of the decal requirement in New Jersey found that citations for violations of licensing restrictions sharply increased and police reported crashes decreased the year after the decal requirement went into effect (Curry, Pfeiffer, Localio, & Durbin, 2013; McCartt, Oesch, Williams, & Powell 2012). Even if the driver is young, teens may only be stopped for a primary offense, such as speeding. Once stopped, there may be a tendency for officers in some situations not to make arrests or for prosecutors to dismiss charges because the offender is "just a kid." Finally, the legal system imposes additional requirements for people under the age of legal adulthood (18 in most States). See NHTSA and NIAAA (1999) for a discussion of these requirements and processes for alcohol-related offenses.

Young drivers are discussed in other chapters of this guide. See:

- Chapter 1, Alcohol-Impaired Driving, Sections 6.1-6.4 (minimum-drinking-age-21 laws, zero-tolerance BAC laws, school and youth alcohol programs).
- Chapter 4, Distracted and Drowsy Driving, Sections 1.1 and Appendix A4, Sections 2.1, 2.2, and 3.1 (GDL requirements, communications and outreach, and employer programs).
- Appendix A5, Motorcycle Safety, Section 3.1 (GDL for motorcyclists).

Except for GDL requirements applying to automobile drivers, these discussions are not repeated in this chapter.

Environmental and vehicular strategies can improve safety for young drivers, as they can for all drivers. However, these types of countermeasures are not included because State Highway Safety Offices do not have authority or responsibility in these areas.

Resources

The agencies and organizations listed below can provide more information on young drivers and links to numerous other resources.

- National Highway Traffic Safety Administration:
  - Teen Drivers – www.nhtsa.gov/road-safety/teen-driving; one.nhtsa.gov/Driving-Safety/Teen-Drivers
  - Driver Safety Research Reports: New Drivers – one.nhtsa.gov/Driving-Safety/Research-&-Evaluation/Driver-Safety-Research-Reports:-New-Drivers-and-Older-Drivers
  - Behavioral Safety Research Reports – ntlsearch.bts.gov/tris/ntlc/nhtsa/index.shtm
- Centers for Disease Control and Prevention: www.cdc.gov/Motorvehiclesafety/Teen_Drivers/index.html
- Governors Highway Safety: Association: www.ghsa.org/html/issues/teens/index.html
- Insurance Institute for Highway Safety: www.iihs.org/iihs/topics/t/teenagers/topicoverview
- National Safety Council: www.nsc.org/learn/NSC-Initiatives/Pages/teen-driving.aspx
- American Automobile Association: http://exchange.aaa.com/safety/teen-driver-safety

For an overview of young-driver issues and research, see the papers in the June 2006 Supplement of *Injury Prevention* (injuryprevention.bmj.com/content/12/suppl_1), the special issue of the 2007 *Journal of Safety Research* (www.sciencedirect.com/science/journal/00224375/38/2), or the special issue of the 2008 American Journal of Preventive Medicine (www.ajpmonline.org/issue/S0749-3797%2808%29X0014-5). See also Williams et al. (2012) for a summary of much of the research on young driver issues. Additionally, an NCHRP Report 500 guide for the American Association of Motor Vehicle Administrators' Strategic Highway Safety Plan provides a detailed discussion of strategies for reducing crashes involving young drivers (Goodwin, Foss, Sohn, & Mayhew, 2007) and GHSA recently published "Curbing Teen Driver Crashes: An In-Depth Look at State Initiatives" (GHSA, 2012) which describes strategies States are currently employing to reduce teen driver crashes.

Young Driver Countermeasures

Countermeasures to improve young-driver safety are listed in the table below. The table is intended to provide a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. Effectiveness is shown using a five-star rating system:

- Countermeasures that receive ★★★★ or ★★★★★ have been determined to be effective.
- Countermeasures that receive ★★★ are considered promising, and likely to be effective.
- Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States, communities and other organizations are encouraged to use ★★★, and especially ★★★★ or ★★★★★, countermeasures. They should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

Further details about the symbols and terms used are included after the table. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate.

Each countermeasure to improve young-driver safety is discussed individually in this chapter. Full descriptions are included for ★★★, ★★★★ and ★★★★★ countermeasures. Brief descriptions are included for ☆ and ☆☆ countermeasures. Further details about the ☆ and ☆☆ countermeasures are included in Appendix A6 to this report.

1. Graduated Driver Licensing

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Graduated Driver Licensing (GDL)	★★★★★	$	High	Medium
1.2 Learner's Permit Length, Supervised Hours	★★★★★	$	High	Medium
1.3 Intermediate – Nighttime Restrictions	★★★★★	$	High	Medium
1.4 Intermediate – Passenger Restrictions	★★★★★	$	High	Medium
1.5 Cell Phone Restrictions	☆☆	$	Medium	Medium
1.6 Belt Use Requirements	☆☆	$	Low	Medium
1.7 Intermediate – Violation Penalties	☆	$	High	Medium

2. Driver Education

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Pre-Licensure Driver Education	☆☆	$$$	Medium	Long
2.2 Post-Licensure Driver Education	☆	$$$	Low	Long

3. Parents

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Parent Roles in Teaching and Managing Young Drivers	☆☆	$$	Medium	Short

4. Traffic Law Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Enforcement of GDL and Zero-Tolerance Laws	★★★	$$	Unknown	Short

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources

$$: requires some additional staff time, equipment, facilities, and/or publicity

$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities

Medium: between one-third and two-thirds of States or communities

Low: fewer than one-third of the States or communities

Unknown: data not available

Time to implement:

Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Graduated Driver Licensing

1.1 Graduated Driver Licensing

Effectiveness: ★★★★★	Cost: $	Use: High	Time: Medium

GDL is a three-phase system for beginning drivers, consisting of a learner's permit, an intermediate license, and a full license. A learner's permit allows driving only while supervised by a fully licensed driver. An intermediate license allows unsupervised driving under certain restrictions. These usually include limits on driving at night or with teenage passengers. The learner's permit and the intermediate license each must be held for a specified minimum period of time.

GDL serves two functions: reducing risk and reducing exposure. GDL allows beginning drivers to acquire driving experience in less-risky situations, under direct supervision during the learner's permit phase. It helps young drivers avoid dangerous conditions such as late-night driving or driving with teenage passengers in the vehicle during the intermediate phase. GDL delays full licensure by requiring a minimum time in both the learner's permit and intermediate phases. Compared to earlier requirements in many jurisdictions, where beginning drivers could receive a full license at 16 (and sometimes earlier) by passing a minimal driving test, GDL reduces the amount of driving by 16-year-olds. GDL also assures that young drivers are more mature when they receive their first unrestricted license. In surveys, both parents and teenagers strongly support GDL overall (Williams, Ferguson, Leaf, & Preusser, 1998). Based on a recent national survey, the majority of parents support GDL policies that are as strong as, or even stronger, than policies currently in place in the United States (Williams, Braitman, & McCartt, 2011).

All States now have some form of GDL in place. However, as of October 2011, no State GDL systems met all of the qualification criteria set forth by MAP-21 for GDL incentive grants. Some States, for example, have night restrictions beginning later than 10 p.m., or allow teens to carry more than one passenger younger than 21. GHSA (2014a) and IIHS (2014a) document GDL laws in each State. These websites are updated monthly. The papers in the special issue of the 2007 *Journal of Safety Research* describe GDL's history, components, effectiveness, parental roles, potential enhancements, and research needs. Strategies for implementing or improving GDL systems are described in NCHRP's *Guide for Reducing Collisions Involving Young Drivers* (Goodwin, Foss, Sohn, & Mayhew, 2007, strategies A1 through A5). See also NHTSA's *Traffic Safety Facts* on GDL (NHTSA, 2008) and Report to Congress (Compton & Ellison-Potter, 2008), and the Traffic Injury Research Foundation's *New GDL Framework: Evidence Base to Integrate Novice Driver Strategies* (Mayhew, 2014).

Use: All States and the District of Columbia had some GDL components in place as of August 2014. In addition, all States and the District of Columbia had a three-phase GDL system in place (GHSA, 2014a; IIHS, 2014a).

Effectiveness: GDL's effectiveness in reducing young driver crashes and fatalities has been well-documented (Baker, Chen, & Li, 2007; Chapman, Masten, & Browning, 2014; Fell, Jones, Romano, & Voas, 2011; Lyon, Pan, & Li, 2012; McCartt, Teoh, Fields, Braitman, & Hellinga, 2010; Masten, Foss, & Marshall, 2011; Masten et al., 2013; Masten et al., 2015; Russel et al, 2011; Shope, 2007; Simpson, 2003). The most restrictive GDL programs – those with at least a 6-month holding period during the learner stage, a night restriction beginning no later than 10 p.m., and restrictions allowing no more than one teen passenger – are associated with a 38% reduction in fatal crashes and a 40% reduction in injury crashes among 16-year-old drivers (Baker et al., 2007). In addition to reducing crashes, GDL is associated with declines in hospitalization rates and charges for 16-year-old drivers (Margolis, Masten, & Foss, 2007; Pressley, Benedicto, Trieu, Kendig, & Barlow, 2009).

Costs: GDL's primary costs result from the intermediate license, which adds to licensing agency workload by requiring each beginning driver to receive three licenses in succession rather than two. These costs are typically covered by small fees charged by the licensing agency.

Time to implement: Licensing changes typically require up to a year to plan, publicize, and implement.

Other issues:

- **Age of licensure:** In recent years, there has been discussion about the most appropriate age for allowing teenagers to drive independently (Williams, 2009; Williams, McCartt, Mayhew, & Watson, 2013). Licensing ages vary from State to State, from a low of 14½ in South Dakota to a high of 17 in New Jersey. Delaying licensure, either through higher entry ages or GDL requirements such as extended learner stages, can reduce young driver crashes. For example, New Jersey's GDL system has eliminated most crashes among 16-year-old drivers, and has reduced crashes among 17-year-olds by 16% (Williams, Chaudhary, Tefft, & Tison, 2010). However, a national study found a significant increase in fatal crash rates among 18-year-olds associated with stronger GDL components (Masten et al., 2011). In addition, licensure rates have decreased among young teenagers during recent years (HLDI, 2013; Shults & Williams, 2013). Thus, there is concern that teens may be delaying licensure until they are 18 or older in order to avoid GDL provisions, thus leading them to miss out on the safety benefits of GDL. Based on findings from additional studies, it appears the economic recession and lack of employment for young teenagers has been the driving force behind the delay of licensure and not avoidance of GDL, specifically (HLDI, 2013; Tefft, Williams, & Grabowski, 2013a; Williams, 2011).

1.2 GDL Learner's Permit Length, Supervised Hours

Effectiveness: ★★★★★	Cost: $	Use: High	Time: Medium

With a learner's permit, novices can drive when accompanied by an adult supervisor. The learner's permit allows and encourages beginning drivers to acquire substantial driving experience. To aid this, most States require the learner's permit to be held for a minimum period of time and most require a minimum number of supervised driving hours. Surveys show that parents and teenagers strongly support the learner's permit holding period and supervised driving requirements (Block & Walker, 2008; Mayhew, 2003; McKay, Coben, Larkin, & Shaffer, 2008).

Use: As of August 2014, 48 States and the District of Columbia required learner's permits to be held for at least 6 months, with 8 of these States requiring a minimum holding period of a full year. However, two States (Connecticut and South Dakota) reduce the required length of time for a permit to be held if the young driver completed driver's education (IIHS, 2014a).

Forty-Six States and the District of Columbia required some minimum number of supervised driving hours, about half of them requiring 50 hours. Forty-Two States plus the District of Columbia required that at least some of these hours be obtained at night. In addition, a few States required additional supervised hours to be completed during the intermediate license phase (IIHS, 2014a). Some States reduced or eliminated supervised driving requirements for driver education graduates. This is not recommended, since evidence suggests this practice results in *higher* crash rates among young drivers (Mayhew, 2007).

Effectiveness: Since learner's permit drivers are being supervised, it is not surprising that crash rates during the learner's permit period are very low. For young drivers holding their first unsupervised license, the limited available evidence suggests that crash rates decreased after jurisdictions with no learner's permit holding requirement implemented a 6-month requirement (Ehsani, Bingham, & Shope, 2013; Mayhew, 2003). Moreover, longer permit holding periods appear to result in even larger crash reductions. Masten et al. (2013) found that a 9- to 12-month leaner's permit holding period resulted in 26% lower fatal crash incidence among 16-year-old drivers and 17% lower incidence among 17- year-olds. Similarly, Curry et al. (2014) found that intermediate-phase drivers had incrementally smaller increases in crash rates during their initial months of driving independently for every month up to six months that they delayed obtaining full licensure.

However, the effect of supervised hours is currently unclear. Some studies have found supervised hours requirements lead to reductions in fatal crashes, when hourly requirements are combined with a mandatory learner's permit holding period (Baker, Chen & Li, 2006; Lyon et al., 2012). However, recent evaluations have found no relationship between the number of required supervised driving hours and fatal crash involvement among young drivers (Ehsani et al., 2013; Foss, Masten, Goodwin & O'Brien, 2012; Masten et al., 2013; McCartt et al., 2010). Based on telephone interviews with parents in 5 States, only 32% knew the correct number of supervised driving hours their teen was required to complete (Foss et al., 2012; O'Brien, Foss, Goodwin, & Masten, 2013). Therefore, the lack of effect of supervised hours on fatal crash outcomes may be explained, in part, by a lack of parental knowledge of the supervised driving requirements.

Costs: Once GDL is in place, requirements for the learner's permit can be implemented at very little cost.

Time to implement: GDL requirement changes typically require about 6 months to notify the public and implement the changes.

1.3 GDL Intermediate License Nighttime Restrictions

Effectiveness: ★★★★★	Cost: $	Use: High	Time: Medium

Driving at night increases the fatal crash risk per mile of travel for all drivers, and especially for teenage drivers (Hedlund et al., 2003; Williams, 2003; Tefft, Williams, & Grabowski, 2013b). A recent study found that the rate of driver fatalities was 5 times higher among 16- and 17-year-olds from 10 p.m. to 5:59 a.m. compared to driving during the day (Tefft et al., 2013b). At night, driving is more difficult, drive r drowsiness is more common, and alcohol is more likely to be used. Many intermediate license drivers have limited experience driving at night. For these reasons, a night driving restriction helps reduce risk for intermediate level drivers.

The restricted hours vary widely, from 6 p.m. to 6 a.m. in the most restrictive State, to 1 a.m. to 5 a.m. in the least restrictive (GHSA, 2014a; IIHS, 2014a). The most common hours are 11 p.m. or midnight to 5 or 6 a.m. However, a starting time earlier than midnight will prevent more crashes, especially since teenage driver crashes occur more frequently before midnight than after (Foss & Goodwin, 2003; Williams, 2003). NHTSA's Motor Vehicle Occupant Safety Survey found that 73% of the general public believe teenagers should not be allowed to drive unsupervised after 9 p.m. (Block & Walker, 2008). Another national survey of parents found 90% support a nighttime driving restriction, with 77% saying it should be 10 p.m. or earlier (Williams et al., 2011).

Use: As of August 2014 there were 49 States and the District of Columbia that restricted intermediate license drivers from driving during specified nighttime hours (the exception is Vermont). Many States allowed driving during the restricted hours for work or school-related activities (GHSA, 2014a; IIHS, 2014a).

Effectiveness: The effectiveness of nighttime driving restrictions in reducing both nighttime driving and nighttime crashes has been demonstrated conclusively (Fell et al., 2011; Hedlund et al., 2003; Hedlund & Compton, 2005; Lin & Fearn, 2003; Lyon et al., 2012; Masten et al., 2013; McCartt et al., 2010). The earlier a night restriction begins, the greater the reduction in crashes. For example, night restrictions that begin at 9 p.m. are associated with an 18% reduction in fatal crashes compared to no restriction. The reduction is only 9% when the night restriction begins at1 a.m. (McCartt et al., 2010).

Costs: Once GDL is in place, a nighttime driving restriction can be implemented or modified at very little cost.

Time to implement: GDL requirement changes typically require about 6 months to notify the public and implement the changes.

1.4 GDL Intermediate License Passenger Restrictions

Effectiveness: ★★★★★	Cost: $	Use: High	Time: Medium

Young passengers are associated with a substantial increase in the risk of a fatal crash for teenage drivers (Chen, Baker, Braver, & Li, 2000; Ouimet et al., 2010; Preusser, Ferguson, & Williams, 1998; Tefft et al., 2013b). Each additional passenger is associated with an additional increase in fatal crash risk (Chen et al., 2000; Preusser et al., 1998; Tefft et al., 2013b). Fatal crash risks are highest when young male drivers carry same age passengers, especially if those passengers are also male (Chen et al., 2000; Ouimet et al., 2010; Tefft et al., 2013b).

To reduce this risk, most States include a passenger restriction in their GDL requirements for intermediate licensees. According to NHTSA's Motor Vehicle Occupant Safety Survey, 86% of the general public believe that teenagers should have a restriction on the number of teenage passengers they can carry (Block & Walker, 2008). Also, in a recent national survey 89% of parents say they support passenger restrictions; 82% think the passengers limit should be one or less (Williams et al., 2011).

Use: As of August 2014 there were 46 States and the District of Columbia that restricted in some way the number of passengers who can be carried by an intermediate license driver (GHSA, 2014a; IIHS, 2014a). The most common passenger restrictions limit teenage drivers to zero or just one passenger. Some restrictions apply to all passengers and some only to passengers younger than a specified age. A few States allow exceptions for transporting family or household members.

Effectiveness: There is growing evidence that passenger restrictions are effective in reducing young driver crashes, though the restrictions sometimes are violated (Carpenter & Pressley, 2013; Fell et al., 2011; Goodwin & Foss, 2004; Lyon et al., 2012; Masten et al., 2013; McCartt et al., 2010; Williams, 2007). California allows no passengers younger than 20 for teenagers who hold intermediate licenses. Four studies demonstrate the positive effects of this restriction. For example, one study showed a 38% decrease in 16-year-old-driver crashes in California in which a teen passenger was killed or injured (Williams, 2007). A NHTSA study evaluated passenger restrictions in three States, California, Massachusetts, and Virginia. Results showed 16-year-old-driver crashes were reduced in all three States, as were motor-vehicle-related injuries among 15- to 17-year-olds (Chaudhary, Williams, & Nissen, 2007). In North Carolina, a teen passenger restriction was enacted independent of any other changes to the State's GDL system. Subsequent to this restriction, 16-year-old-driver crashes involving multiple passengers decreased by 32% (Foss, 2009). Recent national studies have also found large crash rate reductions for passenger restrictions. For example, McCartt et al. (2010) found a 21% reduction in fatal crashes among 15- to 17-year-olds when no passengers were permitted and a 7% reduction when one passenger was allowed. Similarly, Masten et al. (2013) found a 20% lower fatal crash rate among 16-year-old drivers and a 12% lower fatal crash rate among 17-year-old drivers when no more than one young passenger was allowed for at least the first six months of independent driving.

Costs: Once GDL is in place, a passenger restriction can be implemented at very little cost.

Time to implement: GDL requirement changes typically require about 6 months to notify the public and implement the changes.

1.5 GDL Cell Phone Restrictions

Effectiveness: ☆☆	Cost: $	Use: Medium	Time: Medium

This countermeasure involves States including cell phone restrictions in their GDL laws. These bans cover *all* cell phone use, not just hand-held phones. In some States, the cell phone restrictions cover teenagers holding a learner's permit and intermediate license; in other States, the restrictions cover all drivers under a certain age, such as 18 or 19 (GHSA, 2014b; IIHS, 2014b).

Effectiveness Concerns: *This countermeasure is widely used. Its effectiveness has been examined in a few research studies. Although there have been some positive research findings, the balance of evidence regarding countermeasure effectiveness remains inconclusive.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A6, Section 1.5.

1.6 GDL Belt Use Requirements

Effectiveness: ☆☆	Cost: $	Use: Low	Time: Medium

This countermeasure involves explicitly requiring belt use under their GDL laws. Note that young drivers are covered by seat belt laws in all States (with the exception of New Hampshire, which only requires seat belts for people under 18) (GHSA 2014c; IIHS, 2014c). An explicit belt use requirement in a State's GDL law may have more influence on beginning drivers than the State's overall belt use law. This may be especially true in States where a GDL belt use requirement is coupled with primary enforcement for young drivers, and in States where seat belt violations result in delayed graduation to the next GDL stage.

Effectiveness Concerns: *To date, there has been only one evaluation of the effects of explicit seat belt use requirements in GDL laws. This evaluation found no evidence that the countermeasure had any effect on teen driver belt use (Freedman & Levi, 2008).*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A6, Section 1.6.

1.7 GDL Intermediate License Violation Penalties

Effectiveness: ☆	Cost: $	Use: High	Time: Medium

This countermeasure involves a probationary feature included in the intermediate phase of many graduated licensing systems, which is commonly referred to as *contingent advancement*. Typically, contingent advancement means that an intermediate license holder must maintain a violation free driving record for a specified amount of time before they can obtain a full license.

Effectiveness: *The few evaluations of early stand-alone probationary license systems generally found no substantial benefits (McKnight & Peck, 2003; Simpson, 2003). No recent evaluations have attempted to separate out the effect of penalties for GDL or other traffic law violations from the overall effects of GDL. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A6, Section 1.7.

2. Driver Education

2.1 Pre-Licensure Driver Education

Effectiveness: ☆☆	Cost: $$$	Use: Medium	Time: Long

This countermeasure involves some form of driver education before licensure, typically for anyone younger than 18. Most commonly, this includes 30 hours of classroom instruction and 6 hours of behind-the-wheel practice, although requirements vary considerably across States (Thomas et al., 2012a). This training can include either commercial or high school driver education programs.

Effectiveness Concerns: *This countermeasure is used in many States. Its effectiveness has been examined in several research studies. The balance of the evidence suggests that these types of countermeasures are ineffective in the long term.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A6, Section 2.1.

2.2 Post-Licensure or Second-Tier Driver Education

Effectiveness: ☆	Cost: $$$	Use: Low	Time: Long

This countermeasure involves post-licensure driver education curricula that are integrated with driver education included in GDL (Smith, 1994). These “second-tier” post-licensure courses teach safety-related information, building on the on-road experience that the students have acquired in their initial months of driving. They should not be confused with “advanced driving performance” courses that teach driving skills such as panic braking, skid control, and evasive lane-changing maneuvers.

Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A6, Section 2.2.

3. Parents

3.1 Parental Roles in Teaching and Managing Young Drivers

Effectiveness: ☆☆	Cost: $$	Use: Medium	Time: Short

This countermeasure involves programs based on direct interaction and engagement with parents to better equip them to supervise and manage their teens' driving during the GDL phase. These programs typically involve a variety of approaches to educate parents and get them involved in promoting their teen's safe driving.

Effectiveness Concerns: *This countermeasure has been examined in several research studies. Although there have been some positive research findings, particularly in terms of behavioral changes, the balance of evidence regarding countermeasure effectiveness remains inconclusive.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A6, Section 3.1.

4. Traffic Law Enforcement

4.1 Enforcement of GDL and Zero-Tolerance Laws

Effectiveness: ★★★	Cost: $$	Use: Unknown	Time: Short

Two traffic laws apply only to young drivers: GDL laws and zero-tolerance laws that set a maximum BAC of .02 or less for drivers under 21. As discussed in Chapter 1, Section 6.2, zero-tolerance laws are not actively publicized or enforced. It's likely that increased publicity and enforcement would reduce teenage drinking and driving.

GDL laws, discussed in Chapter 6, Sections 1.1-1.6, also appear not to be enforced vigorously. A study in two States identified modest numbers of citations for some offenses, noting that other GDL restrictions were rarely enforced (AAA Foundation for Traffic Safety, 2014). Some GDL provisions such as nighttime driving restrictions are inherently difficult to enforce because violations are difficult to detect (Hedlund et al., 2003). A study in one State found that intermediate license drivers and their parents were quite aware of their GDL law's nighttime and passenger restrictions. Both restrictions were violated, though not frequently. Teenagers expressed little concern regarding GDL enforcement. Although surveys of law enforcement officers found that most were supportive of GDL, officers were not familiar with GDL details and considered GDL enforcement a low priority (Goodwin & Foss, 2004). Another study found that teen drivers reported frequently violating passenger restrictions, with and/or without their parents' knowledge/permission, because local police did not routinely enforce GDL restrictions (Chaudhary et al., 2007).

Parents are in the best position to enforce GDL requirements (Chapter 6, Section 3.1). However, some law enforcement support for GDL nighttime driving and teenage passenger restrictions may be useful to emphasize that the requirements are important. GDL law violations are penalized by driver license actions, such as suspension or revocation of the learner's permit or intermediate license or an extension of the time before full licensure. This means they can be applied administratively and do not involve criminal court proceedings. As noted in Chapter 1, Section 6.2, administrative penalties for zero-tolerance laws are far easier to enforce than criminal penalties. Another issue with enforcement concerns the difficulties in identifying drivers that qualify as falling under the GDL system in a given State. It has been suggested, and is one of NHTSA's GDL recommendations, that young drivers should be required to affix a vehicle decal identifying them as qualifying for the GDL program to make them more readily identifiable. New Jersey is the first State to implement this potential countermeasure.

Use: The amount of enforcement of zero-tolerance and GDL laws is unknown but probably is low.

Effectiveness: Zero-tolerance law publicity and enforcement likely will reduce teenage drinking and driving, as discussed in Chapter 1, Section 6.2. Similarly, high-visibility enforcement of GDL provisions should encourage compliance with nighttime and passenger restrictions. One study investigated whether well-publicized enforcement, including checkpoints near high schools, could increase compliance with seat belt laws and GDL provisions. The study found only modest increases in seat belt use and compliance with the GDL passenger restriction, although levels of compliance prior to the enforcement efforts were already high (Goodwin, Wells, Foss, & Williams, 2006).

Recent studies evaluating the effectiveness of vehicle decals in New Jersey have found increases in citations for violations of licensing restrictions and decreases in crash rates among intermediate license holders in the year after the requirement went into effect (Curry et al., 2013; McCartt et al., 2012).

Costs: See Chapter 1, Section 6.2, for zero-tolerance law enforcement strategies and costs. GDL law enforcement costs will depend on how the enforcement is conducted. Enforcement through regular patrols will require moderate costs for training. Special patrols or checkpoints will require additional staff time. All enforcement will require good publicity to both teens and parents. Publicity to teens can be delivered through high schools, colleges, recreational venues attended by youth, and media directed to youth. The cost of vehicle decals can be paid for by the licensee when they receive a learner's permit or intermediate license. In Virginia, vehicle decals cost $4 for a pair.

Time to implement: Enforcement programs can be implemented within three or four months, as soon as appropriate training, publicity, and equipment are in place.

Other issues:

- **Compliance with restrictions:** Several studies have shown that teenagers do not always comply with GDL restrictions (Goodwin & Foss, 2004; Williams, Nelson, & Leaf, 2002). To the extent that teens do not adhere to restrictions, the effectiveness of GDL may be reduced. It should be noted, however, that GDL has been shown to be effective even in the absence of police enforcement. For example, focus groups with parents and teen drivers conducted in California, Massachusetts, and Virginia revealed that passenger restrictions were frequently violated in all three States, but even incomplete adherence to the restrictions had a positive impact on teen driver crashes (Chaudhary et al., 2007). In general, compliance with restrictions will be higher in States that have well-designed GDL systems with restrictions that are considered reasonable by parents and teens (Foss & Goodwin, 2003).
- **Citation dismissal in the courts:** One study in two States noted relatively high rates of GDL-related citations being dismissed by the courts, which could have a negative impact on the effectiveness of those programs (AAA Foundation for Traffic Safety, 2014).

Young Driver References

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7. Older Drivers

Overview

In 2015 about 18% of licensed drivers in the United States were 65 or older (NCSA, 2017). By 2030 this proportion is expected to rise to at least 20% (U.S. Census Bureau). As drivers age, their physical and mental abilities, driving behaviors, and crash risks all change, though age itself does not determine driving performance. Many features of the current system of roads, traffic signals and controls, laws, licensing practices, and vehicles were not designed to accommodate older drivers. Older Americans are increasingly dependent on driving to maintain their mobility, independence, and health. The challenge is to balance mobility for older drivers with safety for all road users.

Trends. From 1982 to 2015 the proportion of licensed drivers 65 and older rose from 11.2% to 18.4% while the proportion of these older drivers in fatal crashes rose more rapidly, from 7.0% to 13.4%.

People 65 and Older: Number and Proportion of Total Populations

	Resident Population		Licensed Drivers		Drivers In Fatal Crashes	
Year	**Million**	**%**	**Million**	**%**	**N**	**%**
1982	26.8	11.6%	16.8	11.2%	3,894	7.0%
2015	47.8	14.9%	40.1	18.4%	6,490	13.4%
2030	72.8*	19.3%*	60.4*	> 20%*	?	?

*Estimated
Source: FARS data; FHWA Highway Statistics (1995, 2016); NHTSA (2017); U.S. Census Bureau (2014)

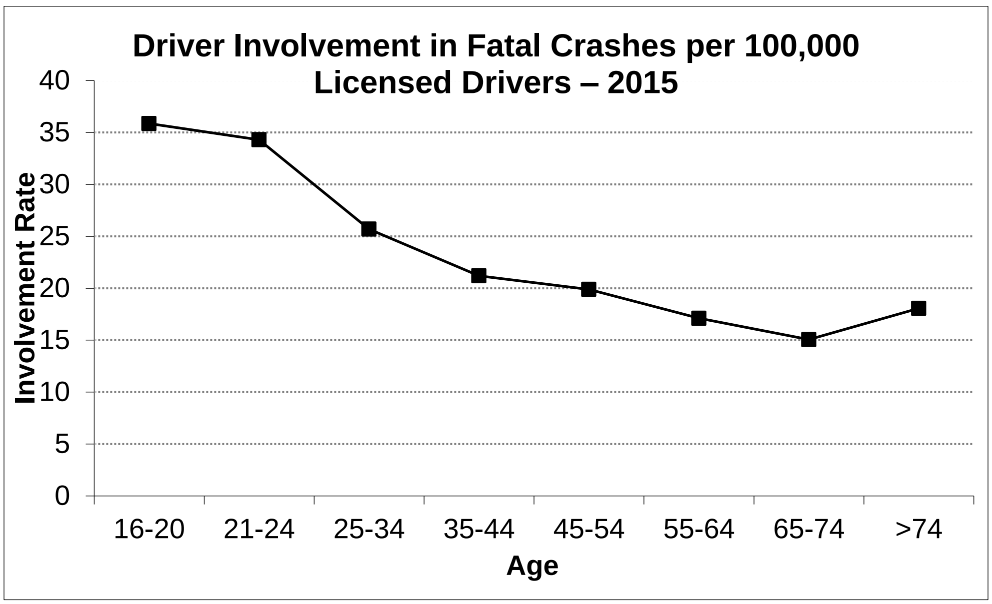
The U.S. population 65 and older increased at a much faster rate (15.1%) than the total population (9.7%) from the years 2000 to 2010 (U.S. Census Bureau, 2014). By 2030, the Census Bureau estimates that the resident population over 65 will double the 2010 population, to over 72 million, and will comprise 19.3% of the total U.S. population.

The licensed driver population likely will grow even faster. The proportion of people 65 or older who held a driver's license rose from 63% in 1982 to 86% in 2015 (FHWA, 2016). As of 2015, 92.0% of people 65 to 69 are licensed, as are 89.2% of people 70 to 74, 84.1% of people 75 to 79, 78.0% of people 80 to 84, and 69.7% of people 85 and older (FHWA, 2016). The licensure rate probably will increase because tomorrow's older people likely will be healthier and more accustomed to driving than today's. By 2030, if 85% of older people are licensed, there will be close to 61 million licensed drivers who are at least 65 years old.

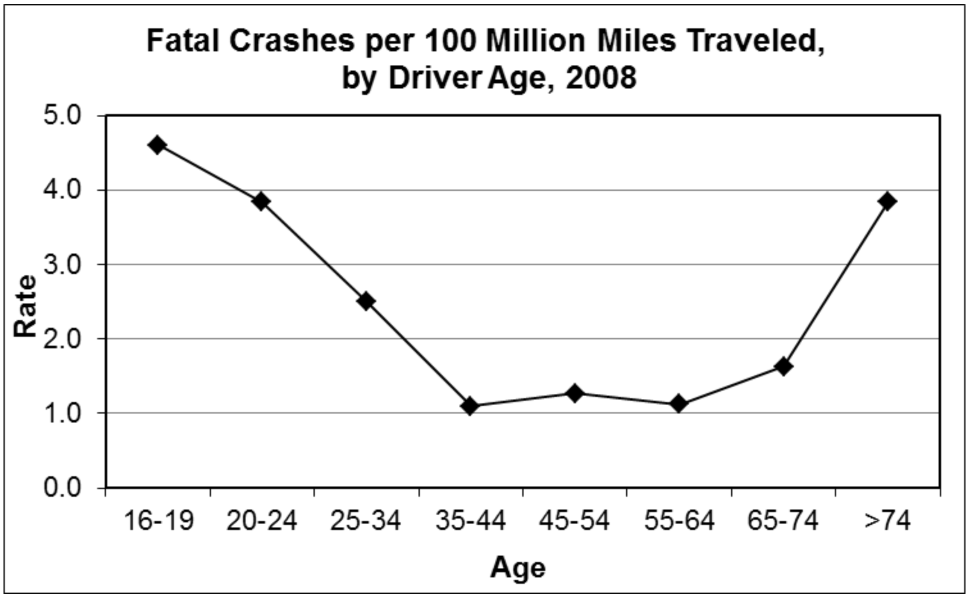
Older driver characteristics. Certain changes are inevitable as drivers age (Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2004; National Cooperative Highway Research Program [NCHRP], 2004, Section III)

- Physical capabilities diminish. Hearing, muscle tone, reaction time, and vision (especially at night) all decline, though at very different rates for different people.

- Fragility increases. The same force produces more serious injuries to a 70-year-old than to a 20-year-old. Injuries take longer to heal.
- Cognitive capabilities can diminish. Driving is a complex activity that requires a variety of high-level cognitive skills that can diminish through changes that occur with normal aging and/or as a result of dementia.
- Many older drivers use medications. These may be necessary to control disease or health conditions but also may cause drowsiness or otherwise affect driving. Older drivers are less likely than younger people to drive after drinking or using recreational drugs.
- Older drivers rarely drive aggressively or speed. However, they may exhibit other risky behaviors such as driving more slowly than prevailing traffic or failing to detect or accurately judge the speed of an oncoming vehicle while making a left turn.
- Most older drivers reduce their driving mileage as their lifestyles change. Many older drivers recognize and avoid driving in situations in which they feel uncomfortable, such as at night, on high-speed roads, or in unfamiliar situations (Staplin & Lococo, 2003).



Source: NHTSA (2017), Table 62



Source: Insurance Institute for Highway Safety [IIHS] (2014a)

These characteristics produce the following results.

- The older driver crash rate per licensed driver is *lower* than for younger drivers.
- The fatal crash rate for drivers 65 and older *per mile traveled* is *higher* than for all but the drivers 16-34 (IIHS, 2014a). This is due to changes in driving habits and increased susceptibility to injury among older drivers:
    - Older drivers drive fewer miles annually than younger drivers but tend to drive more on local roads where there are more potential hazards, such as traffic congestion and confusing intersections (Wang, Kosonski, Schwartzberg, & Shanklin, 2003). However, the majority of older drivers' fatal crashes occur on rural roadways (Stutts, Martell, & Staplin, 2009).
    - Because older drivers are more fragile, a crash is more likely to produce a serious injury or fatality than for younger drivers. Fragility, as measured by deaths per driver involved in a crash, begins to increase at 60 to 64 and increases steadily with advancing age. Fragility, rather than an increased tendency to get into crashes, accounts for about 60% to 95% (depending on age group and gender) of the increased death rates per miles traveled in older drivers (Li, Braver, & Chen, 2003).
    - Other research has concluded that the fatal crash risk for drivers 70 and older declined during the 1997-2008 time period at a rate faster than that for the comparison group of 35- to 54-year-old drivers. The authors suggest that this reduction in fatality risk for the older drivers is due to their decreased likelihood of being involved in crashes combined with an increase in their chances of survival when they are involved in crashes (Cheung & McCartt, 2010).
    - Improvement in occupant restraint systems have been shown to improve crash outcomes across age groups. Although these recent changes have benefitted younger occupants to a greater extent than older occupants, all occupants are safer when belted (Kahane, 2013).

- The declines in the national fatal crash rate for drivers 70 and older were greater than the declines for middle age drivers during the 2007–2012 time period. During this time, fatal crash rates per licensed driver fell 42% for drivers 70 and older and 30% for 35- to 54-year-old drivers. The 49% decline in the national fatal crash involvement rate for drivers 80 and older was the largest for any age group (Cicchino & McCartt, 2014).

Another informative study titled *Identifying Behaviors and Situations Associated with Increased Crash Risk for Older Drivers* reviewed published literature and analyzed crash data from 2002-2006), to identify driving behaviors/performance errors, and combinations of driver, vehicle, and roadway/environmental characteristics associated with increased crash involvement by older drivers (Stutts, Martell, & Staplin, 2009). The study found that drivers over 70 were overrepresented in a variety of types of crashes, but that drivers 60 and older were less likely than younger drivers to be involved in alcohol- or speeding-related crashes. The older drivers were also underrepresented in nighttime-related crashes, probably due in part to this group's tendency to avoid driving at night. Another general trend is that as drivers get older, they tend to be overrepresented in crashes that require navigating more complex situations such as intersections, left turns, and reacting to an impending crash (Stutts, Martell, & Staplin, 2009).

Strategies to Reduce Crashes and Injuries Involving Older Drivers

The overall goal of older-driver-related countermeasures is to enable older drivers to retain as much mobility through driving as is consistent with safety on the road for themselves, their passengers, and other road users. "Safe mobility for life" was the key phrase used in the U.S. Department of Transportation's *Safe Mobility for a Maturing Society: Challenges and Opportunities* plan published in 2003 (U.S. DOT, 2003). The plan established a number of strategies to address safe mobility on the State or local level. Strategies included educating and training older drivers to assess their driving capabilities and limitations; improving skills when possible; voluntarily limiting driving to circumstances in which they can drive safely; helping drivers adapt to medical or functional conditions that may affect driving through treatment (such as eyeglasses or cataract surgery to improve vision) or through vehicle adaptations (such as extra mirrors, extended gear shift levers, or hand controls); and using license renewal procedures or referrals from law enforcement, physicians, family, or friends to identify older drivers who cannot drive safely, in certain situations or at all, and restrict or revoke their driver's licenses.

In 2005 NHTSA developed the *Older Driver Traffic Safety Plan* that synthesized research findings and expert opinions and guided research and programs involving NHTSA during the next few years (NHTSA, 2005).

Building on that work, NHTSA produced the *Older Driver Program Five-Year Strategic Plan* in 2010 focused on how NHTSA will address the safety needs of older drivers from 2012 to 2017 (NHTSA, 2010). Based on interviews and expert panel input and other research, NHTSA identified three main program initiatives (communications, partnerships, and driver licensing policies) to guide the implementation of its *Older Driver Traffic Safety Plan* for 2012-2017.
In 2013, NHTSA developed the *Traffic Safety for Older People – 5-Year Plan* to address traffic safety concerns of older drivers, passengers, and pedestrians. The plan described research and

other program activities in the near term (within the next two years), short term (three to five years), and long term (beyond five years from the initiation of the plan). The plan was developed around four main elements: data, vehicle, behavior, and pedestrian safety. NHTSA notes that this plan is intended to be a dynamic guide that will be reviewed and modified in response to new research and other information related to traffic safety for older persons (NHTSA, 2013). The next update of *Traffic Safety for Older People – 5 Year Plan* is currently in progress and should be released prior to the next Countermeasures That Work edition.

There are a number of vehicular, environmental, and societal strategies critical to providing safety and mobility for older people but are for the most part beyond the control of SHSOs. Vehicles can be designed with better crash protection for older and more easily injured occupants, with controls and displays that are easier to see, reach and understand, and with crash warning and crash avoidance technology. These measures will make vehicles safer for everyone, not just older people. Aftermarket vehicle devices, such as one-hand joystick driving controls, can make driving possible or easier for people with some physical limitations. Roadways with separate left turn lanes, protected left turn signal phases, larger and more-visible signage, more-visible lane markings, rumble strips, and a host of other measures assist all drivers. These subjects are not discussed in this guide because they do not fall under direct SHSO jurisdiction. However, it is important that SHSOs become at least somewhat familiar with basic concepts of transportation planning and engineering – such as those mentioned above – since SHSOs can be expected to play increasingly important roles in partnerships to enhance older driver safety and mobility efforts.

NHTSA's *Highway Safety Program Guideline No. 13 – Older Driver Safety* provides States with key elements of a comprehensive older driver safety program that aims to reduce older driver crashes, fatalities, and injuries. Many of the guideline elements can be addressed directly by SHSOs, as NHTSA notes, "each State older driver safety program should address driver licensing and medical review of at-risk drivers, medical and law enforcement education, roadway design, and collaboration with social services and transportation services providers" to maximize benefits. The guideline also includes recommendations for program management, communications, and program evaluation and data components that should be included in a State older driver safety program (NHTSA, 2014).

Of all the subject areas in this countermeasure guide, those related to older drivers are perhaps the most complex because they involve so many issues beyond traffic safety. Sooner or later, in the interest of safety, most older drivers must restrict or eliminate driving, either by choice or as the result of the State licensing authority restricting or revoking the license. Frequently, this has substantial effects on the older driver's mobility and on physical and mental health. State Highway Safety Offices and licensing agencies cannot act alone but must plan and implement their older driver policies and programs as part of integrated community activities to improve older people' safety, mobility, and health. As just one example, some communities have established referral centers where people can go for "one-stop" access to resources for addressing the full range of transportation safety and mobility issues, including driving skills assessment, educational courses, licensing regulations and practices, and public transportation. See Stutts (2005) for summaries of comprehensive programs for older drivers in 6 States.

Several studies and policy papers discuss these issues. See in particular the Department of Transportation's *Safe Mobility for a Maturing Society: Challenges and Opportunities* (U.S. DOT, 2003) and NCHRP's *Guide for Addressing Collisions Involving Older Drivers* (Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2004) for excellent summaries and references to further information. The Organisation for Economic Co-Operation and Development's *Ageing and Transport: Mobility Needs and Safety Issues* (OECD, 2001) presents a discussion from an international perspective. The NCHRP synthesis *Improving the Safety of Older Road Users* (Stutts, 2005) summarizes State activities as of 2005. A report issued by the AAA Foundation for Traffic Safety (Stutts & Wilkins, 2009) documents current United States policies and practices for improving the safety of older drivers and identifies model programs. These policies and practices and model programs are made available through the AAAFTS "Driver Licensing Policies and Practices" and "Noteworthy Initiatives" databases that can be searched by State or by policy/topic area.

Resources

The agencies and organizations listed below can provide more information on older drivers and links to numerous other resources.

- National Highway Traffic Safety Administration:
  - Older Drivers – www.nhtsa.gov/road-safety/older-drivers; one.nhtsa.gov/Driving-Safety/Older-Drivers
  - Driver Safety Research Reports: Older Drivers – one.nhtsa.gov/Driving-Safety/Driver-Safety-Research-Reports:-Older-Drivers
- Clearinghouse for Older Road User Safety (ChORUS): www.roadsafeseniors.org/
- Behavioral Safety Research Reports – ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Centers for Disease Control and Prevention, Injury Prevention & Control: Motor Vehicle Safety: Older Adult Drivers: www.cdc.gov/Motorvehiclesafety/Older_Adult_Drivers/index.html
- AAA: seniordriving.aaa.com/
- AAA Foundation for Traffic Safety: www.aaafoundation.org/senior-drivers
- AARP: aarp.org/driversafety
- Governors Highway Safety Association: www.ghsa.org/html/issues/olderdriver.html
- Insurance Institute for Highway Safety: www.iihs.org/iihs/topics/t/older-drivers/topicoverview
- National Aging and Disability Center**:** www.nadtc.orgseniortransportation.net/
- The International Association of Directors of Law Enforcement Standards and Training: www.iadlest.org/Projects/OlderDriverLawEnforcementTraining.aspx
- National Safety Council: www.nsc.org/safety_road/DriverSafety/Pages/MatureDrivers.aspx
- Federal Highway Administration's 2014 Handbook for Designing Roadways for the Older Population: safety.fhwa.dot.gov/older_users/#training

Older Driver Countermeasures

Countermeasures to improve older driver safety are listed in the table below. The table is intended to provide a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. Effectiveness is shown using a five-star rating system:

- Countermeasures that receive ★★★★ or ★★★★★ have been determined to be effective.
- Countermeasures that receive ★★★ are considered promising, and likely to be effective.
- Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States, communities and other organizations are encouraged to use ★★★, and especially ★★★★ or ★★★★★, countermeasures. They should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

Further details about the symbols and terms used are included after the table. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate.

Each countermeasure to improve older driver safety is discussed individually in this chapter. Full descriptions are included for ★★★, ★★★★ and ★★★★★ countermeasures. Brief descriptions are included for ☆ and ☆☆ countermeasures. Further details about the ☆ and ☆☆ countermeasures are included in Appendix A7 to this report.

1. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Formal Courses for Older Drivers	☆☆	$	Low	Short
1.2 General Communications and Education	☆	$	Unknown	Short

2. Licensing

Countermeasure	Effectiveness	Cost	Use	Time
2.1 License Screening and Testing	★★★★	$$	High	Medium
2.2 Referring Older Drivers to Licensing Agencies	★★★★	$$	Low	Medium
2.3 License Restrictions	★★★★	$	Unknown	Short
2.4 Medical Advisory Boards	☆	Varies	High	Medium
2.5 License Renewal Policies: In-Person Renewal, Vision Test	☆☆	$$$	Medium	Medium

3. Traffic Law Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Law Enforcement Roles	★★★	Varies	Medium	Varies

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise.

See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities

Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:
Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies

1. Communications and Outreach

1.1 Formal Courses for Older Drivers

Effectiveness: ☆☆	Cost: $	Use: Low	Time: Short

This countermeasure involves formal courses specifically developed for older drivers. These courses are typically offered by organizations such as AAA, AARP, and the National Safety Council, either independently or under accreditation by States. The courses typically involve 6 to 10 hours of classroom training in basic safe driving practices and in how to adjust driving to accommodate age-related cognitive and physical changes. Courses combining classroom and on-the-road instruction have been offered in a number of locations (Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2004, Strategy D2).

Effectiveness Concerns: *The effectiveness of formal courses for older drivers has been examined in several research studies. While these studies have found some positive outcomes, there is no evidence that this countermeasure reduces crashes relative to comparison groups.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A7, Section 1.1.

1.2 General Communications and Education

Effectiveness: ☆	Cost: $	Use: Unknown	Time: Short

This countermeasure involves educational material for older drivers to inform them of driving risks, help them assess their driving knowledge and capabilities, suggest methods to adapt to and compensate for changing capabilities, and guide them in restricting their driving in more risky situations. These include a variety of self-assessment tools, programs, and other materials developed by organizations such as AAA, AARP, American Geriatrics Society (AGS), American Medical Association (AMA), American Society on Aging (ASA), and NHTSA.

Other material is available to assist drivers and family members in understanding how aging affects driving, the effects of medications and health conditions, how to assess an older driver's skills, how to use specialized vehicle equipment to adapt to certain physical limitations, how to guide older drivers into voluntarily restricting their driving, and how to report older drivers to the department of motor vehicles if necessary (Stutts, 2005). Additional information can be found on the NHTSA website (www.nhtsa.gov/road-safety/older-drivers) and the ChORUS website (www.roadsafeseniors.org). In February 2017, American Geriatrics Society (AGS) under a cooperative agreement with NHTSA, released a "Driving Safety" (toolkit) with resources for older drivers and caregives, on their public education website (HealthinAging.org), see: www.healthinaging.org/aging-and-health-a-to-z/topic:driving-safety/

Effectiveness Concerns: *There are no known evaluations of the effects of this material on driving or on crashes (Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2004, Strategy D2).*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix Section 7, 1.2.

2. Licensing

2.1 License Screening and Testing

Effectiveness: ★★★★†	Cost: $$	Use: High	Time: Medium

† Proven for identifying drivers whose driving should be limited

State licensing agencies vary considerably in their procedures for screening and evaluating a driver's abilities and skills (Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2004, Strategy C2). Many State guidelines are outdated, incomplete, or not based on actual functional impairment. Most do not include all the recommendations on medical conditions from the 1st and 2nd Editions of the *Physician's Guide to Assessing and Counseling Older Drivers* (Carr, Schwartzberg, Manning, & Sempek, 2010; Wang et al., 2003) and now a 3rd edition known as the *Clinicians Guide to Assessing and Counseling Older Drivers* (American Geriatrics Society, 2016).

NHTSA and AAMVA have developed *Model Driver Screening and Evaluation Program Guidelines for Motor Vehicle Administrators* (Staplin & Lococo, 2003). This was the final stage in a research program that investigated the relationships between functional impairment and driving skills; methods to screen for functional impairment; and the cost, time, legal, ethical, and policy implications of the guidelines (Staplin, Lococo, Gish, & Decina, 2003a).

The *Model Driver Guidelines'* goal is to keep drivers on the road as long as they are safe, through early identification and assessment together with counseling, remediation, and license restriction when needed (Staplin & Lococo, 2003). The guidelines outline a complete process of driver referral, screening, assessment, counseling, and licensing action (Staplin & Lococo, 2003). They include 9 simple visual inspection tests that licensing agency personnel can administer to screen for functional ability (Staplin & Lococo, 2003). A survey of State motor vehicle departments outlines some of the legal, policy, cost, and other criteria that must be met before the guidelines could be implemented in some States (Staplin & Lococo, 2003, Appendix C). The guidelines were tested in Maryland (Staplin, Lococo, Gish, & Decina, 2003b).

The screening and testing of older drivers was a major issue discussed during the 2008 North American License Policies Workshop sponsored by the AAA Foundation for Traffic Safety. One of the general themes of this workshop was that "while certain declines are generally associated with aging, consensus is lacking on whether or at what age people should be required to be screened or tested. Regardless, it is generally accepted that final licensing decisions should be based on functional performance, not age, as there is wide variation in how people age" (Molnar & Eby, 2008, p.3).

Use: All States screen and test drivers referred to them, though their procedures and criteria vary considerably (Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2004, Strategy C2). No State appears to have implemented the model guidelines. U.S. DOT recommends that further testing and evaluation of the guidelines are needed (U.S. DOT, 2003). See also the AAAFTS (2009a) "Driver Licensing Policies and Practices" database showing each State's driver licensing policies and practices regarding older and medically at-risk drivers.

Effectiveness: There is strong evidence that State screening and assessment programs identify some drivers who should not be driving at all or whose driving should be limited. The Maryland pilot test of the model guidelines concluded that "the analysis results ... have provided perhaps the best evidence to date that functional capacity screening, conducted quickly and efficiently, in diverse settings, can yield scientifically valid predictions about the risk of driving impairment experienced by older individuals" (Staplin et al., 2003b). In a study that evaluated the use of a screening tool on Alabama drivers 18 to 87 (Edwards et al., 2008), older drivers performed significantly worse than younger drivers and older drivers with a crash history performed worse than older drivers without crashes.

A NHTSA-sponsored project conducted by Eby et al. (2008) had the goal of improving upon existing self-screening tools for older drivers by focusing on symptoms associated with medical conditions. A self-screening survey was created to provide feedback to older drivers to increase general awareness of issues associated with driving and the aging process, and to provide recommendations for behavioral changes and vehicle modifications to make to be able to maintain safe driving. Evaluation of the self-screening instrument found it to have positive value, but primarily as a "screening tool to determine gross impairment rather than fitness to drive" (Eby et al., 2008, p. 19).

Costs: The model guideline functional screening tests can be administered for less than $5 per driver, including administrative and support service costs (Staplin et al., 2003a).

Time to implement: States should be able to modify their driver license screening and assessment procedures in 4 to 6 months.

2.2 Referring Older Drivers to Licensing Agencies

Effectiveness: ★★★★†	Cost: $$	Use: Low	Time: Medium

† Proven for increasing physician referrals

Older drivers come to the attention of licensing agencies at regular license renewals, as discussed in Chapter 7, Section 2.1, or when they are referred to the licensing agency for reevaluation of their driving skills.

Licensing agencies in all States accept reevaluation referrals for drivers of any age. A survey of all State licensing agencies found that three sources accounted for 85% of referrals: law enforcement (37%), physicians and other medical professionals (35%), and family and friends (13%) (Stutts, 2005). The remaining 15% came from crash and violation record checks, courts, self-reports, and other sources.

Law enforcement officers have the opportunity to observe drivers directly at traffic stops or crashes. With appropriate training, they can identify many drivers who should be referred to the licensing agency for assessment. NHTSA has developed and field-tested a set of cues that officers can use to identify potentially impaired drivers (NHTSA, 1998; see also Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2004, Strategy C3, and Stutts, 2005, Chapter 7).

Physicians are in an excellent position to assess if changes in their patients' physical or cognitive abilities may increase their crash risk. In addition to assessment, physicians should provide counseling and assistance on driving as needed and refer patients to the licensing agency if appropriate. In 6 States, physicians are required to report patients who have specific medical conditions such as epilepsy or dementia (Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2004, Strategy C3). Other States require physicians to report "unsafe" drivers, with varying guidelines for defining "unsafe." Physicians must balance their legal and ethical responsibilities to protect their patient's health and confidentiality with their duty to protect the general public from unsafe drivers. Physicians have been held liable for damages from crashes involving patients because they failed to report the patient to the licensing agency (Wang et al., 2003, Chapter 7).

NHTSA's *Clinician's Guide to Assessing and Counseling Older Drivers* (2016) provides detailed information for physicians and medical professionals. The guide was prepared by the American Geriatrics Society (AGS), and is an update to the *Physician's Guide to Assessing and Counseling Older Drivers* (Wang et al., 2003; Carr et al., 2010). Chapter 8 has an extensive summary of State licensing and reporting laws. Chapter 9 contains a list of medical conditions and medications that may impair driving and consensus recommendations on what action to take for each. Other chapters include information on treatment and rehabilitation options that may allow patients to continue to drive and on how to counsel patients about retiring from driving. See also Lococo (2003, Appendix C) for State-level information and Potts, Stutts, Pfefer, Neuman, Slack, and Hardy (2004, Strategy C3) for overall discussion.

Chapter 3 of the *Clinician's Guide to Assessing and Counseling Older Drivers* (AGS, 2016) discusses the assessment of functional abilities and provides physicians with the instructions and basic forms needed for them to conduct a brief in-office Clinical Assessment of Driving Related

Skills (CADReS). The CADReS screening tool assesses some aspects of the key functional areas of vision, cognition, and motor/sensory functions to help physicians identify specific areas of concern as they relate to driving. An evaluation of an earlier version of CADReS (McCarthy, Mann, & Lanford, 2009) suggests that while this tool was able to identify all of the study participants who failed the behind-the-wheel test included as a part of the study, the tool may need to be revised to give physicians a more effective and efficient tool for in-office assessments.

In order to encourage more use of the *Clinician's Guide to Assessing and Counseling Older Drivers*, a five-module curriculum that includes slides, video case segments, and handouts was developed by the AMA. The goal is to heighten knowledge and skills necessary for a clinician to evaluate driver fitness in a typical care encounter, and to develop a plan for further evaluation by other specialists or licensing authorities if needed. An evaluation of this curriculum found that continuing education training can enhance the confidence and clinical practices of health professionals as related to driver fitness evaluations and mobility planning (Meuser, Carr, Irmiter, Schwartzberg, & Ulfarsson, 2010).

Many States have established procedures for family members and friends to report drivers of any age whose abilities may be impaired. Potts, Stutts, Pfefer, Neuman, Slack, and Hardy (2004, Strategy C3) provides examples and web links for programs in Florida, Missouri, Minnesota, and Oregon.

States can increase driver referrals by establishing and publicizing procedures for referring drivers, establishing referral policies and providing appropriate training and information to law enforcement officers, and informing physicians and health professionals of their responsibilities. NCUTLO's model law on reporting drivers with a physical or mental disability (NCUTLO, 2000) describes the responsibilities of health care providers and of State Medical Advisory Boards, driver licensing agencies, and license examiners. NHTSA, in collaboration with the American Association of Motor Vehicle Administrators has produced a guide titled "Driver Fitness Medical Guidelines" that is designed to provide guidance to licensing agencies that can be used in making decisions about an individual's fitness for driving (NHTSA, 2009c). Guidelines are provided for a variety of physical limitations and impairments as well as medical conditions. In addition, this guide provides information that can be used by State licensing agencies to educate medical professionals about the effects of functional impairments and medical conditions on safe driving in order to encourage them to refer drivers for additional evaluations related to driving.

Use: A survey of all State licensing agencies found that fewer than 100,000 drivers 65 and older are referred each year from all sources, or less than 0.4% of the 28.6 million older licensed drivers (Stutts, 2005, Appendix E). The number of referrals varies substantially across the States, from a few hundred to 50,000.

Effectiveness: States that establish and publicize effective referral procedures will increase referrals. Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2004, Strategy C3) provides examples and web links. As one example, Pennsylvania increased physician referrals substantially by sending letters to all physicians (Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2004, Strategy C3).

A study of Missouri's voluntary reporting law and the resulting licensing outcomes found that the crash involvement of reported drivers decreased after implementation of the law and, to a lesser degree, mortality declined as well. Though the Missouri law is not specific as to age, the mean age of reported drivers was 80 and only 3.5% of the 4,100 people (reported by a combination of law enforcement officers, driver license office staff, physicians, family members and others) retained their drivers' licenses after the process. (Meuser, Carr, & Ulfarsson, 2009). As part of this law, reported people are required to undergo a physician evaluation. In order to better understand the observations and concerns of family members and to investigate why older drivers were referred to the licensing agency, Meuser, Carr, Unger, & Ulfarsson (2015) reviewed reporting forms submitted by family members indicating an older individual who is potentially unfit to drive. Of the 689 older adults, 448 were reported to have a cognitive issue (e.g., confusion, memory loss, and becoming lost while driving) and 365 cases included a diagnostic label such as Alzheimer's disease, cognitive impairment/dementia or brain injury. When the observations of family members and physicians were compared, agreement was high for Alzheimer's disease (100%) and for acute brain injury (97%). However, agreement was lower for cognitive impairment/dementia (75%). This discrepancy for cognitive impairment/dementia suggests that family members and physicians may understand cognitive impairment differently. Overall, the researchers concluded that physicians and driver licensing authorities would do well to consider family member observations when assessing fitness-to-drive in older people.

The mandatory reporting law in Oregon was enacted in 2002 and requires primary physicians and other health care providers that function as a primary provider to report cognitively impaired drivers to the Department of Motor Vehicles. Reports by primary care providers result in automatic suspensions of driving privileges, but the suspended driver has the opportunity to request retesting and/or a hearing to appeal the suspension. A study of this Oregon law found over 1,600 drivers reported as being cognitively impaired from 2003 to 2006, with the majority of the reported drivers being older than 80. The most common cognitive impairments were in judgment and problem solving, but impairments in memory and reaction time impairments were also reported about half the time. Of the 1,664 people reported who lost their licenses, less than 20% requested retesting or a hearing to contest their license suspensions and only about 10% of the total number reported and suspended (173) regained their driving privileges (Snyder & Ganzini, 2009).

Costs: Costs for establishing and publicizing effective referral procedures vary depending on the procedures adopted, but should not be extensive. Educational and training publications are available for use with law enforcement and medical professionals. Funds will be required to distribute this material and for general communications and outreach. If referrals increase substantially, then licensing agency administrative costs will increase.

Time to implement: States seeking to improve referrals will require at least 6 months to develop, implement, and publicize new policies and procedures.

2.3 License Restrictions

Effectiveness: ★★★★	Cost: $	Use: Unknown	Time: Short

If a State licensing agency determines through screening, assessment, medical referrals, road tests, or other means that a driver poses excessive risks only in certain situations, the driver can be issued a restricted license. This process of "graduated de-licensing" preserves the driver's mobility while protecting the driver, passengers, and others on the road. Drivers whose vision is adequate during daylight hours but not at night present an obvious example. Their licenses can be restricted to daylight driving only. Other common restrictions limit driving to a specific geographical area, such as the town or county where the driver lives, or limit driving only to low-speed roads.

The AAAFTS (2009b) "Noteworthy Initiatives" database lists Iowa, Kansas, and Minnesota as having noteworthy restricted licensing programs. Iowa offers tailored drive tests that allow drivers to be tested in their own community on roads they would typically drive and, if successful, these drivers are allowed to drive where they have demonstrated proficiency. Iowa license examiners conduct approximately 100 to 150 such examinations each year. Kansas offers a "Local Drive" road test program where, if a driver makes a written request, an examiner will meet the driver in his/her community and conduct the test on routes of the driver's own choosing. The driver must agree that the license will be restricted to areas close to home and possible specific routes. Kansas conducts about 200 to 250 local drive tests each year. In Minnesota, drivers who live in a rural area and only need driving privileges close to home may arrange for a road test examiner to go to the driver's home. Examiners perform only about 25 of these road tests per year, and they may result in very customized licenses such as being limited to a specific route, specific hours of the day, or any combination of restrictions as appropriate.

Use: Iowa and Utah are known to issue restricted licenses (Stutts, 2005; Vernon, Diller, Cook, Reading, & Dean, 2001). A survey of State licensing agencies found that two-thirds of the States said that restricted licenses would be feasible under current State policies, though two-thirds of these would require legislative changes before restricted licenses could be issued (Staplin & Lococo, 2003). The number of States that currently issue restricted licenses specifically for older drivers is not known, but the AAAFTS (2009a) "Driver Licensing Policies and Practices" database shows that 46 States and the District of Columbia place at least some types of conditions or restrictions on licenses of older and/or medically at-risk drivers. The most common restriction is the requirement of corrective lenses.

Effectiveness: Several studies show that driver license restrictions lower the crash risk for these drivers, though their crash risk is still higher than for similar-age drivers with unrestricted licenses (Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2004, Strategy C2; Vernon et al., 2001). Research conducted by Braitman, Chaudhary, and McCartt (2010) found that license restrictions may be an effective alternative to complete driving cessation, and provide drivers with some degree of continued mobility and independence. However, they also concluded that while the overall safety benefits of license restrictions may be unknown, license restrictions tend to reduce driving exposure, especially in higher risk situations.

Langford and Koppel (2011) found that imposition of a license restriction was usually associated with a reduction in absolute crash rates, and identified three restrictions that produced lower crash rates and can be thought of as major components of a graduated driving reduction program. The three restrictions are driving within a specified distance of home, not driving at night, and driving only in specified areas.

An evaluation of the "local drive test" (LDT) option offered to older Iowa drivers who might not otherwise be able to renew their licenses found that the overall crash rate of the LDT drivers was higher than for the general population of licensed drivers 65 and older, but was lower than the overall driver crash rate for Iowa drivers (Stutts & Wilkins, 2012).

Costs: Once drivers have been screened and assessed, the costs of issuing a restricted license are minimal.

Time to implement: Restricted licenses can be implemented as soon as any needed policy or legislation changes are enacted.

2.4 Medical Advisory Boards

Effectiveness: ☆†	Cost: Varies	Use: High	Time: Medium

† Quality varies considerably

This countermeasure involves medical advisory boards that assist licensing agencies in evaluating people with medical conditions or functional limitations that may affect their ability to drive (AAAFTS, 2009a). MABs generally make policy recommendations on what licensing actions are appropriate for people with specific medical conditions or functional limitations.

Effectiveness Concerns: *This countermeasure is widely used; however, there are no known studies evaluating the effects of MABs.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A7, Section 2.4.

2.5 License Renewal Policies: In-Person Renewal, Vision Test

Effectiveness: ☆☆	Cost: $$$	Use: Medium	Time: Medium

This countermeasure involves changes to the license renewal requirements for drivers older than a specified age, typically 65 or 70. These changes may include a shorter interval between renewals, in-person renewal (no renewal by mail or electronically), or a vision test at every renewal. Requirements for older renewal applicants can also involve written or road tests.

Effectiveness Concerns: *Some version of this countermeasure has been implemented in over half the States. Its effectiveness has been examined in several research studies. Although there have been some positive research findings, the balance of evidence regarding countermeasure effectiveness remains inconclusive.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A7, Section 2.5.

3. Traffic Law Enforcement

3.1 Law Enforcement Roles

Effectiveness: ★★★	Cost: Varies	Use: Medium	Time: Varies

Law enforcement plays three overall roles in improving the safety of older drivers:

- Enforce traffic laws. In particular, active publicized enforcement of seat belt use laws can help increase belt use for older drivers and occupants. See Chapter 2, Section 2.1, for discussion.
- Identify drivers with potential driving impairments and refer them to licensing agencies. Traffic stops and crash investigations provide officers excellent opportunities to observe and evaluate driving behavior. See Chapter 7, Section 2.2, for discussion.
- Provide information and education. Law enforcement officers have formed many partnerships with public and private organizations to give talks, teach safe driving courses, work with media on news stories and public service announcements, and other communications and outreach initiatives. Stutts (2005) summarizes several examples. NHTSA (2003) lists law enforcement programs that were active in 2003. They include training for officers, training for older drivers, and community relations programs that promote safety.

Use: The International Association of Directors of Law Enforcement Standards and Training (IADLEST) has developed a training course for law enforcement instructors that covers a range of topics related to older persons and driving (www.iadlest.org/Projects/OlderDriverLawEnforcementTraining.aspx). This course aims to train instructors on how to provide law enforcement officers the information they need to effectively interact with and evaluate older drivers.

Effectiveness: Law enforcement officers provide more than one-third of all referrals to licensing agencies for driver screening and assessment (Chapter 7, Section 2.2).

Costs: Costs vary depending on the nature and scope of activities.

Time to implement: Implementation time varies depending on the nature and scope of activities.

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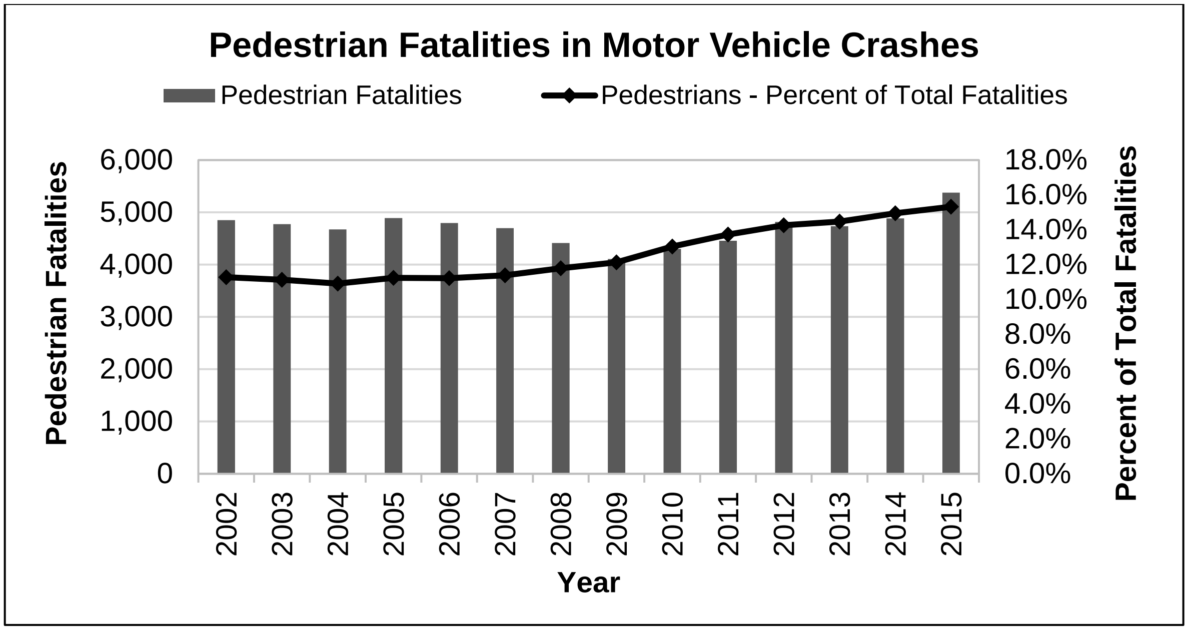
8. Pedestrian Safety

Overview

In 2015, 5,376 pedestrians died and approximately 70,000 were injured in traffic crashes in the United States (NCSA, 2017a). Pedestrians accounted for 15% of total traffic fatalities and 3% of total traffic-related injuries. Since 2003, there has been a gradual rise in the proportion of total fatalities that were pedestrians. Of the pedestrian fatalities in 2015:

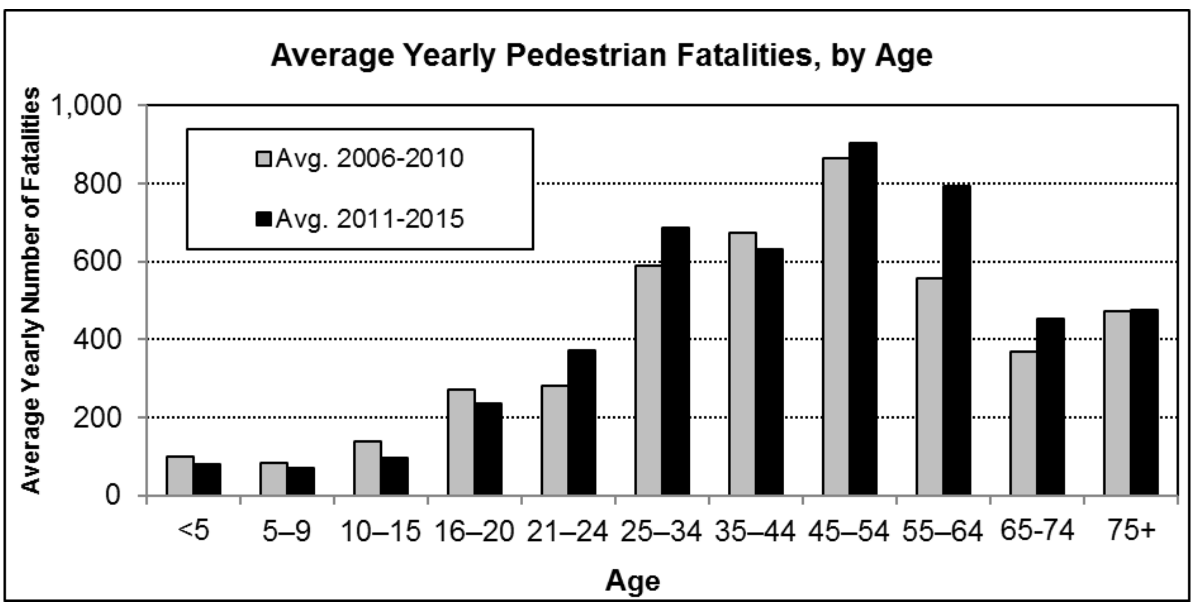
- 70% of pedestrians killed were males;
- 35% of pedestrians killed had BACs of .08 g/dL or greater;
- 76% of pedestrian fatalities occurred in urban areas;
- 72% of pedestrian fatalities occurred at non-intersection locations;
- 74% of pedestrians were killed in collisions that occurred when it was dark;
- The average age of a pedestrian killed was 47; injured was 38;
- Among children, pedestrians aged 10-14 had the highest number of fatalities and injuries, while children under 5 and 5-9 had the highest percentage of pedestrian fatalities;
- Children 14 and younger accounted for 4% of the pedestrian fatalities and an estimated 11% of all pedestrians injured in traffic crashes;
- 19% of those killed were adults 65 and older, including 302 pedestrians 80 years and older; and
- The highest total pedestrian injury rates by age group were those 20 to 24 and 15 to 19 (36 and 35 per 100,000 population, respectively).

Crash Trends. Pedestrian fatalities have dropped gradually over the past 20 years, from an average of about 5,600 per year from 1991-1995, to an average of about 4,850 annually for the most recent five years (2011-2015, see figure below). The number of pedestrians killed in 2015 (5,376) was 9.5% higher than the number killed in 2014 (4,910). Fatality rate trends—or fatalities adjusted per number of walking trips or miles traveled by walking—are unavailable because there is no systematically collected and consistent measure of walking (exposure) to estimate and compare fatality rates each year. The population-based fatality rate for pedestrians overall was 1.67 per 100,000 population, with a rate of 2.37 for males and 0.99 for females (NCSA, 2017a). However, population-based rates do not fully account for trends in amounts of walking.



Source: NCSA (2017a)

While the average age of pedestrians killed has remained similar over the past 10 years, there have been fluctuations in the number of pedestrian fatalities among age groups over the last decade. The largest decrease in pedestrian fatalities over the past 10 years occurred in the age group 35 to 44 and the largest increase occurred in the age group 55 to 64. Not all of the changes are explained by changes in population by age group, as the population-based rates have also varied by year. (Fatalities and fatality rates by population for various age groups are available for 2015 in NHTSA's Traffic Safety Facts reports, NCSA, 2017a).



Source: FARS data

Note that different age group spans are used. The intent of the chart is to compare general trends within different age groups, not to compare fatalities by age.

Comparing average fatalities for 2011 – 2015 to those from 2006 – 2010, pedestrian fatalities decreased for all age groups under 20 and for pedestrians 35 to 44 (see figure above). All other age groups saw an increase in fatalities. For those 55 to 64, a notable increase in pedestrian fatalities was observed from around 550 per year to close to 800 per year. As noted earlier, this increase may reflect an increase in population and walking among this age group. Older pedestrians (generally those over 65) are more likely to die from their injuries when struck due to the inherent fragility associated with the aging process. Factors that may increase vulnerability to *being* struck for some older pedestrians include age-related physical changes that may lead to walking more slowly, difficulty in crossing the curb, difficulty judging walking and oncoming vehicle speeds, dealing with turning vehicles at intersections, and possible confusion about pedestrian signal phases (Dommes, Cavallo, Vienne, & Aillerie, 2012; Holland & Hill, 2010; Coffin & Morrall, 1995).

Several studies have also noted the overrepresentation of minorities, immigrants, and low-income populations in pedestrian-vehicle crashes (Anderson, Vaca, & Chakravarthy, 2010; Chakravarthy et al., 2012; Chen, Lin, & Loo, 2011; Murtha, 2005); however, the causes and contributing factors of these elevated crash rates are not well understood. Some studies attribute higher minority crashes to potential inequities in how pedestrian facilities are distributed across areas with different socioeconomic indicators (Kravetz & Noland, 2012). Other studies have found that lower income and minority populations have higher transit use and walking rates (or exposure) that may help partially explain elevated crash figures (Cottrill & Thakuriah, 2010). Still others have postulated that social-behavioral mechanisms and differing “safety cultures” play a role in pedestrian crashes, particularly for recent immigrants (Chen, Lin, & Loo, 2011).

Despite the vulnerability of these groups to pedestrian crashes, the effectiveness of countermeasures in reaching these special populations is both unknown and challenging to evaluate. This is due to the lack of information about pedestrian safety programs targeted to the specific needs of low-income, minority, or immigrant populations, and because the courses or programs targeting these groups have been unsuccessful in measuring changes in behaviors. NHTSA developed and pilot tested two English as a Second Language courses to teach basic walking and bicycling safety concepts to adult immigrants learning the English language (see nhtsa.gov/pedestrian-safety/english-second-language-esl-teachers-and-learners). Both courses are free for use by formal programs or less formal settings with volunteer instructors. While NHTSA was able to evaluate the ease of use of these courses by ESL instructors, and found increases in pre/post knowledge for the beginning level course, they were unable to successfully evaluate behavior changes as a result of this knowledge. A separate resource, the *Resident’s Guide for Creating Safer Communities for Walking and Biking* was demonstrated for use in multiple communities. This demonstration generated several case studies on inclusive approaches to outreach, community-based planning, and improving conditions for pedestrians and was part of the update to the guide (Sandt, Thomas, Langford, & Nabors, 2015). Finally, another challenge noted by NHTSA relates to translation of educational materials. Among some non English speakers living in the U.S., translation of materials is ineffective because they are not literate in their native language. This knowledge spurred NHTSA to develop visual educational tools (motion graphics) to teach desired pedestrian behaviors, bicyclist behaviors around motorized traffic, and safe driver behavior around pedestrians and bicyclists. The motion graphics demonstrate visually motions without language to deliver safety education and are specifically designed for audiences that lack English language skills or literacy in their native language.

Walking Trends. The National Household Travel Survey (NHTS), conducted by the Federal Highway Administration, has attempted to capture walking and other travel trends in the United States According to estimates from these surveys, the number of walking trips changed from 21.9 billion in 1990 to 20.3 billion in 1995, and to 33.1 billion in 2001 (Santos, McGuckin, Nakamoto, Gray, & Liss, 2011). The latest NHTS in 2009 indicates that about 41 billion walking trips of all purpose types were made in a year over the 2008 to 2009 survey period (Santos et al., 2011). It is likely that at least some of the increases in 2001 and 2009 relate to more detailed questions prompting respondents to include walk trips in those two years, which was not done in the prior surveys (Santos et al., 2011). The 41 billion walking trips in 2009 represents approximately 10% of all transportation mode trips reported. About 3% of all trips to work were made by walking (Santos et al., 2011). Commuting to work, however, makes up only a small percentage (4.5%) of all walking trips (Santos et al., 2011, Table 9). The largest proportion of walking trips were made for recreational and social reasons (46%) followed by family and personal errands (37%). Walking to school or church made up nearly 9% of walking trips (Santos et al., 2011). The percentage of students walking to school has also increased from 11.9% in 2007 to 15.2% in 2014 for morning trips and from 15.2% to 18.4% for afternoon trips (National Center for Safe Routes to School, 2016). This represents a 32% and 24% increase, respectively.

The increase in number of walking trips is especially significant since it represents an increase in the average number of daily walking trips per person (Pucher, Buehler, Merom, & Bauman, 2011), whereas total daily personal trips per person have been declining since the 1995 survey (Santos et al., 2011). The Centers for Disease Control and Prevention's National Health Interview Survey, collected in 2005 and 2010, assessed changes in prevalence of walking for at least 10 minutes one or more times in the preceding seven days. Walking prevalence increased significantly, from 55.7% in 2005 to 62.0% in 2010. In 2010, walkers were also significantly more likely to meet the aerobic physical activity guidelines (CDC, 2012). Using NHTS data, Pucher et al. (2011) also found an increase in the percentage of people meeting recommended daily activity levels through walking from 2001 to 2009. CDC is encouraging walking and bicycling to help meet physical activity guidelines. The CDC also supports the building of communities that provide safe and equitable opportunities to walk such as implementing Complete Streets policies and designs and lowering speed limits in urban areas, etc. For more information, see: www.cdc.gov/nccdphp/dch/programs/communitiesputtingpreventiontowork/resources/physical_activity.htm. Also see Health Resources in Action's web pages on Community Speed Reduction and Public Health: www.hria.org/resources/reports/community-speed-reduction/2013-resources-speed-reduction.html. The Surgeon General, in 2015, released *Step It Up! The Surgeon General's Call to Action to Promote Walking and Walkable Communities.* See: www.surgeongeneral.gov/library/calls/walking-and-walkable-communities/call-to-action-walking-and-walkable-communites.pdf. A status report was released in 2017 www.cdc.gov/physicalactivity/walking/call-to-action/pdf/status-report.pdf

Classifying Crash Types. Beginning in the 1970s, pedestrian crashes were categorized into types based on (1) pedestrian and motor vehicle pre-crash actions, and (2) crash location. In the early 1990s, this methodology was used to type more than 5,000 pedestrian crashes in California, Florida, Maryland, Minnesota, North Carolina, and Utah and analyze related characteristics (Hunter, Stutts, Pein, & Cox, 1996, summarized in www.pedbikeinfo.org/data/library/-details.cfm?id=2755).

Of these 5,000 pedestrian-motor vehicle crashes:

- 32% occurred at or within 50 feet of an intersection. Of these intersection crashes:
  - 30% involved a turning vehicle.
  - 22% involved a pedestrian dashing into the intersection.
  - 16% involved a driver violation (e.g., running a red light).
  - Older pedestrians were overrepresented in collisions with turning vehicles and motorist violations.
  - Children were overrepresented in intersection dashes.
- 26% occurred at the middle of a block (mid-block). Of these mid-block crashes:
  - 1/3 involved the pedestrian running into the street and the driver’s view was not obscured.
  - 1/6 were “dart-outs” in which the pedestrian walked or ran into the street from a location where the pedestrian could not be seen.
  - Children were also overrepresented in dash-and-dart-out crashes.
- 7% occurred walking along a roadway, not on a sidewalk. Of these crashes:
  - 3/4 of the pedestrians were struck from behind while walking in the same direction as traffic.
  - Darkness and rural locations were overrepresented. This association is expected since rural areas are less likely to have sidewalks and supplemental street lighting.

The Pedestrian and Bicycle Crash Analysis Tool (PBCAT) software assists jurisdictions in typing pedestrian crashes and developing a database for analyzing pedestrian crash problems. Crash typing methodology has been used to develop a tool that communities or States may use to discover more information about pedestrian and bicycle crashes. States and communities can utilize the crash type information and other crash characteristics to help select appropriate countermeasures. It is important to consider on-site field review of behaviors and site-specific characteristics before determining whether specific enforcement, educational, or engineering countermeasures are appropriate (Zegeer, Sandt, & Scully, 2008). PBCAT may be downloaded from www.pedbikeinfo.org/pbcat_us/. Registration is requested for this free software so the user may receive software updates or important technical information.

Underreporting and Crash Analysis. Another consideration when analyzing crash data is that pedestrian crashes (as well as bicycle crashes) tend to be underreported. Many States may not require reporting nor collect off-road or private-road crash records. Non-roadway crashes may, however, constitute a significant portion of pedestrian-related crashes with motor vehicles. In several studies, parking lot and driveway-related crashes represented up to 15% to 25% or more of all *reported* pedestrian crashes (Stutts & Hunter, 1999a; Thomas & Levitt, 2014). Many more roadway and non-roadway crashes go unreported. Research is needed to better understand the extent and causes of non-roadway pedestrian crashes and effective countermeasures. NHTSA’s

Not in Traffic Surveillance (NiTS) monitors and reports on not-in-traffic-related motor vehicle deaths. Many of these events involve young children. See Section 1.1 for more information.

Underreporting of traffic-related crashes on road right of ways likely decreases as the crash severity increases because police are likely to be called to injury and fatal crashes, and the pedestrian is more likely to be transported or seek examination at a healthcare facility. Therefore, the FARS data presented earlier is thought to be a reliable source for estimating pedestrian fatal crash frequencies. Even so, not all fatal pedestrian crashes are included in FARS, including fatal pedestrian crashes involving a bicycle, or those that did not occur on public roads, as already mentioned.

Many more pedestrian and bicyclist injuries, including those due to falls, collisions with bicycles, and others, likely go unreported to State crash databases (Stutts & Hunter, 1999a, 1999b). However, up-to-date information is lacking, and research is also needed to better understand the causes of these types of injuries. Maintenance of surfaces and Americans With Disabilities Act-compliant design of sidewalks, landings, and access ramps are certainly important for maintaining smooth surfaces and safe and accessible sidewalks and ramps. Other measures, such as providing space for bicyclists to ride separated from pedestrian walkways may also be important, but are outside the scope of this document.

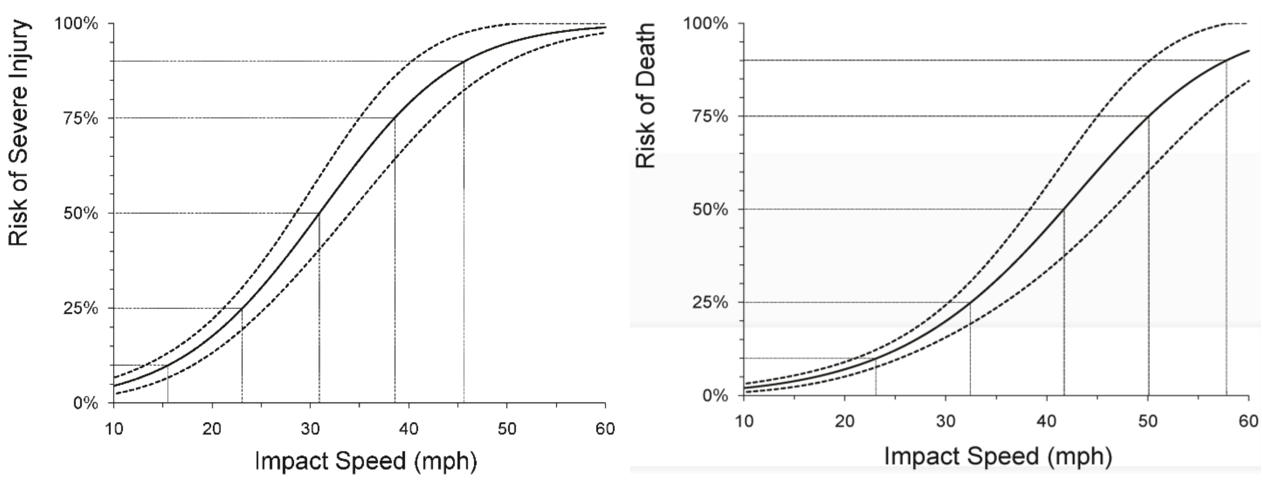
Pedestrian Attributes – Everyone is a pedestrian, though when asked they may not think of themselves as one until prompted. Pedestrians span the full spectrum of ages from babies pushed in strollers to older adults. This includes foreign visitors and immigrantsused to different traffic conventions who speak many languages and who may not be literate in their native language. Pedestrians are also disabled people, including those who are visually impaired, hearing impaired or deaf, or require mobility assistance devices such as wheelchairs or crutches. More generally, however, we are all pedestrians when we walk our dogs, or cross the street to a neighbor, the store, school, or the bus stop.

Crash Factors – A large body of research in the past several decades has established numerous factors associated with pedestrian crashes. Pedestrian and driver pre-crash actions and behaviors (such as distraction, driver speed, and alcohol use, and vehicle type and design) all contribute to pedestrian crashes. Several studies have provided evidence of the role of the transportation environment in pedestrian safety and summarized best practices in engineering and design for pedestrian safety (FHWA, 2011; Redmon, 2011; Retting, Ferguson, & McCartt, 2003). Complete Streets policies are one of the more low-cost and impactful countermeasures, as evidenced by numerous cities and States across the United States (FHWA, 2011). For more on Complete Streets, visit www.smartgrowthamerica.org/complete-streets/. Also, search for a program in your State or city.

Distraction – Cell phone and electronic device use are a source of distraction, not only for motorists (discussed in Chapter 4), but also for pedestrians. A recent literature review from NHTSA found that, based on the limited amount of research done on pedestrian distraction, distraction is associated with a small but statistically significant decrease in pedestrian safety (Scopatz & Zhou, 2016). Talking on cell phones is associated with cognitive distraction that may reduce the frequency of prudent pedestrian behaviors, particularly among college-age pedestrians who may be more engaged with such devices (Hatfield & Murphy, 2007; Nasar, Hecht, & Wener, 2007; Stavrinos, Byington, & Schwebel, 2001, 2009); however, the results from real-world observational studies are mixed (Walker et al. 2012; Thompson, Rivara, Ayyagari, and Ebel, 2013). Thompson et al. (2013) sampled pedestrian behaviors at 20 high risk intersections and only pedestrians who were texting were associated with suboptimal crossing behaviors.

The studies described above report 7% to 30% of pedestrians using varying types of portable electronic devices. Nationally representative estimates on use of portable electronic devices are unavailable, but would likely only capture a snapshot in time, as device use continues to grow in popularity. FARS/GES data on pedestrian device use or involvement in pedestrian crashes is unavailable at the national level.

Driver speed – Driving speed is a key risk factor in severe pedestrian crashes. The study by Rosen and Sander (2009) is believed to be one of the more robust in terms of estimating the risk of pedestrian fatality based on driver impact speeds. The study estimated fatality risk curves based on driver impact speeds, ranging from 8% at 50 km/h (31 mph) and reaching 50% at 75 km/h (about 47 mph). A number of other studies have estimated similar relationships, although the magnitude varies somewhat (Leaf & Preusser, 1999; Tefft, 2011). As pedestrians are particularly vulnerable to severe injury and fatality when struck by higher-speed vehicles, countermeasures aimed at reducing vehicle speeds have the potential to save lives for both pedestrians and drivers. Driving speed also appears to affect the tendency for drivers to yield to pedestrians at crosswalks, with fewer drivers yielding as speeds increase (Bertulis & Dulaski, 2014; Gårder, 2004). Speeding-related countermeasures are presented in Chapter 3.



Risk of severe injury (left) and death (right) in relation to impact speed in a sample of 422 pedestrians aged 15+ years struck by a single forward-moving car or light truck model year 1989–1999, United States, 1994–1998. Risks are adjusted for pedestrian age, height, weight, body mass index, and type of striking vehicle, and standardized to the distribution of pedestrian age and type of striking vehicle for pedestrians struck in the United States in years 2007–2009. Dotted lines represent point-wise 95% confidence intervals. Serious injury is defined as AIS score of 4 or greater and includes death irrespective of AIS score.

Source: Tefft (2011)

Alcohol – The role of alcohol in pedestrian crashes has not been well defined, based on the lack of complete and high-quality data on alcohol use or BAC levels of drivers and pedestrians involved in crashes. Alcohol use—by either the driver or pedestrian— is estimated to be a contributing factor in 48% of pedestrian fatalities (NCSA, 2017a). Thirty-five percent (35%) of pedestrians killed in crashes had a BAC of .08 or higher, while 14% of fatal pedestrian crashes had drivers with BACs of .08 or higher (NCSA, 2017a). Alcohol-related countermeasures that may also help address certain pedestrian crashes are presented in Chapter 1.

Vehicle Type and Design- Previous studies have focused on the role of vehicle type, design, and warning systems in the event of a crash (Searson & Anderson, 2011), and in the ability of pedestrians and even vehicle technology to detect and prevent a crash (Fredriksson, Shin, & Untaroiu, 2011; Greene et al., 2011). Another issue in the literature, as hybrid and electric vehicles constitute a larger portion of the vehicle fleet, is the consequence of "quiet" vehicles on pedestrian safety, particularly among pedestrians with visual disabilities who rely more on auditory cues to detect traffic (Garay-Vega, Pollard, Guthy, & Hastings, 2011).

Strategies to Increase Pedestrian Safety

Countermeasures in this chapter are primarily aimed at improving safety behaviors of pedestrians and drivers through education and enforcement measures, and are organized by pedestrian sub groups:

- Preschool-age children;
- School-age children;
- Alcohol-impaired pedestrians; and
- All pedestrians.

The final section contains countermeasures that may affect all groups of pedestrians as well as drivers. Additional information about countermeasures involving a comprehensive approach to improving pedestrian (and bicycle) safety is provided in NHTSA's *Advancing Pedestrian and Bicyclist Safety: A Primer for Highway Safety Professionals* (Brookshire et al., 2016).

Basic countermeasure principles include addressing those issues identified specifically through problem identification at the community level. Common themes include:

- Reducing vehicle speed, which allows pedestrians and drivers more time to react and reduces impact forces if crashes do occur.
- Conducting speed enforcement, especially at high risk crash locations (for pedestrian/motorist interactions).
- Reducing exposure to known risky situations through behavioral and environmental countermeasures (without necessarily discouraging walking).
- Increasing enforcement of pedestrian-friendly laws addressing behaviors of both pedestrians and motorists.
- Increasing the conspicuity of pedestrians and/or encouraging walking in areas of enhanced lighting for road crossing.
- Reducing distracted walking or driving behaviors (cell phones, headphones, etc.). See the chapter on distracted and drowsy driving for countermeasures targeting drivers.
- Decreasing walking or driving while impaired. See the chapter on strategies to reduce

alcohol-impaired driving. Some of the countermeasures would be applicable to address any type of impaired roadway use.
- Educating motorists and pedestrians on required safety behaviors related to specific laws to enhance safe interaction between motorists and pedestrians on the roadway.
- Tailoring countermeasures to diverse populations, including groups such as recent immigrants who may not be familiar with U.S. traffic laws, the U.S. traffic environment, may not speak or read English, or may not be literate in their native language.

Select countermeasures to address particular problems identified within communities or common to a high risk group within a community, such as middle aged or older adults, the homeless, or children of varying ages. Remember to base the selected groups on the data. Tailoring may be needed to address diverse populations, such as recent immigrants who may not be familiar with U.S. traffic laws, the U.S. traffic environment, may not speak or read English, or be literate in their native language.

Engineering and Roadway Design. While not dismissing the importance of vehicle design and the role of the built environment in preventing pedestrian crashes, the countermeasures described in this report relate primarily to educational and enforcement measures aimed at improving the knowledge and behaviors of road users to prevent a crash. However, there is a growing recognition of the importance of road design and the built environment in fostering safer user behaviors. A comprehensive approach that uses a combination of effective engineering, enforcement, and educational measures may have the best chance of achieving desired crash reductions. U.S. DOT released a national pedestrian safety action plan summaryfocusing significant attention on the built environment research and countermeasures (NHTSA, FHWA, & FMCSA, 2014). Key infrastructure resources are included in the Resources section, and more are planned for release beyond the date of this report.

Emerging Technologies or Emerging Vehicle Technologies. Further, emerging research is exploring whether vehicle technologies, known as Pedestrian Crash Avoidance/Mitigation (PCAM) systems, show promise in reducing motor vehicle-pedestrian crashes (Yanagisawa, Swanson, & Najm, 2014). Current testing is limited to a research environment involving light vehicles, and measuring the systems' capabilities to detect a pedestrian in the road ahead. The systems may alert drivers, automatically brake, or take other measures to prevent crashes with pedestrians.

Safety in Numbers. Finally, the idea that vulnerable road users' safety may be improved by increasing the numbers of pedestrians and bicyclists is gaining traction and some empirical support. As the number of pedestrians increases, drivers should become more expectant of seeing pedestrians and thus become more attentive to them. A 2009 scanning tour by U.S. transportation officials and researchers of Denmark, Sweden, Germany, Switzerland, and the United Kingdom reported that the concept of "safety in numbers" has motivated promotion of more bicycling and walking in these countries as a safety countermeasure (Fischer et al., 2010). However, encouragement in these countries is done in the context of commitments to comprehensive planning, funding, engineering, and design and maintenance policies to provide safe and connected pedestrian networks. The scan report also documents numerous examples of how these policies are put into practice through traffic calming, traffic and parking management, enforcement, education and other systemic approaches. Research, from abroad as well as the United States, finds that, although actual numbers of crashes may go up with increases in walking (and bicycling) with increased exposure, individual risk of crashes with motor vehicles (crash rate) is lower as numbers of pedestrians and bicyclists increase (Alliance for Biking and Walking, 2014; Geyer, Raford, Ragland, & Pham, 2006; Jacobsen, 2003; Leden, Gårder, & Pulkkinen, 2000). The European countries mentioned above are also committed to driving down the total numbers of pedestrian fatalities and injuries while increasing walking and bicycling, and many European countries have adopted a toward zero deaths safety philosophy. In the U.S., Vision Zero is primarily an initiative targeting local jurisdictions to get them to adopt speed-management policies and roadway design practices that encourage driving at speeds that are less likely to result in serious injuries or fatalities. As of mid-2017, more than twenty cities had adopted policies from this initiative (Vision Zero Network, 2017).

A non-linear relationship between traffic volumes (motorist, pedestrian, or bicyclist) and crashes has long been demonstrated (AASHTO, 2010; Bhatia & Wier, 2011), but a causal mechanism for how increased volumes improve pedestrian safety has not been demonstrated (Bhatia & Wier, 2011). This means that crashes do not tend to increase in direct proportion to increases in volume, but absolute crash numbers are still likely to increase (and have increased) with increases in walking – all else being equal. Additionally, all the studies cited above, and others attempting to characterize pedestrian safety relationships, are based on cross-sectional comparisons. There are frequently safety factors such as motorist speed, congestion, or law enforcement activity that are unmeasured or have not been accounted for in such studies. Also, these cross-sectional studies cannot demonstrate the direction of effect – that is, whether a safer environment comes before the greater numbers or is a result (Bhatia & Wier, 2011). Impaired pedestrians also contribute to the overall safety problem; however, more research is needed about this issue in general, in addition to a better understanding of how laws and education can mitigate risks posed by impaired pedestrians. It is clear, however, that a focus on improving the environment, both infrastructure and road users' compliance with laws and safe behaviors, are important to increasing both population-level safety (measured as a reduction in population-wide fatalities and injuries) and numbers of pedestrians or amounts of walking. As these two elements – safety improvements and increases in walking – go together, individual risk will also be reduced.

Resources

The agencies and organizations listed below can provide more information on comprehensive pedestrian safety issues and countermeasures, and links to numerous other resources.

- National Highway Traffic Safety Administration:
  - Pedestrians – www.nhtsa.gov/road-safety/pedestrian-safety; one.nhtsa.gov/Driving-Safety/Pedestrians
  - Research and Evaluation – www.nhtsa.gov/research-data; one.nhtsa.gov/Driving-Safety/Research-&-Evaluation
  - Behavioral Safety Research Reports – ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Pedestrian and Bicycle Information Center: www.pedbikeinfo.org – a national

information center funded by FHWA and NHTSA.

- Federal Highway Administration: www.fhwa.dot.gov/
  - Office of Planning, Environment, & Realty (Pedestrian and Bicycle Program) – www.fhwa.dot.gov/environment/bicycle_pedestrian/
  - Safety Office, Pedestrian and Bicycle Safety – http://safety.fhwa.dot.gov/ped_bike/
  - Federal Highway Administration Research and Technology, Coordinating, Developing, and Delivering Highway Transportation Innovations, Pedestrian and Bicyclist Safety – www.fhwa.dot.gov/research/topics/safety/pedbike/
  - Federal Highway Administration Division Office State Bicycle and Pedestrian Coordinators: www.fhwa.dot.gov/environment/bicycle_pedestrian/state_fhwa_contacts.cfm
  - State Bicycle and Pedestrian Coordinators: www.fhwa.dot.gov/environment/bicycle_pedestrian/state_contacts.cfm
- Governors Highway Safety Association: www.ghsa.org/issues/bicyclists-pedestrians
- National Center for Safe Routes to School: www.saferoutesinfo.org
- Research and Administrative Technology Administration, National Transportation Library, Bicycle and Pedestrian Research: ntlsearch.bts.gov/repository/category.do?cat=5
- Smart Growth America – National Complete Streets Coalition: www.smartgrowthamerica.org/complete-streets
- SAFE KIDS Worldwide: www.safekids.org
- Safe Routes to School National Partnership: www.saferoutespartnership.org
- Safe States Alliance: www.safestates.org/
- United States Access Board: www.access-board.gov
- National Center for Bicycling and Walking: www.bikewalk.org
- America Walks: www.americawalks.org
- Association of Pedestrian and Bicycle Professionals: www.apbp.org
- Vision Zero Network: www.visionzeronetwork.org

Several specific resources that provide further information on engineering, enforcement, and educational strategies are:

- Pedestrian Safety Enforcement Operation: A How-to Guide: www.nhtsa.gov/staticfiles/nti/pdf/812059-PedestrianSafetyEnforceOperaHowToGuide.pdf
- Child Pedestrian Safety Curriculum (NHTSA, 2011): www.nhtsa.gov/pedestrian-safety/child-pedestrian-safety-curriculum
- Pedestrian Safer Journey: Skills for Safe Walking for Ages 5 to 18 www.pedbikeinfo.org/pedsaferjourney/
- Everyone is a Pedestrian online resource: one.nhtsa.gov/nhtsa/everyoneisapedestrian/index.html
- Uniform Guidelines for State Highway Safety Programs: Highway Safety Program Guideline No. 14: Pedestrian and Bicycle Safety: one.nhtsa.gov/nhtsa/whatsup/tea21/tea21programs/pages/PedBikeSafety.htm
- How to Develop a Pedestrian Safety Action Plan (FHWA & NHTSA, 2006): safety.fhwa.dot.gov/ped_bike/ped_focus/docs/fhwasa 0512.pdf

- Pedestrian Safety Training for Law Enforcement (NHTSA, 2011): www.nhtsa.gov/pedestrian-safety/pedestrian-safety-training-law-enforcement
- The Pedestrian Safety Workshop: A Focus on Older Adults, Instructor Guide (NHTSA, 2010): www.nhtsa.gov/staticfiles/nti/older_drivers/pdf/PedSafetyWorkshop-02.pdf
- Pedestrian Countermeasure Policy Best Practice Report (Redmon, 2011): safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa11017/fhwasa11017.pdf
- Public Policies for Pedestrian and Bicycle Safety and Mobility: An Implementation Project of the Pedestrian and Bicyclist Safety and Mobility International Scan: www.pedbikeinfo.org/cms/downloads/PBSPolicyReview.pdf
- AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities: bookstore.transportation.org/item_details.aspx?id=119
- NCHRP Report 500 Guide for Reducing Collisions Involving Pedestrians (Zegeer at al., 2004): onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_500v10.pdf
- Vehicle Travel Speeds and Pedestrian Safety: one.nhtsa.gov/people/injury/research/pub/HS809012.html
- NHTSA Motion Graphics:
  - Walking Safety – www.nhtsa.gov/links/PedMotionGraphics/PedMotionWalkingSafely.zip
  - Driving Safely Around Pedestrians and Bicyclists - www.trafficsafetymarketing.gov/file/17963/download?token=LTY0OcoO
- The Role of Law Enforcement in Pedestrian and Bicycle Safety Programs www.pedbikeinfo.org/programs/enforcement.cfmNHTSA, 2013: Identifying Countermeasure Strategies to Increase Safety of Older Pedestrians: www.nhtsa.gov/staticfiles/nti/pdf/811799.pdf
- FHWA, 2013: PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System: www.pedbikesafe.org/PEDSAFE/
- FHWA, 2014: Road Diet Informational Guide: safety.fhwa.dot.gov/road_diets/info_guide/rdig.pdf
- FHWA, n.d.: Pedestrian Safer Journey: www.pedbikeinfo.org/pedsaferjourney/Safer
- People, Safer Streets: Summary of U.S. Department of Transportation Action Plan to Increase Walking and Biking and Reduce Pedestrian and Bicyclist Fatalities (2014): www.dot.gov/sites/dot.gov/files/docs/safer_people_safer_streets_summary_doc_acc_v1-11-9.pdf
- World Health Organization, 2013: Pedestrian safety: a road safety manual for decision-makers and practitioners: apps.who.int/iris/bitstream/10665/79753/1/9789241505352_eng.pdf?ua=1

Resources released or updated since the last *Countermeasures That Work* update:

- Alliance for Biking and Walking. Bicycling and Walking in the United States 2016, Benchmarking Report: www.bikewalkalliance.org/storage/documents/reports/2016benchmarkingreport_web.pdf
- FHWA, 2015: A Resident's Guide for Creating Safer Communities for Walking and Biking: safety.fhwa.dot.gov/ped_bike/ped_cmnity/ped_walkguide/
- FHWA Strategic Agenda for Pedestrian and Bicycle Transportation: www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/strategic_agenda/fhwah

ep16086.pdf

- NHTSA, 2016: Advancing Pedestrian and Bicyclist Safety: A Primer for Highway Safety Professionals: www.nhtsa.gov/staticfiles/nti/pdf/812258-Peds_Bike_Primer.pdf
- NHTSA, 2017: The Effect of High-Visibility Enforcement on Driver Compliance With Pedestrian Right-of-Way Laws: Four-Year Follow-Up: www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812364_highvisibilityenfdrivercomppeds4yearfollowup.pdf
- NHTSA, 2016: Effect of Electronic Device Use On Pedestrian Safety: A Literature Review: www.nhtsa.gov/sites/nhtsa.dot.gov/files/812256-effectelectronicdeviceusepedestriansafety.pdf

Pedestrian Safety Countermeasures

Countermeasures to improve pedestrian safety are listed in the table below. The table is intended to provide a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. Effectiveness is shown using a five-star rating system:

- Countermeasures that receive ★★★★ or ★★★★★ have been determined to be effective.
- Countermeasures that receive ★★★ are considered promising, and likely to be effective.
- Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States, communities, and other organizations are encouraged to use ★★★, and especially ★★★★ or ★★★★★, countermeasures. They should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

Further details about the symbols and terms used are included after the table. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate.

Each pedestrian safety countermeasure is discussed individually in this chapter. Full descriptions are included for ★★★, ★★★★ and ★★★★★ countermeasures. Brief descriptions are included for ☆ and ☆☆ countermeasures. Further details about the ☆ and ☆☆ countermeasures are included in Appendix A8 to this report.

1. Preschool-age Children

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Children's Safety Clubs	☆	Varies	Unknown	Unknown
1.2 Child Supervision	☆	$	Unknown	Short

2. School-age Children

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Elementary-Age Child Pedestrian Training	★★★	$	Unknown	Short
2.2 Safe Routes to School	★★★	$	High	Short

2.3 Child School Bus Training	☆☆	$	High	Short

3. Impaired Pedestrians

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Communications and Outreach Addressing Impaired Pedestrians	☆☆	Varies	Low	Medium
3.2 “Sweeper” Patrols of Impaired Pedestrians	☆	$$	Low	Medium

4. All Pedestrians

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Pedestrian Safety Zones	★★★★	$$$	Low	Medium
4.2 Reduce and Enforce Speed Limits	★★★	$	High	Varies
4.3 Conspicuity Enhancement	★★★	$	Low	Medium
4.4 Enforcement Strategies	★★★	$$	Low	Short
4.5 Driver Training	☆	$	Low	Medium
4.6 Pedestrian Gap Acceptance Training	☆	$$	Unknown	Medium
4.7 University Educational Campaign	☆	$	High	Medium

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources

$$: requires some additional staff time, equipment, facilities, and/or publicity

$: can be implemented with current staff, perhaps with training; limited costs for equipment, facilities, and publicity

These estimates do not include the costs of enacting legislation or establishing policies.

Use:
High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: less than one-third of the States or communities
Unknown: data not available

Time to implement:
Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Preschool-Age Children

1.1 Children's Safety Clubs

Effectiveness: ☆	Cost: Varies	Use: Unknown	Time: Unknown

This countermeasure involves sponsoring safety clubs in which parents/caregivers can enroll their children as young as age three. Children then regularly receive books or other print or electronic media that provide instruction to both the child and parents about safe walking practices. A primary purpose of children's safety clubs is to help parents and caregivers become more involved in educating young children about safe walking practices. An equally important objective of safety clubs is for parents and other caregivers to recognize children's limits and capabilities, and to understand their obligation to provide adequate supervision and control (Gregersen & Nolen, 1994).

Effectiveness Concerns: *This countermeasure has been examined in a small number of research studies. The research suggests that this countermeasure does not translate into crash and injury reductions.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A8, Section 1.1.

1.2 Child Supervision

Effectiveness: ☆	Cost: $	Use: Unknown	Time: Short

The primary purpose of this countermeasure is to increase caregiver supervision of children when they are exposed to traffic, or when they are nearby direct access to traffic. The State can require such training for teachers, day care workers, and others licensed to care for children. The programs can also be made available to parents, babysitters, or other caretakers through PTAs, faith-based organizations or places of worship, medical providers, or even direct mail or internet access.

Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A8, Section 1.2.

2. School-Age Children

2.1 Elementary-Age Child Pedestrian Training

Effectiveness: ★★★	Cost: $	Use: Unknown	Time: Short

The purpose of elementary school pedestrian training is to equip school-age children with knowledge and practice to enable them to walk safely in environments with traffic and other safety hazards. A number of elementary school pedestrian training programs have been developed over the years by NHTSA and multiple States. NHTSA's "Willy Whistle" pedestrian safety videos were updated: "Stop and Look and Listen with Willy Whistle" (2008) for children grades K-2 emphasizing to look left-right-left before crossing, and "Getting There Safely" (2014) for children grades 3-6, emphasizing critical thinking with walking around traffic. Both videos are best used in conjunction with some discussion allowing for questions/answers and clarification. The Willy Whistle video is available at www.youtube.com/watch?v=-idpfcP6bY4 and Getting There Safely at www.youtube.com/watch?v=ATyNXDMvBuE.

WalkSafe, a program adapted from many earlier resources, was implemented initially as a five-day program in a high risk district in Miami-Dade County, Florida and later as a three-day program in all 220 Miami-Dade County elementary schools as part of a comprehensive effort to address pedestrian crashes in Miami-Dade County (Zegeer, Blomberg et al., 2008).

In 2011 NHTSA produced a Child Pedestrian Safety Curriculum for elementary age students along with an instructor guide (www.nhtsa.gov/pedestrian-safety/child-pedestrian-safety-curriculum). Features of the curriculum include five lesson plans for each grade group K-1, 2-3, and 4-5 with developmentally appropriate lessons and messages that also address standards of learning, caregiver tip sheets, skills practice exercises, and student tests to evaluate knowledge change. The curriculum was pilot tested in schools when it was developed, and the final formal evaluation will be published in early 2018.

School-based programs are useful to teach basic pedestrian concepts and safe behaviors at schools, faith-based settings, and other institutions with groups of elementary-aged children. Pedestrian safety programs are especially important for children such as those from lower-income families and neighborhoods, or those who may be more likely to make risky decisions and are less able to control their behavior (Barton & Schwebel, 2007). A study from Australia identified younger ages, and attentional and developmental issues including hyperactivity and inattentiveness as factors in unsafe road-crossing decisions by children. Children who had some independent walking experience were less likely to make incorrect decisions (Congiu et al., 2008).

Other resources that may be used independently or in a group setting include an online, video-training resource, Pedestrian Safer Journey, developed for the Federal Highway Administration. This resource provides separate video-based training modules for child pedestrians 5 to 9, 10 to 14, and 15 to 18, and educator materials including discussion guides. These materials are available on the PBIC website at www.pedbikeinfo.org/pedsaferjourney/index.html. In addition, the National Center for Safe Routes to School hosts extensive educational resources including

Teaching Children to Walk Safely as They Grow and Develop: A Guide for Parents and Caregivers, with learning objectives and tips for caregivers of children 4 and older. This resource can be found at archive.saferoutesinfo.org//sites/default/files/TeachingChildrentoWalk-Safely.pdf. Other resources and tips for educators, parents, drivers, children, and even neighbors are available at www.pedbikeinfo.org/programs/education.cfm

Resources are also available to help parents become role models and provide on-going practice and positive reinforcement. As mentioned in Section 1.1 on preschool age children, NHTSA has several brochures to educate parents and caregivers on child pedestrian safety, including Preventing Pedestrian Crashes: Parents and Caregivers of Preschool Children and Elementary School Children (www.nhtsa.gov/document/pedestrian-crashes). Safe Kids Worldwide also has tips for caregivers and links to other resources (www.safekids.org/child-pedestrian-safety).

Use: Unknown. Materials have been available for years, and distributed widely, but not necessarily as part of a systematic or national program. In addition, many materials and resources have been updated to new technologies and formats such as interactive internet resources and video trainings. With schools being called on for a wider variety of services and narrower set of teaching requirements, finding time to add child traffic safety modules may be difficult. Newer technologies and materials formats may help expand the reach of training materials. Some States are adapting existing curriculum or developing curriculum to meet their State's Standards of Learning; this allows teachers to use pedestrian (and bicycle) educational materials to correlate with meeting the establish minimum expectations for what students should know and be able to do at the end of each grade or course in English, mathematics, science, history/social science and other subjects.

Effectiveness: Child pedestrian training programs have been shown to increase knowledge. Long-lasting behavior improvements may be harder to achieve. Evaluations of five-day and three-day WalkSafe programs in the Miami school district that used videos, formal curricula, workbooks, and outside simulation activities on an imaginary road on school grounds showed improvements in safety knowledge compared to before, although no control group was used in the evaluation. Improvements were more consistent for grades K-3 than for 4 and 5. Actual in-traffic behaviors were also reportedly improved in the short term, but did not hold up at 3 months after the program and no comparison group was used (Hotz et al., 2004; Hotz et al., 2009). In a study of the longer-term impacts of the WalkSafe program, knowledge and behavior of more than 1,500 students receiving a one-time per year WalkSafe instruction were evaluated over 2 years (Livingston et al., 2011). While short- and intermediate-term knowledge retention was observed among all grades, long-term (i.e., more than a year) knowledge retention of pedestrian safety behaviors were observed only among children moving from 3rd to 4th grade. Knowledge change did not appear to result in improved pedestrian behaviors. The authors concluded that repetition and reinforcement may be needed for long-term knowledge and behavior change, as well as engagement by caregivers.

Another study by Gates, Savolainen, Datta, and Buck (2010) also indicates the importance of repetition in school-based trainings. In a study of 930 students in grades 2 to 7 in Detroit, pedestrian safety training was provided once and then again seven to 12 months later (Gates et al., 2010). Measures of safety violations gathered by observing street-crossing behaviors before and after the trainings, as well as knowledge change based on pre/post tests were collected. After the initial training, both test scores and observed behaviors improved, but were only partially sustained. Once retraining occurred, there was an increase in test scores, and the cumulative difference (after initial training and retraining) was consistently larger than the impact of initial training alone for both test scores and observational behavioral measures. One trial suggested that video-based training may be an effective method for conveying knowledge and appropriate behaviors (Arbogast et al., 2014), although neither before (baseline) nor long-term behavioral observations were conducted. Another study suggested that virtual and roadside training are more effective than videos for improving behaviors (Schwebel, McClure, & Severson, 2014), but more research is needed. Reach, feasibility, and cost are also factors to consider.

Barton, Schwebel, and Morrongiello (2007) also reported that children crossed a road more safely immediately following a brief pedestrian safety training that included instruction followed by practice crossings on a pretend road. In the United Kingdom, a combination of adult-led training and peer discussions for children 5 to 8 led to improved roadside search skills (Tolmie et al., 2005). In a small study of mostly white and middle class preschool children, Albert and Dolgin (2010) also reported that 4- and 5-year-olds trained by adults in groups of 3 or 4 using a playmat model retained real-world behavioral (street crossing choices) improvement 6 months later compared to peers trained using two other less interactive methods or who received no training. According to the authors, the success of this treatment may lie in the opportunities for peer collaboration and corrective feedback from the adult trainers.

Thus, numerous studies suggest that knowledge and behaviors of young children may be improved through education and training programs, but that behavior in real-world traffic situations is more likely to be modified if the program incorporates interactive training with opportunities for practice and positive reinforcement (Percer, 2009). Effectiveness of school-based child pedestrian training would also likely be enhanced if it combined child training with emphasis to teachers, parents, and other caregivers on the limits of children and the need for careful supervision, particularly for those younger than 10 years (see Section 1.2).

Costs: NHTSA publications are free for download, and can be distributed at low expense.

Time to implement: Short, once a decision is made by a school district to offer such a program. Time is needed to review the recommended material, work it into the school's existing curriculum, and train teachers. As indicated by the above research, the training needs to be repeatedly implemented to sustain effectiveness.

Other issues:

- A consensus from reviews is that practical training—that is, learning by doing with reinforcement of correct behaviors—is the most effective way for children to learn traffic safety skills (Bruce & McGrath, 2005; Dragutinovic & Twisk, 2006; Percer, 2009). The need for experiential learning is especially key for younger children who lack the capacity to generalize concepts and need to practice in environments with real objects that are as close as possible to those they will experience (Dragutinovic & Twisk, 2006). Although it can be done with adult supervision, real-world practice may be difficult to achieve with large groups of school children and without undue exposure to traffic risks.

- Classroom education may be enhanced by using outdoor simulation, three-dimensional models, games, or other interactive learning methods such as with computer games and models, particularly in adult-led and small-group activities. These methods do not replace real-world practice but evidence from a few studies suggests that interactive training with opportunities for feedback, correction, and practice (more than one session) may lead to more lasting behavior improvements (Tolmie et al., 2005; Albert & Dolgin, 2009).
- Hammond, Cherrett, and Waterson (2014) found that trainers often modified the training from recommended best practices in a program (“Kerbcraft”) developed to provide roadside training for 5- to 7-year-olds in the United Kingdom. This deviation seems to have been towards conserving resources by conducting shorter trainings and introducing more classroom elements than the program recommended. It isn’t clear, however, if the adaptations diminish effectiveness, but that is certainly a risk since the modifications have not been evaluated. The other possible implication is that the longer, all-roadside training may not be practical for consistent implementation (Hammond et al., 2014). It is important that whenever programs are modified, however, that the changed program is also evaluated to ensure continued effectiveness.

2.2 Safe Routes to School

Effectiveness: ★★★	Cost: $	Use: High	Time: Short

From 2006 to 2015, 1,313 people were killed in school-transportation-related crashes—an average of 131 fatalities per year (NCSA, 2017b). During that period, 102 school-age pedestrians (younger than 19) have died in school-transportation-related crashes.

The goal of Safe Routes to School Programs (SRTS) is to increase the amount of walking and bicycling trips to and from school while simultaneously improving safety for children walking or bicycling to school. SRTS programs are community-based and are intended to be comprehensive in nature. Programs include education of children, school personnel, parents, community members, and law enforcement officers about safe walking and bicycling behavior and safe driving behavior around pedestrians and bicyclists. In addition, programs include enforcement and engineering activities to improve traffic safety and reduce or eliminate risky elements of the traffic environment around primary and secondary schools so children can safely walk or bicycle to school. Walking or biking to school has additional benefits to students' health. Studies have found an association between active transport to school and lower BMIs as well as higher performance on standardized tests (Active Living Research, 2015).

From 2005to 2012 SAFETEA-LU legislation required each State to have its own SRTS program including a full-time coordinator to manage Federal funds. Each year Federal funding was allocated on infrastructure (engineering) improvements, and on non-infrastructure projects to encourage walking and bicycling to school (public awareness and outreach, enforcement near schools, education, and training for volunteers). In June 2012 Congress passed the Moving Ahead for Progress in the 21st Century (MAP-21) Act. The Act significantly altered how SRTS and other pedestrian and bicycle programs are structured and funded. Under MAP-21, SRTS is no longer a standalone program (no new funding), however old SAFETEA-LU funds can still be used if they are available. Under MAP-21 SRTS projects were still eligible, to compete for funding alongside other pedestrian and bicycle-related programs, including former Transportation Enhancements and Recreational Trails projects. Now under the Fixing America's Surface Transporation (FAST) Act (signed in December 2015) as part of a new program called Transportation Alternative set-aside funds, States can determine their own funding priorities. All funding is still eligible as it was under MAP-21 for infrastructure and non-infrastructure funds for SRTS at the State's discretion. While Federal funding is less available for programming, States and localities as well as local schools may continue to support the SRTS program and at a minimum continue to promote safe behaviors to allow children to safely walk or bicycle to school.

Use: With the establishment of the national SRTS program, all 50 States and the District of Columbia initiated SRTS programs. From July to September 2016 four out of 37 reporting States announced $7 million in MAP-21 funding for local and statewide SRTS projects, two States announced $1.9 million in SAFETEA-LU funding for local and statewide SRTS projects, and one State announced $5.3 million in FAST Act funding. Additionally, as of January 31, 2017, $1.06 billion out of the $1.147 billion in SAFETEA-LU funds apportioned to local and statewide SRTS programs had been allocated. At that time 19,378 schools, representing an estimated 7.6

million students, had received funding or were slated to receive funds for SRTS programs. Importantly, approximately 68% of award recipients were classified as Title 1 (low-income) schools, a finding that is relevant because areas with lower median income are over-represented in bicyclist- and pedestrian-related crashes (McArthur, Savolainen, & Gates, 2014).

Of the projects funded, 48% included infrastructure improvements, such as sidewalk improvements (20%), pedestrian and bicyclist access (15%), and traffic calming improvements (13%). In addition, 10% of projects funded were related to law enforcement countermeasures. About 19.5% of all elementary and middle schools have had SRTS programming in the past 10 years. To learn more, visit www.fhwa.dot.gov/MAP21/. From 2005 to 2012, nearly 14,000 schools received SRTS funding (Active Living Research, 2015). See Chapter 9, Section 1.2 for more information.

Effectiveness: SRTS efforts include, at a minimum, a 3E approach to pedestrian and bicycle safety addressing engineering, education and enforcement (programs can also include encouragement, evaluation, and equity considerations). SRTS programs including education and training can be effective in teaching children and their parents how to evaluate and choose the safest routes for walking or bicycling to and from school, what safe behaviors are associated with walking and biking, and instilling the need to practice and model safe behaviors when walking, biking or driving around children walking/biking to school, how to use common engineering treatments to enhance their safety (sidewalks, crosswalks), the need to adhere to crossing guard direction, and to abide by traffic laws, especially in and around school zones. See Section 2.1 (Elementary-Age Child Pedestrian Training), Section 4.2 (Reduce and Enforce Speed Limits), and 4.4 (Enforcement Strategies).

There is a growing body of evidence that suggests SRTS programs are effective in reducing injuries. Overall safety improvements have been demonstrated for SRTS programs in regional studies (NCSRTS & FHWA, 2015). One study found a 60% decrease in the number of pedestrians involved in car crashes after the implementation of SRTS in Miami-Dade County. Similarly, school-aged injury rates in New York City decreased by 44% in census tracts with SRTS interventions relative to those without interventions (NCSRTS & FHWA, 2015). A cost-effectiveness model estimated a savings of $224 million for one cohort of intersection users in New York City by implementing the SRTS program (Muenning, Epstein, Li, & DiMaggio, 2014). The authors concluded that SRTS programs can remain effective for decades because of the engineering component.

Although the full SRTS program emphasizes a comprehensive education, enforcement, and engineering approach, some specific implementations have centered on site-appropriate engineering changes; results have shown behavioral improvements for pedestrians, bicyclists, and motorists (Britt, Bergman, & Moffat, 1995). However, a study by the NCSRTS found that schools that were able to increase the percentage of students walking or bicycling to school were more likely to have a leader within the school to promote SRTS, frequent events to reinforce walking or biking to school, strong parental support, and supportive policies (NCSRTS & FHWA, 2015).

Data for 130 legacy SRTS programs (initiated before the national program) were evaluated to ascertain safety effects (Blomberg, Cleven, Thomas, & Peck, 2008). Declining trends in school-age child pedestrian and bicycle crashes during school trip times were found for both SRTS focus sites and non-SRTS sites in the same States. Either no decrease or inconsistent patterns were found for other ages. The results suggested that the programs at least did not cause any adverse safety effects on total crash numbers although exposure data were lacking to know whether the amounts of biking and walking had changed. If children were walking and biking at higher rates in SRTS locations than in other areas, or the programs resulted in positive spillover effects to other areas, the programs may have reduced crash rates, although data were insufficient to test this (Blomberg et al., 2008). A later study of 801 schools found that engineering improvements were associated with an 18% increase in the percentage of students walking or biking to school, regardless of when the improvements were made (McDonald et al., 2014). Education and encouragement programs were associated with a 5% increase per year in the percentage of children walking or biking to school. This increase was cumulative, so a school could expect to see a 25% increase over 5 years from education and encouragement efforts. In contrast, enforcement efforts were not associated with a significant change (McDonald et al., 2014). A detailed analysis of a specific SRTS implementation in Maryland found that using a combination of education, enforcement, and engineering programs resulted in a 79% decrease in the number of collisions within a quarter mile of targeted SRTS areas over the first five years of the program (Dunckel, Haynes, Sharp, & Cohen, 2014).

A 2013 study attempted to assess the safety effects of New York City's SRTS program. Results were encouraging, but again, not conclusively so. The study compared school-aged pedestrian injury rates (by population) for traffic injuries that occurred during typical school travel times for census areas that had SRTS interventions compared to rates in areas with no such treatments (DiMaggio & Li, 2013). Census tracts that covered 30 schools with either short-term interventions (apparently low-cost engineering measures such as signs and crosswalk markings) or completed capital infrastructure improvement projects were included in the SRTS group. Although study design limitations preclude a conclusion that SRTS treatments were responsible, the trends were encouraging. Injury rates in census tract areas with SRTS treatments fell substantially compared to non-intervention areas, where injury levels remained virtually unchanged (DiMaggio & Li, 2013). Since schools were chosen for treatment because of high crash rates, it is likely that some of the crash reductions observed were due to a natural tendency for crashes to return toward an "average" level (known as regression toward the mean). A separate cost analysis study found that New York City's SRTS program was cost effective when analyzed over just one cohort, and even more effective over the course of many years (Muenning, Epstein, Li, & DiMaggio 2014). The authors concluded that SRTS programs can remain effective for decades, because of the engineering component.

Costs: Education and encouragement activities associated with SRTS may be low cost and may also be eligible for grant funding through the State, and perhaps other sources. Activities formerly eligible under Federal SR2S funding are now eligible under the TAP program outlined in MAP 21, but funding priorities are established by each State. State contacts may be located on the NCSRTS website (archive.saferoutesinfo.org/data-central/find-state-contacts), or search individual States' DOT websites for information about TAP and SR2S funding. Other funding sources may also be identified through the SRTS Funding Portal webpage (archive.saferoutesinfo.org/program-tools/funding). Material and resources can be accessed at no cost. NCSRTS provides downloadable material for State and local SRTS programs.

Time to implement: Once the school or district has decided to implement a SRTS program, a range of material, including an on-line step-by-step guide on getting started, is available from NCSRTS. Programs funded through State DOTs typically require applications on a funding cycle and can take significantly longer to implement.

Other issues:

- A variation on the SRTS theme, "walking school buses," uses volunteer adults, usually parents, to walk a specific route to and from school, collecting or dropping off children on the way, so that a group of children walk to school under the supervision of adults. The program has been popular and practical in New Zealand and Italy (Collins & Kearns, 2005; Roberts, 1995). Roberts found in New Zealand that when parents walked with children to and from school, the risk of injury was 64% lower than the risk for unaccompanied children, though the sample sizes were small and the differences were not statistically significant. In a study of fourth grade students from eight low-income schools in Houston, Texas, researchers examined the impact of walking school buses on several pedestrian behaviors (Mendoza, Watson, & Chen, 2012). Researchers found these students were five times more likely to cross at the intersection or crosswalk (rather than midblock locations) as opposed to children at schools without walking school buses. An evaluation of a walking school bus program in Seattle found a modest increase in most student safety crossing behaviors after the implementation of the program, but safe crossing behaviors remained low overall (Johnston, Mendoza, Rafton, Gonzalez-Walker, & Levinger, 2006). The National Center for Safe Routes to School and PedNet released a primer and training materials to help communities plan and launch a walking school bus program, identify community partners, and secure program funding. Materials are available at apps.saferoutesinfo.org/training/walking_school_bus/modules.cfm/.

2.3 Child School Bus Training

Effectiveness: ☆☆	Cost: $	Use: High	Time: Short

The purpose of school bus training for children is to teach school-age children how to safely approach, board, disembark, and walk away from school buses. Basic training for children who ride school buses is provided as part of the normal school routine. Additionally, education about safety behaviors of parents in school zones and around school buses can be reinforced as part of Back to School night, in school bulletins, or other creative means. NHTSA also has a refresher training module for school bus drivers.

Effectiveness Concerns: *There are no evaluation studies showing reductions in crashes or injuries. These outcomes are difficult to demonstrate because minimal, basic training is very widespread and the choice to adopt a stronger curriculum would be confounded with any number of other factors.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A8, Section 2.3.

3. Impaired Pedestrians

3.1 Impaired Pedestrians: Communications and Outreach

Effectiveness: ☆☆	Cost: Varies	Use: Low	Time: Medium

Communications and outreach to reduce impaired-pedestrian crashes can be directed at a wide variety of audiences, including law enforcement, drivers, alcohol servers and vendors, civic and neighborhood leaders, faith-based communities, universities, and friends and family of likely impaired pedestrians. Impaired pedestrians are also a target audience, of course. However, they are viewed as a difficult audience for communications and outreach to have a meaningful effect on their behavior because their decision-making is compromised.

Effectiveness Concerns*:* *There is insufficient evaluation data available to conclude that the countermeasure is effective*.

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A8, Section 3.1.

3.2 “Sweeper” Patrols of Impaired Pedestrians

Effectiveness: ☆	Cost: Varies	Use: Low	Time: Medium

The purpose of this countermeasure is to keep alcohol-impaired pedestrians off the streets until they no longer have high BACs. This measure is intended to reduce the exposure of these at-risk pedestrians to traffic, and can also address other social issues such as public intoxication and crime. One approach involves police “sweeper” squads and “support on call” programs involving taxis and trained escorts to get intoxicated people home or to a detoxification center.

Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A8, Section 3.2.

4. All Pedestrians

4.1 Pedestrian Safety Zones

Effectiveness: ★★★★	Cost: $$$	Use: Low	Time: Medium

The pedestrian safety zone concept was developed in a joint effort study by NHTSA and FHWA (Blomberg & Cleven, 1998). The idea is to strive for large decreases in pedestrian crashes and injuries by more effectively targeting resources to problem areas. Specifically, the objective of pedestrian safety zones is to increase cost-effectiveness of interventions by targeting education, enforcement, and engineering measures to geographic areas and audiences where significant portions of the pedestrian crash problem exist (NHTSA, 2008). Pedestrian zone programs can target a full range of pedestrian crash problems within a limited geographic area or focus on particular types of problems that make up a large portion of the problem within a limited area.

Blomberg and Cleven (1998) implemented and analyzed an early pedestrian safety zone program in Phoenix, Arizona. Crash data were analyzed to identify areas where older pedestrian crashes occurred and “zones” were drawn around the high-incidence areas. Countermeasures were developed for the kinds of crashes that involved older pedestrians. The measures included lengthening the signal timing to allow more time for older pedestrians to cross the street, providing communications and outreach to both drivers and pedestrians living near the crash zones, and enhanced enforcement. The result was a significant reduction in crashes and injuries involving older pedestrians in the target areas.

In a Miami-Dade County, Florida, comprehensive application of the safety zone strategy, high crash zones were identified, and then the characteristics of those crashes were further analyzed within the zones (Zegeer, Blomberg, et al., 2008). The four zones, comprising less than 1% of the total land area of the County, accounted for about 20% of the total number of collisions (Zegeer, Henderson, et al., 2008). Further analyses identified high child involvement in crashes in some areas, young adult involvement in others (particularly at night), and older adult involvement in certain corridors. Overall, there was an 8.5% to 13.3% reduction in pedestrian crash rates during and following the program implementation compared to control groups (Zegeer, Blomberg, et al., 2008).

Montgomery County, Maryland reduced crashes in high incidence areas using a combination of education, enforcement, and engineering measures (Dunckel, Haynes, Conklin, Sharp, & Cohen, 2014). After three years of the program, crashes in ten high-incidence areas fell by 43% and countywide pedestrian crashes fell by 7%, with a 38% decrease in pedestrian fatalities.

Use: Pedestrian zone programs are known to have been implemented in only a handful of cities.

Effectiveness: Properly designed and implemented pedestrian zone programs have been shown effective in reducing crashes and injuries for older pedestrians (Blomberg & Cleven, 1998), for impaired pedestrians (Blomberg & Cleven, 2000), and for child and adult pedestrian crashes in Miami-Dade County (Zegeer, Blomberg, et al., 2008; Zegeer, Henderson, et al., 2008) and in decreasing pedestrian fatalities (Dunckel et al., 2014).

Costs: Pedestrian zone programs require up-front analysis and planning, countermeasure development and tailoring, and implementation.

Time to implement: Medium. A pedestrian zone program can take several months of concentrated activity before countermeasures can be implemented. More comprehensive programs, such as in Miami-Dade, may be years-long programs involving data analysis and on-site evaluations, lining up partners, and identifying, implementing, and evaluating countermeasures. Programs to date have included local task forces, usually assembled for the program, to take critical leadership roles.

4.2 Reduce and Enforce Speed Limits

Effectiveness: ★★★	Cost: $	Use: High	Time: Varies

The goal of reducing motorist travel speeds is to increase reaction time for both drivers and pedestrians to avoid crashes, as well as reduce the severity of pedestrian injuries when these crashes occur. Higher vehicle speeds produce more frequent and more serious pedestrian crashes and casualties, as evidenced by several studies (Leaf & Preusser, 1999; Rosen & Sander, 2009; Tefft, 2011). The Rosen and Sander (2009) study estimated fatality risk curves based on driver impact speeds, ranging from 8% at 50 km/h (31 mph) and reaching 50% at 75 km/h (about 47 mph).

Reducing speeds through lowering speed limits is a time-honored countermeasure. Evidence shows, though, that actual speeds are reduced by only a fraction of the reduction in speed limits – typically 1-2 mph speed reduction for every 5-mph speed limit reduction. However, even 1-2 mph reductions in average speed are estimated to yield substantial fatal and injury crash reductions over all, with higher percentage reductions on streets with lower initial speeds (AASHTO, 2010, Table 3E-2; and see Chapter 3). Speed affects pedestrian injury severity to an even greater degree, as mentioned above and earlier in the chapter, and consequently also affects pedestrians' perceptions of whether it is safe to walk. For maximum effectiveness, speed limit reductions need to be accompanied by communications and outreach that inform the public and make the case for the speed reduction, and by heightened, visible enforcement (Leaf & Preusser, 1999). Some reasons that travel speeds do not decrease by the same proportion as speed limit reductions, include drivers not noticing the new speed limit, drivers not understanding the safety reasons to reduce speed, drivers speeding out of habit, or continuing to keep up with the speeds maintained by other drivers. Speed limit reductions need to be made compelling through communications strategies (framing the problem), appropriate engineering changes such as road diets (typically modifying a four-lane roadway to three lanes, with the middle lane becoming a turn lane), traffic calming, and roundabouts, and by speed enforcement (including by automated means). On roads intended for higher speeds, measures that separate pedestrians from traffic as they travel along the road (on sidewalks), or cross the road (such as median refuges and signals like pedestrian walk signals or leading pedestrian intervals, that provide pedestrians opportunities to cross) should be provided and are also keys to safer environments (Howard, Mooren, Nilsson, Quimby, & Vadeby, 2008). For more on speeding-related issues and countermeasures, see Chapter 3.

Speed limit reductions can be most effective when introduced to a limited area as part of a visible area-wide change, for example, identifying a downtown area as a special pedestrian-friendly zone through signs, new landscaping or "streetscaping," lighting, etc. If done cleverly, this can be accomplished with relatively modest engineering changes and expense. As mentioned above, road diets, a proven safety measure, may be a low-cost way to reduce a "big, wide" street that suggests high speeds to drivers and also provide more space for pedestrians, bicyclists, or on-street parking. (For more information, see http://katana.hsrc.unc.edu/cms/downloads/-WhitePaper_RoadDiets_PBIC.pdf for a review of road diets and safety effects and FHWA's *Road Diet Informational Guide*, safety.fhwa.dot.gov/road_diets/guidance/info_guide.

If speed limits are routinely ignored, then enforcing speed limits may be a more effective strategy than attempting to change them. Blomberg and Cleven (2006) reported on demonstration programs in two cities in which speed limit enforcement, combined with engineering changes and extensive publicity, reduced both average speeds and the number of excessive speeders in residential neighborhoods. A recent attempt to scale up a similar program to a large city (Philadelphia) met with challenges in garnering community involvement and increasing enforcement due to a State restriction on using radar to enforce speeds, and seemed to have limited success in reducing injuries (Blomberg, Thomas, & Marziani, 2012). However, speed reductions were observed on 17 of 24 corridors, six of which had pavement treatments simulating traffic calming devices. Although no pedestrian crash reductions were observed in the police districts with the program compared to those without, pedestrian crashes were too small in number to achieve measurable effects. For more information, see Chapter 3, Sections 1.1, 2.2, and 4.1.

Use: High, in the sense that all public roads have a speed limit and speed limit enforcement is widely employed.

Effectiveness: Reduced speed limits and enforcement can reduce vehicle speeds and all types of crashes and crash severity. The association of pedestrian injury with speed trends strongly suggests that pedestrian injuries and crashes will be reduced if travel speeds are reduced, although direct evidence is lacking.

Costs: Simply changing speed limits is low-cost, only requiring updating speed limit signs or, where few signs exist, adding some new ones. Combining speed limit changes with communications and outreach, enforcement, and engineering changes can be significantly more expensive.

Time to implement: Depending on the scope of the program, the time can be very short, or it can take several months to a year to plan and implement a complex plan.

Other issues:

- Speed limit changes exist in the context of other, unchanged speed limits. The normal expectation is that there is an overall consistent approach to speed-limit setting. Where, for safety, some speed limits need to be reduced in a manner inconsistent with other speed limits, there must be clear and visible reminders that distinct conditions exist that justify the lower limits. Also, speed limit changes can be more effective if there is citizen buy-in, which involves a clear understanding of the reasons for the change.

4.3 Conspicuity Enhancement

Effectiveness: ★★★	Cost: $	Use: Low	Time: Medium

The purpose of enhancing conspicuity for pedestrians is to increase the opportunity for drivers to see and avoid pedestrians, particularly when it is dark, since this is when 74% of pedestrian fatalities occur nationally (NCSA, 2017a). Pedestrians who are more visible are less likely to be struck. Retroreflective materials (that is materials that reflect light – such as from car headlights – back toward the source) are built into many shoes, including children's and athletic shoes. Other accessories, such as arm or leg bands, gloves, vests, and caps are available from sporting goods stores and other vendors. Light sources, including strobes and other flashing lights, are also available. Many have been designed for bicyclists but are equally applicable to pedestrians. The difficulty with most of these devices is that the user must decide in advance to take and use them. Due to the extra step and the appearance of the conspicuity enhancements not looking like "normal" clothing, they are very much underused. Pedestrians also tend to overestimate their own visibility, wrongly assuming if they can see vehicles, vehicles must see them (Karsh, Hedlund, Tyson, & Leaf, 2012). See also Chapter 9, Section 3.1 on bicyclist conspicuity measures for more information. Bright colored and fluorescent clothing may also help to improve daytime conspicuity for pedestrians in some environments, but most research has focused on bicyclists and there may be differences in effectiveness for these groups.

Nearly 16% of pedestrian fatalities in 2014 involved pedestrians who were not visible – dark clothing, no lighting, etc. (NHTSA, 2016, Table 100). There are a number of opportunities for improving pedestrian conspicuity. NHTSA's child education program includes information about conspicuity messages targeting different age groups. (See www.nhtsa.gov/pedestrian-safety/child-pedestrian-safety-curriculum) Other educational efforts should include a focus on being visible at night and in the daytime and making use of the conspicuity aids described in this section. Devices designed to be semi-permanently fastened to children's clothing can be provided to parents through schools, group activities, or health care providers. Light sticks and reflective bands can be supplied with new cars, or distributed by automobile clubs or insurance companies for use during vehicle breakdowns or emergencies. In these cases, drivers become pedestrians in potentially vulnerable locations on the roadside (e.g., changing a flat tire), where other drivers may not expect them. Thus, pairing visibility devices with the vehicle provides a way for these unintential pedestrians to remain visible regardless of their level of preparation.

Use: Retroreflective materials are used regularly in athletic-type shoes, occasionally in backpacks and jackets, and minimally in other clothing.

Effectiveness: Widespread use of retroreflective materials would increase the ability of drivers to detect pedestrians at night in time to avoid crashes. Pedestrians wearing good retroreflective materials, particularly materials that highlight a person's shape and moving extremities (i.e., wrists and ankles), or widespread use of active (flashing) lights can be detected hundreds of feet farther than can pedestrians in normal clothing, even with low-beam illumination (Koo & Huang, 2015; Karsh, Hedlund, Tyson & Leaf, 2012; Zegeer et al., 2004, Strategy B5). A study in a controlled (closed road) environment also validated that pedestrians are detected more readily when they wear reflective elements on their moving body parts rather than attached to the torso (Tyrrell et al., 2009).

Costs: Cost to provide retroreflective materials is low, if such supplementary materials are distributed in quantity and added to existing programs. Such items as reflective wrist and ankle bands are available commercially. To develop new programs promoting use of conspicuity materials would require somewhat more planning and start-up time and costs would also depend on communications strategies used.

Time to implement: Promoting increased conspicuity may require development of targeted messages and a publicity strategy.

4.4 Enforcement Strategies

Effectiveness: ★★★	Cost: $$	Use: Low	Time: Short

The purpose of enforcement strategies is to increase compliance with the pedestrian and motorist traffic laws that are most likely to enhance the safety of pedestrians in areas where crashes are happening or most likely to happen due to increased pedestrian and motorist exposure. Behavioral pedestrian safety initiatives require improvements in unsafe driver and pedestrian behaviors. Once pedestrians and drivers are informed of the behavior changes needed and why they are important, enforcement often is necessary to encourage compliance for the same reasons found with seatbelt use, etc. Although enforcement was implied or stated for many of the earlier countermeasures, enforcement strategies and targeted enforcement deserve additional discussion in relation to pedestrian safety. Many enforcement or crosswalk operations use plainclothes officers to act as pedestrians crossing the street, typically with one or two uniformed officers observing for violations and another giving warnings or writing citations (NHTSA, 2014).

Traffic enforcement is most effective when it is highly visible and publicized, to reinforce the required behavior and to raise the expectation that failure to comply may result in legal consequences. Enforcement campaigns should be aimed at drivers and pedestrians, starting with the communications and outreach efforts that announce, describe, and publicize the traffic safety campaign through community meetings, media coverage, social media, mass emails, and signage (NHTSA, 2014).

A coordinated program of targeted enforcement should involve a range of support activities, such as communications and outreach to notify the public of the campaign, training law enforcement officers on enforcement procedures and pedestrian and crosswalk laws, and educating prosecutors and judges so they understand the purposes of the campaign and are prepared for the increase in citations enforcement will produce (NHTSA, 2014). Training for prosecutors and judges can help build the case for enforcement of traffic laws and planned enforcement operations with appropriate follow-up throughout the judicial system. A pilot study in North Carolina found that once more stringent prosecution was publicized, the court case load did not increase as feared, as more drivers paid their citations automatically (Hunter, Thomas, & Stewart, 2001).

NHTSA's web-based law enforcement training course teaches law enforcement personnel the basics of pedestrian safety and targeted enforcement techniques and is available from the International Association of Directors of Law Enforcement Standards and Training (IADLEST), an international organization of training managers and executives dedicated to the improvement of public safety personnel. IADLEST serves as the national forum of Peace Officer Standards and Training (POST) agencies, boards, and commissions as well as statewide training academies throughout the United States. Training officers or individual officers wishing to access the training, can submit a request for access: www.nhtsa.gov/pedestrian-safety/pedestrian-safety-training-law-enforcement. This resource will be updated in the coming years to include new pedestrian laws and engineering countermeasures to assist officers' understanding of how engineering, education, and enforcement play a vital role in pedestrian safety enforcement. Note this training is national in scope, so common themes and laws are addressed. Officers must look to their own States for specific laws. Some States are offering quick training and resources to supplement the NHTSA course with a State specific focus through bulletins, on-line, group in-person, or on the job training training. As part of their Alert Today, Alive Tomorrow pedestrian safety campaign in Florida, for example, officers may sign up for overtime pedestrian crosswalk enforcement. However, they first must provide documentation that they have taken NHTSA's web-based training (referenced above) and watched both their State specific Pedestrian Safety Roll Call for Law Enforcement (YouTube) and the Cycling Safety Roll Call for Law Enforcement (YouTube) , each approximately 15 minutes.

As part of a Watch for Me pedestrian safety campaign, 118 police officers in North Carolina attended one-day workshops on pedestrian safety. In a pre-post test evaluation, officers who participated scored 24% higher on knowledge surveys about pedestrians and driver yielding laws after taking the workshop (Sandt, LaJeuness, Cohn, Pullen-Seufert, & Gallagher 2015). Only 14% of participating officers reported having taken a pedestrian and bicycle law course before. The NHTSA, *Pedestrian Safety Enforcement Operations: How-To Guide* (2015) offers law enforcement agencies a resource for setting up staged crosswalk enforcement operations, see: www.nhtsa.gov/sites/nhtsa.dot.gov/files/812059-pedestriansafetyenforceoperahowtoguide.pdf

Use: Low. Enforcement is largely a local option, and often is integrated into other police duties, so special enforcement efforts are difficult to isolate and track. However, the use of targeted pedestrian safety enforcement is on the rise. Several localities (including Chicago, Detroit, Miami, Pinellas County, Florida and Raleigh/Durham, North Carolina) and States such as New Jersey and New Mexico have, within the past few years, implemented training for law enforcement officers and conducted targeted enforcement efforts for pedestrian safety. North Carolina is expanding its "Watch for Me" campaign, which includes targeted enforcement and tailored safety messages. As mentioned in the discussion of crash factors at the beginning of the chapter, a few localities have also recently passed laws banning texting while walking, which they are now enforcing. Another Florida enforcement program in Gainesville has been evaluated and is described below.

Effectiveness: Enforcement strategies and targeted enforcement can be employed for a wide range of purposes in a wide range of circumstances, so effectiveness is context-dependent. A carefully done before/after study with a comparison group examined the effects of sustained, enhanced high-visibility enforcement of motorist yielding to pedestrians, combined with publicity and other community outreach in Gainesville, FL (e.g., flyers given to stopped drivers, information sent home with school children, roadside feedback signs, and earned and paid media) (Van Houten, Malenfant, Blomberg, Huitema, & Casella, 2013; Van Houten, Malenfant, Huitema, & Blomberg, 2013). Driver yielding rose throughout the 1 year study period, which included four, two-week waves of enforcement, along with the other activities. Four of the six enforcement sites observed significant increases in yielding at the end of the period with a fifth experiencing a positive trend. Only one location, on a University campus with an already high baseline rate of yielding, did not observe an increase. Yielding also increased at the comparison sites, although not by the same degree. Driver awareness of the enforcement, especially awareness of the enforcement-related feedback signs, also increased to a high level (from 13% at baseline to 78% at the end of the year). A follow up study, four years after the high-visibility enforcement program ended, found that yielding behavior actually increased at both the enforcement and comparison sites after the program had ceased despite there being no additional enforcement efforts (Van Houten, Malenfant, Blomberg, & Huitema, 2017). This suggests that there was a sustained change in the driving culture of the area. Earlier, Van Houten and Malenfant (2004) had found more modest increases in driver yielding to pedestrians in response to a single wave of targeted police enforcement at crosswalks on two corridors in Miami Beach, Florida. Warnings and educational flyers were handed out to most violators, while citations were issued for flagrant violations. Some publicity also resulted from the enforcement efforts. The yielding reductions are promising, but effects on crashes and injuries were undetermined as pedestrian crashes are relatively infrequent events.

In a NHTSA study by Savolainen, Gates, and Datta (2011), law enforcement officials in Detroit, MI implemented two pedestrian-oriented enforcement campaigns at Wayne State University aiming to educate campus pedestrians on proper use of crosswalks and the importance of obeying signals through the issuance of warnings. The study saw pedestrian violations (walking outside the crosswalk or against the signal) reduced 17% to 27% immediately after the campaign, with sustained reductions of 8% to 10% several weeks after active enforcement ceased. Study authors noted that pedestrian compliance was also heavily associated with the presence, quality, and location of pedestrian facilities (including pedestrian signals, bus stops, crosswalks, and convenient crossing opportunities).

Costs: The cost of the enforcement is a direct function of the size of the effort, the amount of enforcement, and associated supplies, ranging from vehicle operating costs to equipment such as speed measurement devices or alcohol test machines. If overtime is used to increase enforcement, costs would be higher. Free or low cost training of enforcement officers on data driven focused efforts at the local level, can enhance both the cost and time spent to educate and enforce those laws and pedestrian and motorist behaviors most likely to influence serious injury or fatalities to pedestrians.

Time to implement: Short. Law enforcement resources can be diverted to targeted enforcement very quickly. However, special training to ensure safe and consistent crosswalk enforcement operations may be needed, and periodic data analysis conducted to ensure potential high crash locations are targeted for safety behaviors that influence the safety of pedestrians, including speed and distraction. Developing a plan that coordinates law changes, environmental changes, or support communications and outreach with enforcement activities can take longer. Communications and outreach are keys to maximal effectiveness.

4.5 Driver Training

Effectiveness: ☆	Cost: $	Use: Low	Time: Medium

The purpose of pedestrian safety-related driver training is to increase the sensitivity of drivers to the presence of pedestrians and their shared responsibility as drivers to prevent crashes and enhance the safety of all road users, including pedestrians. Specifications for driver education curricula, typically a State requirement, can be adjusted to include more specific information on pedestrians as part of the traffic environment, right of way laws for drivers and pedestrians in relation to one another, high risk behaviors in relation to pedestrian/motorist crash types, and key ways drivers can avoid being involved in such crashes.

Effectiveness Concerns*: Driver training alone has not been shown to reduce overall crash rates. There is no evidence indicating that this countermeasure is effective. However, driving skill begins with knowledge education and then practicing defensive driving in relation to all other types of traffic, including pedestrians.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A8, Section 4.5.

4.6 Pedestrian Gap Acceptance Training

Effectiveness: ☆	Cost: $$	Use: Unknown	Time: Medium

The purpose of pedestrian gap acceptance training is to help pedestrians learn to make better road crossing decisions, which may reduce the incidence of crossing-related injuries and fatalities. This can include video-based training and feedback geared towards improving pedestrian judgment of speed and/or distance of oncoming traffic.

Effectiveness Concerns: *This countermeasure has been examined in few research studies. While there is some evidence that certain approaches may lead to limited positive outcomes, there is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A8, Section 4.6.

4.7 University Educational Campaign

Effectiveness: ☆	Cost: $	Use: High	Time: Medium

This countermeasure involves conducting educational campaigns targeted at new students and staff that may be unfamiliar with walking and driving in the campus environment. Potential educational messages include right-of-way rules and the importance of yielding right-of-way (pedestrians and drivers), being visible and predictable at both day and night times and during inclement weather (pedestrians and cyclists), making eye contact at conflict points (pedestrians and drivers), avoiding distractions (pedestrians and drivers), and speed control (drivers and potentially cyclists) (Zegeer, Sandt, & Scully, 2008). Partnerships may include campus public safety offices, student health and wellness programs, city/county public safety agencies, injury prevention agencies, parking and transportation services, transit agencies, and student groups.

Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A8, Section 4.7.

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9. Bicycle Safety

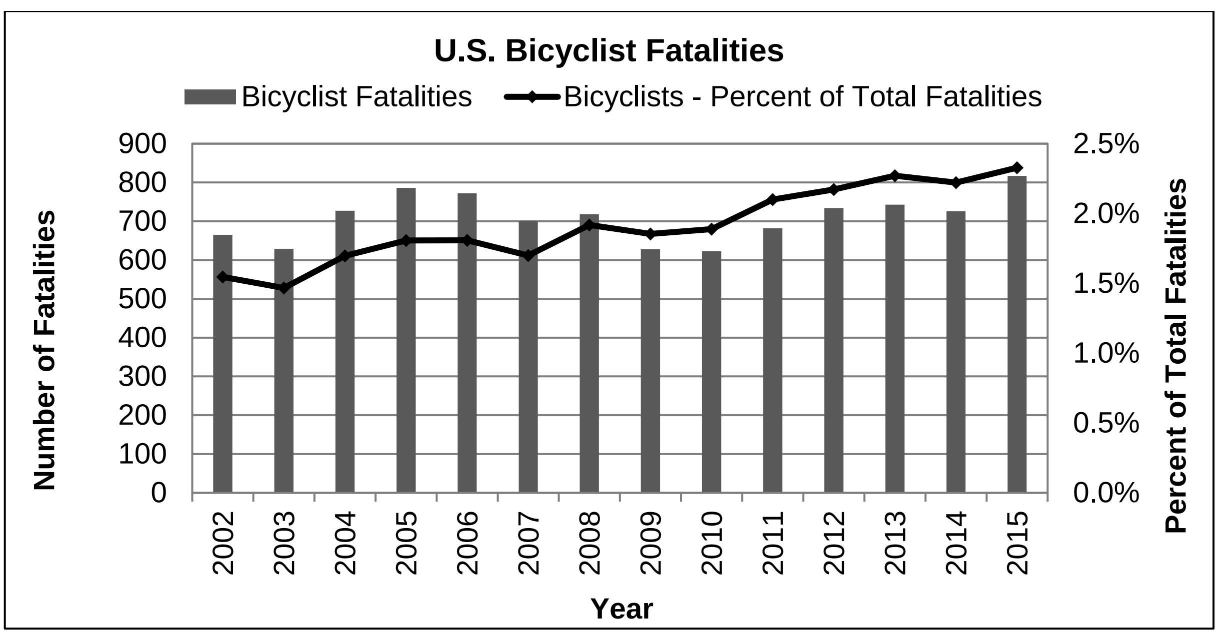
Overview

In 2015, 818 bicyclists and other cyclists died in traffic crashes nationwide, an increase of 12.2% from 2014 (NCSA, 2017). In addition, approximately 45,000 bicyclists were injured. Bicyclists accounted for 2% of total traffic fatalities and 2% of total injuries (NCSA, 2017). Of the bicyclist fatalities during 2015 (NCSA, 2017):

- Children 15-19 had the highest rates of fatality and injury among children, followed by 10-14 year olds;
- The average age of cyclists killed was 45, and 35 for cyclists injured;
- Cyclists 25 to 64 represented 69% of all bicycle fatalities;
- 85% of the bicyclists killed and 80% of those injured were male; and
- 22% of bicyclists killed had BACs of .08 g/dL or higher, with alcohol use by either bicyclist, driver, or both reported in 31% of fatal crashes.

The majority of bicyclist fatalities occurred in urban areas (70% in 2015), and at non-intersection locations (61% in 2015). The number of bicyclists killed in urban areas has remained relatively stable over recent years.

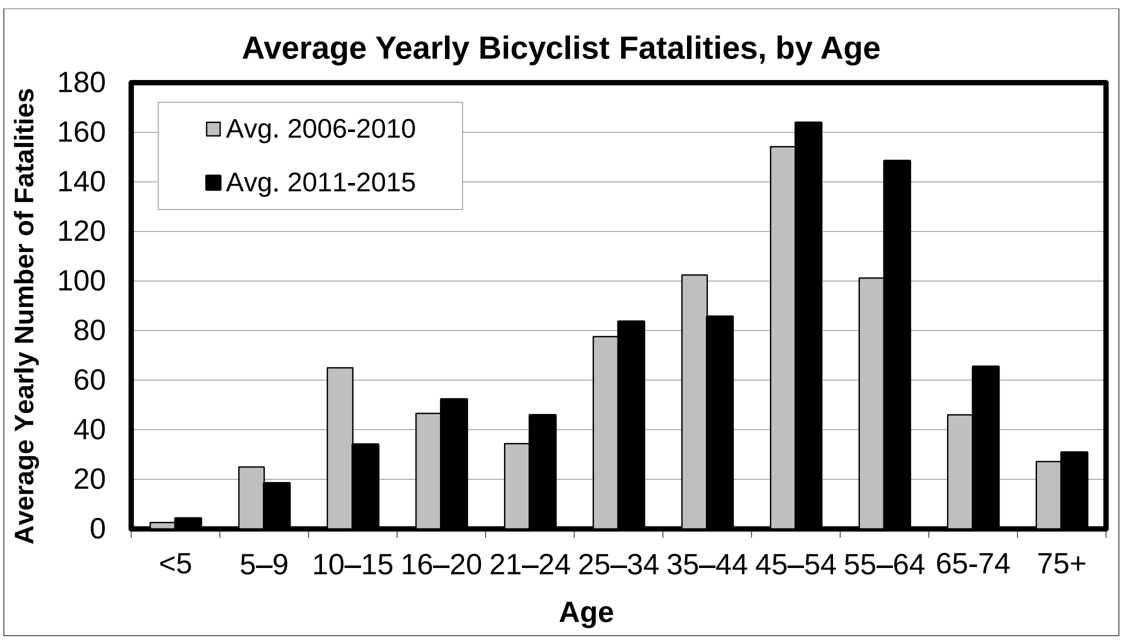
Crash Trends. Since 1996, bicyclist fatalities have fluctuated between 600 and 800 per year. The most recent upward trend in fatalities pushed the number of fatalities over 800 in 2015 and may reflect increases in riding. (See trends in riding below.) There are, however, substantial fluctuations in fatalities year-to-year that may not be explained only by exposure.



Source: NCSA (2017)

A study assessed the burden of injured bicyclists admitted to hospitals in terms of length of hospital stay in days, total hospital charges, and non-routine discharge (Hamann, Peek-Asa, Lynch, Ramirez, & Torner, 2013). Non-routine discharges included death, transfer to a nursing or other short-term hospital, or home health care. The data came from the Nationwide Inpatient Sample (NIS) database. In total, more than $1 billion of hospital charges, $425 million for motor-vehicle crashes and $588 million for non-motor vehicle crashes, per year resulted from bicycle crash injuries. Despite non-motor vehicle collisions (18,457) accounting for nearly 2.7 times as many admissions as collisions with motor vehicles (6,877) from 2002 to 2009, the total economic costs of longer hospital stays for those involved in motor vehicle collisions was 72% higher than the same costs for the non-motor vehicle collisions, not including further care associated with non-routine discharges.

There has been a slight rise in the average age of bicyclists killed over the past decade, from an average of 41 in 2006 to 45 in 2015 (NCSA, 2017). Comparing the five year period from 2011 to 2015 with the period from 2006 to 2010, fatalities increased most among bicyclists 45 and older, particularly those 55 to 64 (47% higher) (see figure below). It is likely that much of these differences relate to changes in population age distributions over this time period, including the rapid expansion of older age groups since 2000. It is unclear whether increases in amounts or types of riding or other changes in exposure among these age groups may also play a part in the increases in fatalities among those in the 45 and older age groups. However, fatalities decreased about 30% for bicyclists 10-15 years of age.



Source: NCSA, 2017
Note that different age group spans are used; the intent of the chart is to compare change in fatalities by age group, not to compare fatalities by age.

It is also worth noting that older adult bicyclists are more vulnerable when involved in a crash. Data from Sweden found that older adult bicyclists were twice as likely to be hospitalized when injured, and spent three times as long in the hospital as cyclists under 65 (Scheiman et al., 2010).

Bicycling Trends. Estimates from the American Community Survey (ACS), conducted by the U.S. Census Bureau, suggest that the number of U.S. workers (of all ages) who travel to work by bicycle increased from 0.4% of workers in 2000 to an average of 0.6% of workers for the 2008 to 2012 period (McKenzie, 2014). The share of workers that "usually traveled to work" by bicycle increased at a faster rate than any other mode of travel (McKenzie, 2014). Fatality rate trends, fatalities adjusted per different measures of exposure such as time spent bicycling, number of bicycling trips, or total miles traveled by bicycle are currently unavailable because there is no consistent measure of bicycling (exposure) to estimate and compare such fatality rates. According to the Federal Highway Administration's National Household Travel Survey (NHTS), which aims to capture all kinds of bicycling trips, not just commuting trips, the annual number of bicycling trips has also increased from 1.7 billion in 1990 (FHWA, 1990) to 3.3 billion in both 1995 (FHWA, 1995) and 2001 (FHWA, 2001), and to 4.1 billion in 2009, the latest NHTS data published (Pucher, Buehler, Merom, & Bauman, 2011). The various surveys used somewhat different methodologies. For example, the use of multiple prompts beginning with the 2001 survey has resulted in capturing more bicycle trips in the 2001 and later surveys (Hu & Reuscher, 2004). The current NHTS recently completed data collection (April 2017).

An analysis by Pucher, Buehler, Merom, and Bauman (2011) found the average number of cycle trips, and the average miles of cycling per capita per year, each rose a few percentage points from 2001 to 2009. More cycling trips were taken by males, adults 24-64, people without cars, and people with university degrees. An important note is that while the number of trips has risen, there has not been a significant increase in cycling trip rates (e.g., number of trips per capita) on a national basis. In select cities, however, there has been a substantial increase in cycling in recent years. In a study of nine large cities in the United States and Canada (Chicago, Minneapolis, Montréal, New York, Portland, San Francisco, Toronto, Vancouver, and Washington, DC), the authors found bike commuting rates more than doubled since 1990, while bicycle fatality rates subsequently dropped (Pucher, Buehler, & Seinen, 2011). The authors attribute these trends to the substantial investment in infrastructure and bicycle-supportive programs implemented in these cities.

In addition to number of trips, exposure to traffic and crashes is affected by where, when, and for how long a cyclist rides; the skill, knowledge and application of safe behaviors by the cyclist; and the application of safe behaviors by drivers around the cyclist. The risk of a crash may also be increased due to inattention, distraction, or impairment by either the cyclist or driver. The severity of a crash also increases with higher impact speeds (AASHTO, 2010). While impaired driving and riding have been an ongoing challenge, emerging problems include the use of cell phones, media players, or other electronic devices while riding or driving.

Classifying Crash Types. Bicycle crashes can be classified into types based on bicyclist and motor vehicle pre-crash actions and the location of the crash. In the early 1990s this methodology was used to classify more than 3,000 bicycle-motor vehicle crashes in California, Florida, Maryland, Minnesota, North Carolina, and Utah (Hunter, Stutts, Pein, & Cox, 1996). The sample was approximately evenly divided among small/rural communities, medium-sized cities, and large cities (as opposed to representing the proportion of crashes that occurred in each of those area types).

Of the more than 3,000 bicycle-motor vehicle crashes:

- Half (51%) occurred at intersections or were related to intersections.
  - The most common type of crash involved bicyclists riding out or through intersections and into the path of a motorist.
  - The second most common type of crash involved motorists failing to yield at intersections.
  - Another common type included motorists turning or merging into the path of a parallel moving bicyclist (same or opposite direction).
  - Child bicyclists were overrepresented when the bicyclist failed to yield at an intersection
  - Adult bicyclists were overrepresented in crashes at intersections where motorists turned across their path.
- Twenty-two percent occurred at junctions with commercial and private driveways or alleys.
  - Children were highly overrepresented in these crashes.
- Twenty-seven percent occurred at roadway sections with no special features (meaning no intersections or driveways at the segment near the crash); fatal and serious injuries occurred at a higher rate at such non-junction locations.
  - Adult cyclists were over-involved in crashes with overtaking motor vehicles at midblock locations.

<u>Bicyclist Factors</u>.

- In the Hunter et al. (1996) study, bicyclist factors contributing to crashes, especially at intersections or other junctions, included bicyclists riding the wrong-way (facing traffic rather than riding with traffic).
- Thirty-two percent of all bicyclists in the study were riding against traffic; for intersection collisions, the proportion was 42%.
- Fifteen percent of crashes were coded with bicyclist riding wrong-way as a contributing factor to the crash.
- Twenty-one percent of crashes were coded as bicyclist failure to yield
- Eight percent of crashes were coded as stop sign violations.
- Children were overrepresented in stop sign and yield violations and crashes on local and two-lane streets, whereas adult bicyclists were more likely to contribute to their crashes through alcohol or drug use and lane position and lane change errors.

<u>Driver Factors</u>.

- The Hunter et al. (1996) study also found that most common driver contributing factor was a yield violation at either an intersection or midblock location (a factor in 24% of crashes). However, as mentioned the bicyclist riding the wrong-way may have been a contributing factor in such crashes.

Different crash types can be targeted by different countermeasures. The Pedestrian and Bicycle Crash Analysis Tool (PBCAT) software (www.pedbikeinfo.org/pbcat_us/) is available to assist jurisdictions in typing bicycle-motor vehicle crashes and developing a database that contains information on pre-crash maneuvers as well as other crash factors. States and communities can then analyze their own bicycle crashes and can also use PBCAT and PedSafe (www.walkinginfo.org/pedsafe/) to help select appropriate countermeasures.

Underreporting and Crash Analysis. Another consideration when analyzing crash data is that bicycle crashes (as well as pedestrian crashes) tend to be underreported. Many States may neither require reporting nor collect off-road or private-road crash records. Non-roadway crashes may however, constitute a significant portion of bicycle-related crashes with motor vehicles. In one study, parking lot, sidewalk, and driveway-related crashes represented 31% of all *reported* bicyclist crashes (Stutts & Hunter, 1999a). Many more roadway and non-roadway crashes go unreported. Research is needed to better understand the extent and causes of non-roadway bicycle crashes and effective countermeasures. NHTSA's Not in Traffic Surveillance (NiTS) monitors and reports on not-in-traffic-related motor vehicle deaths. Many of these events involve young children. See Section 1.1 for more information.

Underreporting of traffic-related crashes on road right of ways likely decreases as the crash severity increases because police are likely to be called to injury and fatal crashes, and the bicyclist is more likely to be transported or seek examination at a health care facility. Therefore, the FARS data presented earlier is thought to be a reliable source for estimating bicyclist fatal crash frequencies. Even so, not all fatal bicycle crashes are included in FARS, including fatal bicycle crashes involving another bicycle or a pedestrian, or those that did not occur on public roads, as already mentioned.

Many more bicyclist and pedestrian injuries, including those due to falls, collisions with bicycles, and others, likely go unreported to State crash databases (Stutts & Hunter, 1999a, 1999b). However, up-to-date information is lacking, and research is also needed to better understand the causes of these types of injuries. Maintenance of (roadway and sidewalk) surfaces and Americans With Disabilities Act-compliant design of sidewalks, landings, and access ramps are certainly important for maintaining smooth surfaces, which bicycles are more sensitive to and which puts bicyclists at higher risks than motorists if not maintained due to their lighter weight and tire size. Other measures, such as providing space for bicyclists to ride separated from motorists and pedestrian walkways may also be important, but are outside the scope of this document.

Bicyclist Attributes. As with pedestrians, bicyclists come in all ages with many levels of knowledge, skill, perception, and judgment. Thus, educational and enforcement programs must take these factors into account and be designed to target age-specific concerns and the knowledge, skills and behavioral attributes of these different groups of riders. Several studies have also identified demographic differences in injury risk, amounts of bicycle riding, and helmet use. Davison et al. (2013) found being male and being a recent immigrant were both associated with increased bicycling injury risk among Canadian youth. Lower socioeconomic class was associated with lower helmet use. Richard, Thélot, and Beck (2013) found helmet use to be lower among females, younger and older ages, lower income persons, and urban dwellers than among rural and suburban residents in France, although some of the gaps were lessening over time. At a minimum, programs should be inclusive, or incorporate extra focus on groups at higher risk of injury.

Bicycles have an even smaller profile than motorcycles, and while they have white front reflectors and red rear reflectors, headlights and rear active lights typically must be purchased and attached separately. Bicyclists are more difficult for many motorists to notice than four-wheeled vehicles, especially at night. Because they are human powered, there may be substantial speed differentials between bicycles and motorized traffic, though this certainly varies in high traffic areas and with avid bicyclists. Bicyclists also lack the protective body of a motorized vehicle in the event of a crash and some riders feel uncomfortable mingling with traffic, especially in high speed, high-volume situations.

Crash Factors. As with all crashes, bicycle crashes often result from multiple contributing factors. Bicyclist and driver pre-crash actions and behaviors (such as distraction, driver speed, and alcohol/drug use), vehicle type and design, cyclist and vehicle volumes/exposure, and elements of the built environment (including roadway design, presence of bicycle facilities) all contribute to cycle crashes. Several resources have provided evidence of the role of the transportation environment in bicycle safety and summarized best practices in planning, engineering, and design for bicycle safety (AASHTO, 2012; FHWA, 2010; NACTO, n.d.). Adopting and implementing Complete Streets policies has been identified as one of the lower cost and more effective strategies to improve conditions for bicyclists. (For more on Complete Streets, visit www.completestreets.org/.)

Other. Some studies have focused on the role of vehicle type and design in the event of a crash. Ackery, McLellan, and Redelmeier (2012) found that larger motor vehicles—especially freight trucks and SUVs—were overrepresented in bicycle crashes compared to other vehicle types. While not dismissing the importance of vehicle design and the role of the built environment in preventing bicycle crashes, the countermeasures described in this report relate primarily to educational and enforcement measures aimed at improving the knowledge and behaviors of road users to prevent or mitigate the severity of a crash. For more discussion, see Chapter 8, page 6-7 related to distraction, driver speed, alcohol, and vehicle type and design.

Strategies to Increase Bicyclist Safety

Many of the same principles discussed in Chapter 8: Pedestrians (pages 8-10) also apply for bicyclists. Countermeasures in this chapter are primarily aimed at improving safety behaviors of bicyclists and drivers through education and enforcement measures, and are organized by bicyclist subgroups:

- Children;
- Adult Bicyclists;
- All Bicyclists;
- Drivers and Bicyclists.

A combination of several strategies should be used to decrease bicycle crashes and injuries.

- Increase the use of properly fitted bicycle helmets by all bicyclists, including children and adults, to mitigate head/brain injury in the event of a crash.
- Increase enforcement of helmet laws to increase compliance.
- Increase the conspicuity of bicyclists.

- Reduce vehicle speeds, which allows bicyclists and drivers more time to react and reduces impact forces if crashes do occur.
- Reduce exposure to known risky situations through behavioral and environmental countermeasures (without necessarily discouraging bicycling).
- Reduce distracted riding or driving behaviors (cell phones, headphones, etc.). See the chapter on distracted and drowsy driving for countermeasures targeting drivers.
- Decrease riding or driving while impaired. See the chapter on strategies to reduce alcohol-impaired driving. Some of the countermeasures would be applicable to address any type of impaired roadway use.
- Enact and enforce bicycle friendly laws to facilitate safe, predictable, and efficient bicycling in traffic, and safe driving around bicyclists, to update and fill gaps in existing laws.
- Educate law enforcement officers on enforcement of bicycle-specific laws. Educate the public on any new laws, such as safe passing of bicyclists.
- Increase traffic law compliance by both motorists and bicyclists. Train law enforcement officers in appropriate enforcement strategies. In particular, decrease wrong-way riding, sidewalk riding, and traffic control violations by bicyclists (and motorists); proper nighttime lighting; decrease speeding, cutting off bicyclists, passing too closely, or blocking or driving in a designated bicycle lane by motorists; and decrease distraction and impairment that impacts the safety of all road users including bicyclists.
- Educate motorists and bicyclists on required safety behaviors related to specific laws to enhance safe interaction between motorists and bicyclists on the roadway.
- Improve bicycle handling skills for bicyclists of all ages.
- Tailor countermeasures to diverse populations, including groups such as recent immigrants who may not be familiar with U.S. traffic laws, the U.S. traffic environment, may not speak or read English, or may not be literate in their native language.

Additional information about countermeasures involving a comprehensive approach to improving pedestrian safety is provided in NHTSA's *Advancing Pedestrian and Bicyclist Safety: A Primer for Highway Safety Professionals* (Brookshire et al., 2016).

Most of the above strategies are covered in this chapter under various descriptions. A few, such as "*reduce distracted riding or driving*" are not described, because as yet, literature searches do not detect any studies that have evaluated laws or programs aiming to reduce distracted riding. A recent survey of bicyclist attitudes and behaviors indicates that 21% of bicyclists use an electronic device on at least some of their bicycle trips with 9% indicating they use a device during nearly all of their trips (Schroeder & Wilbur, 2013). Currently, there is a lack of information about the impact of distracted bicycling on bicyclist safety. Organizations with existing or new training or educational programs might consider including these topics in outreach and educational programs and evaluating how well target audiences respond. Trying new strategies and evaluating them is the only way to gain new knowledge of what works. In addition, emerging technologies may help to combat distractions associated with those technologies. A number of cell phone applications are now available that have the ability to block incoming calls and texts while the cyclist (or other driver) is in motion.

Engineering and Roadway Design. While not dismissing the importance of vehicle design and the role of the built environment in preventing pedestrian crashes, the countermeasures described in this report relate primarily to educational and enforcement measures aimed at improving the knowledge and behaviors of road users to prevent a crash. However, there is a growing recognition of the importance of road design and the built environment in fostering safer user behaviors. A comprehensive approach that uses a combination of effective engineering, enforcement, and educational measures may have the best chance of achieving desired crash reductions.

Safety in Numbers. Finally, the idea that vulnerable road users' safety may be improved by increasing the numbers of pedestrians and bicyclists is gaining traction and some empirical support. Research from abroad as well as the United States finds that, although actual numbers of crashes may go up, individual risk of crashes with motor vehicles are often lower as numbers of bicyclists and pedestrians increase (Fyhri, Sundfør, Bjørnskau, & Laureshyn, 2016; Geyer, Raford, Ragland, & Pham, 2006; Jacobsen, 2003; Leden, Garder, & Pulkkinen, 2000). A 2009 scanning tour (accesses innovative technologies and practices in other countries that could significantly improve highways and highway transportation services in the United States) by U.S. transportation officials and researchers of Denmark, Sweden, Germany, Switzerland, and the United Kingdom reported that the concept of "safety in numbers" has motivated promotion of increased bicycling and walking in these countries as a safety countermeasure (Fischer et al., 2010). These European countries are committed to driving down the total numbers of bicyclist fatalities and injuries while increasing amounts of bicycling. Encouragement in these countries is done in the context of commitments to comprehensive planning, funding, engineering and design improvements, and maintenance policies to provide safe and connected bicycle networks. The report also documents numerous examples of how these policies are put into practice.

A non-linear relationship between traffic volumes (motorist, pedestrian, or bicyclist) and crashes has been demonstrated (AASHTO, 2010; Bhatia & Wier, 2011), but a causal mechanism for how increased volumes improve bicyclist safety has not been demonstrated (Bhatia & Wier, 2011). This means that crashes do not tend to increase in direct proportion to increases in volume, but absolute crash numbers are still likely to increase (and have increased) with increases in cycling – all else being equal. Additionally, all of the studies cited above, and others attempting to characterize volume and safety relationships, are based on cross-sectional comparisons. Other safety factors such as motorist speed, congestion, or law enforcement activity that are unmeasured or have not been accounted for in such studies are likely to influence crashes, making it challenging to isolate the influence of safety and crashes based on increases in cycling alone. Also, cross-sectional studies cannot easily demonstrate the direction of effect – that is, whether a safer environment comes before the greater numbers of bicyclists or is a result of that increase (Bhatia & Wier, 2011). It is clear, however, that a focus on improving the environment, both the infrastructure and road users' compliance with laws and safe behaviors, are important to increasing both population-level safety (measured as a reduction in population-wide fatalities and injuries) and numbers of bicyclists or amounts of cycling. As these two elements – safety improvements and increases in bicycling – occur collectively (or in combination), individual risk, or crash rates, may also be reduced.

Resources

The agencies and organizations listed below can provide more information on bicycle safety issues and countermeasures and links to numerous other resources.

- Pedestrian and Bicycle Information Center: www.pedbikeinfo.org/
- National Highway Traffic Safety Administration:
  - Bicycles – www.nhtsa.gov/road-safety/bicyclists
  - Research and Evaluation – www.nhtsa.gov/research-data; one.nhtsa.gov/Driving-Safety/Research-&-Evaluation
  - Behavioral Safety Research Reports – ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Federal Highway Administration:
  - Office of Planning, Environment, & Realty (Pedestrian and Bicycle Program) – www.fhwa.dot.gov/environment/bicycle_pedestrian/
  - Office of Safety – www.fhwa.dot.gov/safety.fhwa.dot.gov/ped_bike/
- League of American Bicyclists: www.bikeleague.org
  - Smart Cycling Videos – www.bikeleague.org/ridesmartvideos
- Governors Highway Safety Association: www.ghsa.org/issues/bicyclists-pedestrians
- Centers for Disease Control and Prevention: www.cdc.gov/
- National Center for Safe Routes to School:
- SAFE KIDS Worldwide: www.safekids.org
- Consumer Product Safety Commission: www.cpsc.gov
- Bicycle Helmet Safety Institute: www.helmets.org
- Association of Pedestrian and Bicycle Professionals: www.apbp.org
- Complete Streets Coalition: www.completestreets.org
- National Center for Bicycling and Walking: www.bikewalk.org
- Safe Routes to School National Partnership: www.saferoutespartnership.org
- Bicycle Safer Journey: Skills for Safe Bicycling for Ages 5 to 18: www.pedbikeinfo.org/bicyclesaferjourney/
- A Resident's Guide for Creating a Safer Communities for Walking and Biking: safety.fhwa.dot.gov/ped_bike/ped_cmnity/ped_walkguide/

Specific resources that provide further information on engineering, enforcement, and educational strategies are:

- NHTSA Advancing Pedestrian and Bicyclist Safety: A Primer for Highway Safety Professionals: www.nhtsa.gov/staticfiles/nti/pdf/812258-Peds_Bike_Primer.pdf
- NHTSA Motion Graphics:
  - Fitting a Bicycle Helmet – www.trafficsafetymarketing.gov/file/17966/download?token=9FEJYfUM
  - Rules of the Road – www.trafficsafetymarketing.gov/file/17971/download?token=ZqRbj0ZD
  - Driving Safely Around Pedestrians and Bicyclists – www.trafficsafetymarketing.gov/file/17963/download?token=LTY0OcoO
  - Bike Riding Safety – www.trafficsafetymarketing.gov/file/17969/download?token=nHrtcQD3

- AASHTO Guide for the Development of Bicycle Facilities, 4th Edition, American Association of State Highway and Transportation Officials: bookstore.transportation.org/collection_detail.aspx?ID=116
- NACTO Urban Bikeway Design Guide, National Association of City Transportation Officials: nacto.org/cities-for-cycling/design-guide/
- Public Policies for Pedestrian and Bicycle Safety and Mobility: An Implementation Project of the Pedestrian and Bicyclist Safety and Mobility International Scan: www.pedbikeinfo.org/cms/downloads/PBSPolicyReview.pdf
- Uniform Guidelines for State Highway Safety Programs: Highway Safety Program Guideline No. 14: Pedestrian and Bicycle Safety: www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/PedBikeSafety.pdf
- National Cooperative Highway Safety Research Program, NCHRP Report 500, Volume 18, A Guide for Reducing Collisions Involving Bicycles (Raborn et al., 2008): onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v18.pdf
- BIKESAFE: Bicycle Countermeasure Selection System: www.pedbikesafe.org/BIKESAFE/
- National Center for Safe Routes to School (SRTS), Enforcement: Role for Law Enforcement in SRTS. apps.saferoutesinfo.org/lawenforcement/AAA
- Share the Road and Save a Life: http://exchange.aaa.com/wp-content/uploads/2012/03/ShareTheRoad_Flyer.pdf

Resources released or updated since the last *Countermeasures That Work* update:

- Alliance for Biking and Walking. Bicycling and Walking in the United States 2016, Benchmarking Report: www.bikewalkalliance.org/storage/documents/reports/2016benchmarkingreport_web.pdf
- FHWA, 2015: A Resident's Guide for Creating Safer Communities for Walking and Biking: http://safety.fhwa.dot.gov/ped_bike/ped_cmnity/ped_walkguide/
- FHWA Strategic Agenda for Pedestrian and Bicycle Transportation: www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/strategic_agenda/fhwahep16086.pdf
- NHTSA, 2016: Advancing Pedestrian and Bicyclist Safety: A Primer for Highway Safety Professionals: www.nhtsa.gov/staticfiles/nti/pdf/812258-Peds_Bike_Primer.pdf

For more information on education, engineering, vehicular, and legislative practices and recommended strategies from Europe, refer to *Keeping Children Safe in Traffic* by the Organization for Economic Co-operation and Development (2004).

Bicycle Safety Countermeasures

Countermeasures to improve bicycle safety are listed in the table below and discussed individually in the remainder of this chapter. The table is intended to provide a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. Effectiveness is shown using a five-star rating system:

- Countermeasures that receive ★★★★ or ★★★★★ have been determined to be effective.
- Countermeasures that receive ★★★ are considered promising, and likely to be effective.
- Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States, communities and other organizations are encouraged to use ★★★, and especially ★★★★ or ★★★★★, countermeasures. They should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

Further details about the symbols and terms used are included after the table. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate. See each countermeasure discussion for more information.

Each countermeasure to improve bicycle safety is discussed individually in this chapter. Full descriptions are included for ★★★, ★★★★ and ★★★★★ countermeasures. Brief descriptions are included for ☆ and ☆☆ countermeasures. Further details about the ☆ and ☆☆ countermeasures are included in Appendix A9 to this report.

1. Children

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Bicycle Helmet Laws for Children	★★★★★	$$	Medium	Short
1.2 Safe Routes to School	★★★	$	High	Short
1.3 Bicycle Safety Education for Children	☆☆	$	Unknown	Short
1.4 Cycling Skills Clinics, Bike Fairs, Bike Rodeos	☆	$	Unknown	Short

2. Adults

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Bicycle Helmet Laws for Adults	★★★★	$	Low	Short
2.2 Bicycle Safety Education for Adult Cyclists	☆	$$	Low	Medium

3. All Bicyclists

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Active Lighting and Rider Conspicuity	★★★	$	High†	Varies
3.2 Promote Bicycle Helmet Use with Education	☆☆	$$$	Medium	Medium
3.3 Enforcement Strategies	☆	$$	Unknown	Varies
3.4 Motorist Passing Bicyclist Laws	☆	$	Medium	Short

†High for active lighting laws; unknown for promoting other conspicuity measures

4. Drivers and Bicyclists

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Driver Training	☆	$	Low	Medium
4.2 *Share the Road* Awareness Programs	☆☆	$$	Unknown	Medium

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment, facilities, and publicity

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: less than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Children

1.1 Bicycle Helmet Laws for Children

Effectiveness: ★★★★★	Cost: $$	Use: Medium	Time: Short

The purpose of bicycle helmet laws for children is to increase bicycle helmet use, thereby reducing the number of severe and fatal head injuries to children involved in bicycle crashes. Earlier crash-trend analyses using FARS data suggested that State helmet-use laws for children reduce child bicycle fatalities by about 15% in the long run (Grant & Rutner, 2004). Several meta-analyses discuss the effectiveness of bicycle helmets in reducing head injuries and fatalities in all types of crashes including bike-only falls (Attewell, Glase, & McFadden, 2001; Thompson, Rivara, & Thompson, 2006). Elvik (2011) focused on all riders, not just children, estimating that bicycle helmet use results in about a 42% (95% CI [25, 55]) reduction in the risk of a non-fatal head injury. In another case control study, Bambach et al. (2013) found protective effects of helmet use to be 50% for moderate injury, 62% for serious injury, and 75% for severe head injury. Additional recent studies have reported increased risk of severe injury or death for non-use of helmets among riders involved in crashes. For more information, see Section 2.1 Bicycle Helmet Laws for Adults.

A helmet law is a significant tool in increasing helmet use, but as with all laws effectiveness is related to implementation. Legislation effectiveness is enhanced when combined with supportive publicity and education campaigns or programs. See, for example, Rivara, Thompson, Patterson, and Thompson (1998), Kanny, Schieber, Pryor, and Kresnow (2001), Rodgers (2002), and Sandt, LaJeunesse, Pullen-Seufert, and Gallagher (2015). The practical effect of bicycle helmet laws is to encourage parents to require their children to use helmets (and educate parents to serve as role models to wear a helmet despite the lack of a law).

Law enforcement and other safety officials can reinforce the need to wear a helmet through positive interactions, free, or discounted helmet distribution programs (combined with proper helmet fitting), or other positive incentives for helmet use. Publicizing helmet laws and child/parent education on helmet fitting and the importance of wearing a helmet every ride may enhance effectiveness. Educational programs have been shown to increase knowledge about proper use of helmets. See Chapter 9, Sections 1.3 and 3.2 for more information.

Use: As of March 21, 2016, 22 States, the District of Columbia, and at least 201 municipalities or counties have child helmet laws (BHSI, 2016). Most U.S. laws cover child bicyclists younger than 18. Only 13 States have no State or local bicycle helmet laws.

Effectiveness: Two systematic reviews found that legislation may be effective at increasing helmet use (Karkhaneh, Kalenga, Hagel, & Rowe, 2006; Macpherson & Spinks, 2007). Two of three controlled studies reported reductions in head or traumatic brain injury following legislation (Macpherson & Spinks, 2007). The degree of improvement varied but there was a lack of evidence to determine whether enforcement, supporting publicity, and helmet distribution efforts explain some of the variation (Karkhaneh et al., 2006; Macpherson & Spinks, 2007). There was a non-significant trend toward a greater overall increase in helmet use in communities with laws covering all cyclists compared to those covering only children, and effects were larger among children (Karkhaneh et al., 2006). Dennis et al. (2010) also found self-reported helmet use was highest in a province with a law covering all ages, next highest in a province with a law covering children up to 18, and lowest in a province with no law.

Effectiveness of legislation in reducing head injuries is challenging to assess because of the difficulty of controlling for other safety measures that may differ across jurisdictions, and for exposure to crashes of different severities across people in case control studies. Two recent studies from Canada have found somewhat mixed results. Karkaneh et al. (2013) found that legislation targeting those less than 18 had a beneficial effect on child, adolescent, and adult bicyclists hospitalized for head injury in the province of Alberta, Canada. Helmet use increased from 75% to 92% among children, from 30% to 63% among adolescents, and from 52% to 55% among adults (Karkaneh et al., 2011). A national study compared trends in provinces with and without legislation. Despite lower injury rates in provinces with helmet laws than in those without, the effect could not be attributed to the introduction of the laws (Dennis et al., 2013). However, the study also found that one province that implemented a law covering all ages, not just children, did have a significantly lower injury rate trend for the period covered by the law.

Enactment of a helmet law can be effective even if the law is difficult to enforce. Bonander, Nilson, and Andersson (2014) found that the proportion of juvenile head injury hospitalizations in Sweden decreased by 7.8% for males younger than 14 after the enactment of a law requiring children to wear a helmet when riding a bicycle. Importantly, Swedish law prohibits law enforcement from issuing fines to children under 15, effectively preventing police from enforcing the law; however, the law may have been successful because it provided parents with additional leverage to persuade their children to wear a helmet.

Costs: A helmet law should be supported with appropriate communications and outreach to parents, children, schools, pediatric health care providers, and law enforcement. NHTSA has a wide range of material that can be used to educate and promote the use of a helmet every ride, demonstrate helmet effectiveness, and educate and demonstrate how to properly fit a helmet. Helmets that meet safety requirements can be purchased for under $20. Some States provide free or discounted helmets to some children (or parents if requested). When considering the costs of providing helmets, agencies should consider the benefits. A NHTSA summary of helmet laws reported that “every dollar spent on bicycle helmets saves society $30 in indirect medical and other costs” (NHTSA, 2008). The Bicycle Helmet Safety Institute (BHSI) has information on important considerations in buying a helmet, sources for low-cost helmets, and partners such as Safe Kids may be able to help with providing low-cost or free helmets (www.helmets.org/index.htm). A helmet should be replaced when it has been involved in a crash, when any part of the helmet is damaged, or the foam appears to be dry or changed in texture (brittle). According to BHSI, some manufacturers suggest replacement every five years, although BHSI indicates that it may depend on use and care of the helmet and that a helmet may provide good protection for longer (www.helmets.org/guide.htm).

Time to implement: A bicycle helmet law can be implemented as soon as the appropriate legislation is enacted. Enacting local ordinances may take less time than enacting statewide legislation. To develop custom communications and outreach, train law enforcement officers on implementing the law, or start a helmet distribution or subsidy program in support of the law may require a medium-to longer-term effort.

1.2 Safe Routes to School

Effectiveness: ★★★	Cost: $	Use: High	Time: Short

The goal of Safe Routes to School Programs is to increase the amount of bicycling and walking trips to and from school while simultaneously improving safety for children bicycling or walking to school. SRTS programs are community-based and are intended to be comprehensive in nature. Programs include education of children, school personnel, parents, community members, and law enforcement officers about safe bicycling and walking behavior and safe driving behavior around pedestrians and bicyclists. In addition, programs include enforcement and engineering activities to improve traffic safety and risky elements of the traffic environment around primary and secondary schools so children can safely bicycle or walk to school. Information on the role of law enforcement in SRTS is available on the National Center for Safe Routes to School website (apps.saferoutesinfo.org/lawenforcement).

From 2005 to mid-2012 the SAFETEA-LU legislation required each State to have its own SRTS program, including a full-time coordinator to manage Federal funds. Each year, Federal funding was allocated on infrastructure (engineering) improvements and on non-infrastructure projects to encourage walking and bicycling to school (public awareness and outreach, enforcement near schools, education, and training for volunteers). In June 2012 Congress passed the MAP-21 Act. The Act significantly altered how SRTS and other pedestrian and bicycle programs are structured and funded once the previously obligated funding is depleted. Under MAP-21, SRTS is no longer a standalone program (no new funding); however, old SAFETEA-LU funds can still be used if they are available. Under MAP-21, SRTS projects were still eligible to compete for funding alongside other bicycle and pedestrian-related programs, including former Transportation Enhancements and Recreational Trails projects. Now under the Fixing America’s Surface Transporation (FAST) Act (signed in December 2015), as part of a new program called Transportation Alternative Set-Aside funds, States can determine their own funding priorities. All funding is still eligible as it was under MAP-21 for infrastructure and non-infrastructure funds for SRTS at the State’s discretion. To learn more, visit www.fhwa.dot.gov/MAP21/.

Use: With the establishment of the national SRTS program, all 50 States and the District of Columbia have initiated SRTS programs. As of March 31, 2015, more than $1.03 billion out of the $1.147 billion in SAFETEA-LU funds apportioned to local and statewide SRTS programs had been allocated (FHWA, 2015). At that time 17,400 schools, representing 6.8 million students, had received funding or were slated to receive funds for SRTS programs. Importantly, 68% of award recipients were classified as Title 1 (low-income) schools, a finding that is relevant because areas with lower median income are over-represented in bicyclist- and pedestrian-related crashes (McArthur, Savolainen, & Gates, 2014).

Of the projects funded, 48% included infrastructure improvements, such as sidewalk improvements (20%), pedestrian and bicyclist access (15%), and traffic calming improvements (13%). In addition, 10% of projects funded were related to law enforcement countermeasures. About 19.5% of all elementary and middle schools have had SRTS programming in the past 10 years. To learn more, visit www.fhwa.dot.gov/MAP21/. From 2005 to 2012, nearly 14,000 schools received SRTS funding (Active Living Research, 2015). See Chapter 8, Section 2.2 for more information.

Effectiveness: SRTS efforts include, at a minimum, a 3E approach to pedestrian and bicycle safety addressing engineering, education, and enforcement (programs can also include encouragement, evaluation, and equity considerations). SRTS programs, including education and training, can be effective in teaching children and their parents how to evaluate and choose the safest routes for walking or bicycling to and from school, to practice safe behaviors when walking, biking or driving around children walking/biking to school, how to use common engineering treatments to enhance their safety (sidewalks, crosswalks), to adhere to crossing guard direction, and to abide by traffic laws, especially in and around school zones. Although the full program emphasizes broad education, some specific implementations have centered on site-appropriate engineering changes; results have shown behavioral improvements for pedestrians, bicyclists, and motorists (NHTSA, 2004, 2015). Although no bicycle-specific safety studies have been reported, overall safety improvements have been demonstrated for SRTS programs in regional studies. One study found a 60% decrease in the number of pedestrians involved in car crashes after the implementation of SRTS in Miami-Dade County. Similarly, school-aged injury rates in New York City decreased by 44% in census tracts with SRTS interventions relative to those without interventions (NHTSA, 2015). A cost-effectiveness model estimates a savings of $224 million for one cohort of intersection users in New York City by implementing the SRTS program (Muennig, Epstein, Li, & DiMaggio, 2014). The authors concluded that SRTS programs can remain effective for decades because of the lasting engineering component. Because funds are limited for SRTS programs, prioritizing the allocation of funding across the schools in a State can help improve the overall effectiveness of SRTS programs by focusing on those schools that are most likely to experience the greatest safety benefits. McArther, Savolainen, and Gates (2014) found that frequency of pedestrian/bicycle crashes generally were greater with greater population density, larger average family sizes, lower median income, and fewer two-parent households. In addition, schools located on local roads experienced higher crash rates than those located on higher-class roads or arterials. For more information about the effectiveness of SRTS (including information on the effectiveness of SRTS on injury rates, behavioral improvements, and the percentage of students walking or biking to school, see Chapter 8, Section 2.2.

Costs: Activities associated with SRTS may be low cost and may also be eligible for grant funding (non-infrastructure grants mentioned above). Grants are administered by each State's SRTS coordinator. Significant materials and resources can be accessed at no cost. NCSRTS provides downloadable material for State and local SRTS programs.

Time to implement: Short for education. Once a school or district has decided to implement an SRTS program, a range of materials, including an on-line step-by-step guide on getting started, is available from the NCSRTS. Programs funded through State DOTs, including engineering/infrastructure components typically require applications on a funding cycle and can take significantly longer to implement.

1.3 Bicycle Safety Education for Children

Effectiveness: ☆☆	Cost: $	Use: Unknown	Time: Short

The purpose of bicycle education is to teach children basic bicycle handling skills, traffic signs and signals, how to ride on streets with traffic present, proper helmet use, bicycle safety checks, and bicycle maintenance. As part of a regular school curriculum, education can reach every student, but providing training outside of school settings such as through parks and recreation departments, community centers, or faith-based organizations may be more feasible in some circumstances. Community-based programs could also provide greater flexibility in tailoring a program to meet the needs of specific target groups.

Effectiveness Concerns: *Previous studies examining the effectiveness of this countermeasure found that bicycle safety education increases children's knowledge of laws and safe behaviors (Hooshmand, Hotz, Neilson, & Chandler, 2014; Lachapelle, Noland, & Von Hagen, 2013; Thomas et al., 2005), but whether this translates into adoption of the safe behaviors is less certain. The balance of evidence regarding countermeasure effectiveness remains inconclusive.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A9, Section 1.3.

1.4 Cycling Skills Clinics, Bike Fairs, Bike Rodeos

Effectiveness: ☆	Cost: $	Use: Unknown	Time: Short

Cycling Skills Clinics, bicycle safety fairs, and rodeos are local events often run by law enforcement, school personnel, or other civic and volunteer organizations. Their purpose is to teach children on-bicycle skills and how to ride defensively in a number of traffic conditions. The intent of these types of activities is to introduce or reinforce bicycle safety concepts learned in a classroom with actual on-bike practice and application. Events can also include discussions and examples of proper bicycle helmet fitting.

Effectiveness Concerns: *While cycling skills clinics or rodeos can result in an increase in knowledge and skills, a review of the research literature does not reveal any studies that document crash and injury reduction, at least not in isolation. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A9, Section 1.4.

2. Adults

2.1 Bicycle Helmet Laws for Adults

Effectiveness: ★★★★	Cost: $	Use: Low	Time: Short

The purpose of bicycle helmet laws is to reduce the number of severe and fatal injuries resulting from bicycle crashes. Bicycle helmets, when worn properly, are the single most effective piece of equipment to reduce head injuries in the event of a crash. A meta-analysis of bicycle helmet effectiveness estimated that bicycle helmet use results in about a 42% (95% CI [25, 55]) reduction in the risk of a non-fatal head injury (Elvik, 2011). Other studies have also found increased risk for all types of severe injury for helmet non-use (Boufous et al., 2012); for head and brain injury controlling for alcohol use by the bicyclist (Crocker et al., 2012); and controlling for other risk factors such as type of crash, age, and sex of the rider (Persaud et al., 2012).

According to a nationally representative population-based survey of attitudes and behaviors about walking and biking, 63% of respondents (16 and older) favored laws requiring adults to use helmets when bicycling (Schroeder & Wilbur, 2013). However, only 37% of these respondents indicated that they use a helmet on all or nearly all rides. Forty-six percent indicated they never use a helmet (Schroeder & Wilbur, 2013).

Use: No States have yet enacted laws requiring adults to wear bicycle helmets. More than 60 local jurisdictions require people of all ages to wear helmets when bicycling (BHSI, 2014).

Effectiveness: Several studies (two studies from Canada, and one study from three New York city suburbs) show helmet laws for all ages produce higher helmet wearing rates than laws covering only children (Dennis et al., 2010; Karkhaneh et al., 2006; Puder, Visintainer, Spitzer, & Casal, 1999), See the Effectiveness section on Bicycle Helmet Laws for Children (Chapter 9, Section 1.1) for more information.

Dennis et al. (2013) found suggestive trends that laws in Canadian provinces that cover all ages resulted in fewer head injuries as a ratio of all bicycle injuries than no helmet law or a law covering only youth. Walter et al. (2011) found a decrease in head injury rates over and above decreasing trends in all bicyclist injury rates associated with a comprehensive and long-term bicycle helmet use law in New South Wales, Australia. Further, the proportion of cyclists involved in crashes who were wearing a helmet increased from 20% to more than 60% among children, and to more than 70% among adults. For adults, the increase occurred within two months of the law effective date, whereas the increase was more gradual among children. Olivier, Walter, and Grzebieta (2013) also found the rate of bicyclist head injuries decreased in comparison to the rate of bicyclist arm injuries (used to reflect differences in the amounts of riding) since 1991, when the law was enacted, suggesting that benefits continue long term. Studies have also found that when children are accompanied by adults using helmets, the children are also more likely to be using helmets (Wesson et al., 2008). Universal (all ages) helmet requirements for motorcyclists similarly result in higher helmet use rates and the greatest reductions in fatalities and injuries (see Chapter 5, Section 1.1).

Costs: Minimal costs could be incurred for informing and educating the public and providing training for enforcement personnel.

Time to implement: A universal helmet use law can be implemented as soon as the law is enacted.

Other issues:

- **Encouragement to use helmets:** While helmet use is effective for preventing serious head injuries among all ages, some jurisdictions are concerned mandatory helmet use for all ages will discourage bicycling. Given that increased riding provides health benefits, some agencies prefer to use encouragement in lieu of a law to increase helmet use by adults. See Section 3.2 for more information.
- **Helmet standards**: All helmets sold in the United States must pass minimum testing standards for head protection ("impact attenuation"), requirements to prevent helmets coming off in a crash, peripheral vision tests and other requirements developed by the Consumer Product Safety Commission (CPSC). Final rules were passed in 1999. The full standards are available on the BHSI website (www.helmets.org/index.htm#standards). A folding helmet intended to be more convenient to carry that meets the CPSC standards is now available per the BHSI website (www.helmets.org/shared.htm#studies).
- **Buying, fitting, and replacing helmets**: Most importantly, helmets must fit properly, be worn properly, and be worn every time in order to offer the desired protection. NHTSA (one.nhtsa.gov/staticfiles/nti/bicycles/pdf/8019_Fitting-A-Helmet.pdf, www.trafficsafetymarketing.gov/sites/tsm.nhtsa.dot.gov/files/campaign_media/bicycle_safety/bicycle_safety/web_videos/helmet.zip), the League of American Bicyclists (bikeleague.org/content/smart-cycling-tips-0), and SafeKids Worldwide www.safekids.org/sites/default/files/documents/bike_safety_tips-2015.pdf, provide tips on helmet fitting and other guidance on riding safely in traffic. Such tips may be included on bike maps and other local resources for bicyclists. Helmets should be replaced if involved in a crash. They should also be replaced at some interval just because of natural deterioration (e.g., the foam is dented or becomes brittle, there are cracks in the outer shell, or the straps breaking or becoming loose). The Bicycle Helmet Safety Institute has more information on buying, fitting, and replacing helmets, and also reviews new helmets that come out each year and discusses costs (www.helmets.org/). BHSI suggests, from the results of impact tests they conducted, that lower-cost helmets are just as impact-resistant as more costly ones. Reflective and bright colors are recommended, and rounder helmets are also suggested by BHSI to provide a smoother, less snag-prone surface in the event of a crash.

2.2 Bicycle Safety Education for Adult Cyclists

Effectiveness: ☆	Cost: $$	Use: Low	Time: Medium

The goal of bicycle safety education for adult bicycle commuters is to improve knowledge of laws, risks, and cycling best practices, and to lead to safer cycling behaviors, including riding predictably and use of safety materials such as reflective clothing and helmets. This countermeasure can include educational materials, tip sheets, and a pledge program for local agencies to adopt and disseminate.

Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A9, Section 2.2.

3. All Bicyclists

3.1 Active Lighting and Rider Conspicuity

Effectiveness: ★★★	Cost: $	Use: High†	Time: Varies

†High for active lighting laws; unknown for promoting other conspicuity measures

Improving bicyclist conspicuity is intended to make bicyclists more visible to motorists and to allow motorists more opportunity to see and avoid collisions with bicyclists. A common contributing factor for crashes involving bicyclists in the roadway is the failure of the driver to notice the bicyclist, particularly at night. White or light-colored clothing, long a recommended solution, does little to improve conspicuity at night (Raborn et al., 2008, Strategy F2). A study of bicyclists admitted to hospitals from bicycling injuries suggested that white upper body clothing may provide a protective effect for motor vehicle collisions during daylight hours (Hagel et al., 2014).

New bicycles must be sold with reflectors meeting the CPSC requirements. The reflectors may improve a bicycle's night-time visibility when they are illuminated by motor vehicle lights approaching from behind. Active bicycle lighting requires the user turn it on/off to activate it versus a passive light (reflector). Active bicycle lighting can also be critical for the detection of bicyclists coming toward the path of a motor vehicle, because the bicyclist is outside the vehicle's headlight beam until the last moment (Raborn, et al., 2008). In most States and jurisdictions, bicycles ridden after dark are required by law to have active white front lights and most States also require red rear reflectors or active lights. White in front and red in rear is meant to replicate the lighting used in motorized vehicles. Some State laws have specific requirements for the power of the light, i.e., ability to see the light at a certain distance of feet ahead. Some laws, such as in Oregon, require bicycle lighting not only at night, but also in other less than favorable conditions. Efforts to increase enforcement of laws requiring use of lights is needed to maximize use (Raborn et al., 2008). Communications and outreach to the general public and law enforcement officers about State and local laws regarding the use of active bicycle lighting (and other conspicuity aids) should be provided. However, a recent study from Australia found the use of a bicycle light alone, whether static or flashing, did not enhance the conspicuity of the bicyclist among study drivers, so additional measures to improve conspicuity (such as clothing or reflective leg straps) may be needed (Wood et al., 2012).

Most bicycles do not come equipped with permanently mounted lighting (Osberg, Stiles, & Asare, 1998). Newer mounting devices may, however, make it easy to attach or remove lights as needed. Many currently available lights may also be easily switched from continuously lit to flashing modes. Batteries also last much longer with LED lighting, increasing convenience.

Additional materials attached to bicyclists or their bikes can increase rider conspicuity day or night. For daytime, bright-colored or fluorescent clothing, including shirts, vests, caps, etc., make the bicyclist more noticeable. In low light conditions (e.g. rain, fog) and at night, the same items can have retroreflective (reflects light directly back toward the original source of light) materials incorporated in them, to make the bicyclist more visible and identifiable from much greater distances. Retroreflective bicycle tires, and now frames, are also available. For example, bright neon tubes are designed to be mounted on the bicycle frame, where they cast a bright, broad pattern of light onto the roadway, creating the illusion of a vehicle much wider than a bicycle. Lower cost stickers to put on rims (or cyclist extremities) and other parts of the bike are also available. Pedal reflectors are another option and may help drivers identify cyclists and estimate their speeds based on pedal rotations, though further research is needed. Lights also may be applied to helmets or backpacks to make the rider more conspicuous to other vehicles. Other emerging active lighting technologies may also enhance conspicuity of nighttime cyclists when used. Lights or reflective material attached to moving extremities (i.e., wrists and ankles) can create the perception of human movement and increase cyclist visibility (Koo & Huang, 2015; Karsch, Hedlund, Tyson & Leaf, 2012). A study of the effectiveness of different configurations of flashing lights on bicyclists' joints found that lights placed on the lower body (hips, knees, and ankles) were the most effective in increasing bicyclist visibility (Koo & Huang, 2015). See also Chapter 8 Section 4.3 on pedestrian conspicuity measures for more information.

Use: Most States have laws requiring use of active lights and reflectors on bikes ridden at night. There is no data on how frequently active lighting is used among those who bicycle after dark, but bicyclists involved in collisions at night appear to use lights infrequently. Use of bicycle reflectors is thought to be higher since they come pre-attached to bicycles at purchase, but these may be removed, or broken, after purchase, so use is not guaranteed. Nearly three-fourths of U.S. survey respondents who reported having ridden in the dark indicated they took some measures, either using a bike headlight or reflective/fluorescent gear or clothing, to make themselves more visible (Schroeder & Wilbur, 2013).

Most, if not all, athletic shoes contain some retroreflective material. Some athletic clothing also has retroreflective material. Bicycle helmets may have retroreflective elements. Some bicyclists may be seen wearing additional retroreflective materials, such as vests, jackets, arm bands, or rear-mounted reflective triangles located under their bicycle seats.

Effectiveness: A Cochrane review of studies of pedestrian and bicycle conspicuity aids concluded that "fluorescent materials in yellow, red, and orange improved driver detection during the day ..." (Kwan & Mapstone, 2004). Even low beam headlights can illuminate figures wearing florescent materials hundreds of feet away, much farther than figures wearing normal clothing (Zegeer et al., 2004, Strategy B5; Raborn et al., 2008, Strategy F2). One study among a cohort of riders who had participated in a large mass bicycle event found results suggesting that consistent use of fluorescent colors provides a protective effect against crashes and injuries (Thornley, Woodward, Langley, Ameratunga, & Rodgers, 2008).

A small Australian study found that bicyclist clothing (such as vests and ankle and knee reflectors) significantly affected conspicuity, enabling drivers to react to bicyclists from further away than when the bicyclist wore only a vest or no reflective material at all (Wood et al., 2012). Younger drivers detected and responded to bicyclists more often and from a further distance than older drivers. A study of bicyclists admitted to hospital emergency departments in Edmonton and Calgary, Canada did not find a significant protective effect for using head or tail lights, for retroreflective upper body clothing, nor for other reflective items for nighttime crashes; however, the sample size was small, and there was no apparent control for the riding environment or type of ambient/street lighting available (Hagel et al., 2014). More research is needed to assess the effects of various types of conspicuity aids under different road environments and ambient and supplemental light conditions.

Another challenge is getting bicyclists to wear retro-reflective materials and use proper lighting and other conspicuity aids routinely (and appropriately). It is possible to obtain widespread use of lighting. Osberg et al. (1998) found nearly half of nighttime bicyclists in Paris used active lighting, compared to just 14% of Boston bicyclists, reflecting differences in laws, public health priorities, and perceived risk.

Evidence is unavailable about the effectiveness of various conspicuity promotional measures, or of laws requiring use of active lighting at increasing use. Raborn et al. (2008) suggest that increased enforcement of laws enhanced by coordinated communications and outreach efforts could heighten awareness among cyclists of the need for using proper lighting and the benefits of retroreflective materials at enhancing conspicuity. Logic suggests that if bicyclists are more noticeable, the frequency and severity of crashes would likely be reduced. With this goal in mind, certain local law enforcement agencies are engaging in community outreach and handing out bicycle safety lights rather than ticketing bicyclists.

Costs: Moderate costs are involved for communications and outreach and for law enforcement training to enforce active lighting laws. Conspicuity-enhancing gear, such as retroreflective wrist and ankle straps, or small active front and back lights, are sometimes distributed for free as part of school and community educational efforts. Additional costs for such materials are modest.

Time to implement: Brochures and flyers for a bicycle safety education campaign highlighting conspicuity can be created quickly. Often an extra line or two about rider conspicuity can be added to existing educational materials and/or reinforced at community events. Several months can be taken up by designing, producing, and implementing the communications and outreach and law enforcement training for enforcing active lighting laws. See Section 3.3 for more on enforcement and available resources.

3.2 Promote Bicycle Helmet Use With Education

Effectiveness: ☆☆	Cost: $$$	Use: Medium	Time: Medium

The purpose of bicycle helmet promotions is to increase the use of helmets and thereby decrease the number of severe and fatal brain injuries to bicyclists involved in crashes. This countermeasure involves conducting single events or extended campaigns to promote helmet distribution and use among children and adults. Promotions can target various barriers to helmet use, including absence of a helmet, child and families' lack of understanding of the importance of helmet use, and negative attitudes or beliefs about helmet use. Programs that provide helmets can include sponsoring organizations and often involve law enforcement and schools to deliver helmets, fit the helmets, and teach proper fitting and use. Bicycle helmet promotions must include teaching adults and children the importance of and how to properly fit the bicycle helmet. Many schools and community centers are able to assist in identifying those families that due to their socioeconomic status or eligibility for lunches, are suitable for free helmets. Other times, helmets can be purchased in bulk and distributed at a lower cost.

Effectiveness Concerns: *This countermeasure has been examined in several research studies. There is some evidence that certain approaches may lead to increased helmet use and more favorable attitudes towards helmet use, especially among children. However, more research is needed to conclude that the countermeasure is effective when broadly targeted towards all cyclists.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A9, Section 3.2.

3.3 Enforcement Strategies

Effectiveness: ☆	Cost: $$	Use: Unknown	Time: Varies

This countermeasure involves promoting traffic safety laws to enhance the safety of bicyclists, including those laws expected of bicyclists and drivers around them. This includes communications and outreach campaigns and by training law enforcement officers about the laws, the safety benefits of obeying the laws, and how to enforce bicycle safety-related laws. The purpose of targeted enforcement is to increase compliance with appropriate traffic laws by both bicyclists and motorists through enforcement of traffic laws for all operators.

Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A9, Section 3.3.

3.4 Motorist Passing Bicyclist Laws

Effectiveness: ☆	Cost: $	Use: Medium	Time: Short

The purpose of bicyclist passing laws is to require motor vehicle drivers to leave at least a legally defined amount of clearance space between the vehicle and the cyclist when overtaking the cyclist. This helps to minimize the likelihood of a sideswipe, and to reduce the chance of a close encounter that could potentially destabilize or divert the course of a cyclist and cause a crash.

Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A9, Section 3.4.

4. Drivers and Bicyclists

4.1 Driver Training

Effectiveness: ☆	Cost: $	Use: Low	Time: Medium

This countermeasure involves enhancing existing driver training or conducting new driver training about sharing the road with bicyclists. The purpose of addressing bicycle safety as part of driver education is to increase the sensitivity of drivers to the presence and characteristics of bicyclists and how to safely share the road with them.

Effectiveness Concerns*:* *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A9, Section 4.1.

4.2 *Share the Road* Awareness Programs

Effectiveness: ☆☆	Cost: $$	Use: Unknown	Time: Medium

The purpose of Share the Road programs is to increase drivers' awareness of bicyclists' rights and the need for mutual respect of bicyclists on the roadway. Campaign education efforts are intented to improve the safety of all raod users, including bicyclists and to enhance the understanding and compliance with relevant traffic laws.

Effectiveness Concerns: *This countermeasure has been examined in a small number of research studies. Although there have been some positive findings, the balance of evidence regarding countermeasure effectiveness remains inconclusive.*

Further information about the known research, potential effectiveness, costs, use, and time to implement is available in Appendix A9, Section 4.2.

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A1. Alcohol and Drug Impaired Driving

This section provides expanded discussion of the ☆ and ☆☆ countermeasures. Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

The ☆ and ☆☆ countermeasures covered in this section of the Appendix are listed below.

3. Deterrence: Prosecution and Adjudication

Countermeasure	Effectiveness	Cost	Use	Time
3.4 Sanctions	☆☆	Varies	Varies	Varies

5. Prevention, Intervention, Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
5.3 Responsible Beverage Service	☆☆	$$	Medium	Medium
5.4 Alternative Transportation	☆☆	$$	Unknown	Short
5.5 Designated Drivers	☆☆	$	Medium	Short

6. Underage Drinking and Drinking and Driving

Countermeasure	Effectiveness	Cost	Use	Time
6.5 Youth Programs	☆☆	Varies	High	Medium

7. Drug-Impaired Driving

Countermeasure	Effectiveness	Cost	Use	Time
7.2 Drug-Impaired Driving Laws	☆	Unknown	Medium†	Short
7.3 Education Regarding Medication	☆	Unknown	Unknown	Long

† Use for drug per se laws

Effectiveness:

☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of States or communities
Unknown: data not available

Time to implement:

Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies.

3. Deterrence: Prosecution and Adjudication

3.4 Sanctions

Effectiveness: ☆☆	Cost: Varies	Use: Varies	Time: Varies

Overall Effectiveness Concerns: *Most of these measures are widely used. Their respective effectiveness has been examined in multiple research studies. Although there have been some positive research findings, the balance of evidence regarding the effectiveness of these countermeasures remains inconclusive.*

The standard court sanctions for DWI offenses are driver's license suspension or revocation, fines, jail, and community service. All States use some combination of these sanctions. Details of each State's laws may be found in NHTSA's *Digest of Impaired Driving and Selected Beverage Control Laws* (NHTSA, 2015). Some States set mandatory minimum levels for some sanctions, which often increase for second and subsequent offenders.

DWI offenders also may have their driver's licenses revoked or suspended administratively and may have sanctions imposed on their vehicles or license plates. See Chapter 1, Section 1.1, Administrative License Revocation or Suspension, and Chapter 1, Section 4.3, Vehicle and License Plate Sanctions, for discussions of these sanctions. See also NHTSA's *Guide to Sentencing DWI Offenders* (NHTSA, 2006) for an overview of sanctions and sentencing practices for judges and prosecutors, with extensive references. The *Guide* also includes screening and brief intervention, alcohol treatment, and DWI courts.

License suspension or revocation: All States allow post-conviction license actions. As of 2013, 22 States and the District of Columbia set mandatory minimum lengths for first offenders (NHTSA, 2015). This suspension or revocation typically runs concurrently with any administrative license action. In most States, offenders may obtain an occupational or hardship license during part or all of the revocation or suspension period.

Although *administrative* license actions are highly effective in reducing crashes (see Chapter 1, Section 1.1), *court-imposed* license actions appear less effective. A study of 46 States found that post-conviction license suspension had no discernible effects on alcohol-related fatal crashes (Wagenaar & Maldonado-Molina, 2007). As discussed in Chapter 1, Section 1.1, some DWI offenders continue to drive with a suspended or revoked license, and many DWI offenders do not reinstate their license when they are eligible to do so. Consequently, long court-imposed license suspensions may do little to reduce recidivism. Instead, it may be important to encourage DWI offenders to reinstate their licenses, but with appropriate controls such as ignition interlocks (Section 4.2) and close monitoring (Section 4.4).

Fines: Most States impose fines on DWI offenders. As of 2013, there were 29 States and the District of Columbia that had mandatory minimum fines for first offenders, ranging from $100 (West Virginia) to $1,500 (Alaska) (NHTSA, 2015). In addition to fines, offenders often face substantial costs for license reinstatement, mandated alcohol education or treatment, insurance rate increases, and legal fees. Available evidence suggests that fines appear to have little effect on reducing alcohol-impaired driving. For example, Wagenaar et al. (2008) examined alcohol-related fatal crashes across 32 States and concluded that mandatory fines “do not have clearly demonstrable general deterrent or preventive effects” (p. 992). Another study from Australia found the size of fines was unrelated to recidivism rates among DWI offenders (Weatherburn & Moffatt, 2011). Even though fines may not reduce alcohol-impaired driving, they do help support the system financially.

Jail: All States allow some DWI offenders to be sentenced to jail. The length of sentences varies by State and often depends on the number of prior convictions, the driver’s BAC level, whether the crash resulted in an injury or fatality, whether a child passenger was present (child endangerment laws), and a number of other factors. Additionally, some States allow community service in lieu of jail. Details of each State’s laws may be found in NHTSA’s *Digest of Impaired Driving and Selected Beverage Control Laws* (NHTSA, 2015).

Jail is the most severe and most contentious of the DWI sanctions. Jail is expensive. For example, in Ohio, it is estimated to be $20,267 per inmate per year (Century Council, 2008). Judges and prosecutors may be reluctant to use limited jail space for DWI offenders rather than “real” criminals. Offenses with mandatory jail terms may be pled down, or judges simply may ignore the mandatory jail requirement (Robertson & Simpson, 2002).

Research on the effectiveness of jail is equivocal at best (Voas & Lacey, 2011, pp. 215-216; NTSB, 2000). Very short (48-hour) jail sentences for first offenders may be effective (NTSB, 2000) and the threat of jail may be effective as a deterrent (as is done in DWI and drug courts), but other jail policies appear to have little effect. Wagenaar et al. (2000) reviewed 18 studies and concluded: “The balance of the evidence clearly suggests the ineffectiveness of mandatory jail sentence policies” (p. 12). In fact, they find “numerous studies that indicate that [mandatory jail] might be a counterproductive policy” (p. 12) that increases alcohol-related crashes.

Community service: Many States allow community service as part of a DWI offender’s sentence and 11 States allow community service in lieu of mandatory jail for first-time offenders (NHTSA, 2015). Community service can provide benefits to society if offenders perform useful work, but even if appropriate jobs can be found there are costs for program operation, offender supervision, and liability. The effects of community service programs on alcohol-impaired driving have not been evaluated (Century Council, 2008).

Victim Impact Panels: DWI offenders are often required to attend a Victim Impact Panel, in which offenders hear from people whose lives have been permanently altered by an impaired driver. Each year, an estimated 400,000 offenders attend Victim Impact Panels, conducted by more than 200 MADD chapters across the United States (Voas & Lacey, 2011). Although Victim Impact Panels are intuitively appealing, most studies suggest they do not reduce recidivism (Crew & Johnson, 2011; deBaca, Lapham, Liang, & Skipper, 2001; Shinar & Compton, 1995; Wheeler, Rogers, Tonigan, & Woodall, 2004).

5. Prevention, Intervention, Communications and Outreach

5.3 Responsible Beverage Service

Effectiveness: ☆☆	Cost: $$	Use: Medium	Time: Medium

Overall Effectiveness Concerns: *This countermeasure's effectiveness has been examined in several research studies; however, server training programs are the only segment of responsible beverage service for adults that has been adequately documented and evaluated. Research suggests that server training programs can be effective if they involve intensive, high-quality, face-to-face server training that is accompanied by strong and active management support (Shults et al. 2001). When server training programs are not intensive and are not supported, they are unlikely to result in greater refusals of service to intoxicated patrons. Despite these positive research findings, the balance of evidence regarding countermeasure effectiveness remains inconclusive.*

Responsible beverage service covers a range of alcohol sales policies and practices that prevent or discourage restaurant and bar patrons from drinking to excess or from driving while impaired by alcohol. Server training programs teach servers how to recognize the signs of intoxication and how to prevent intoxicated patrons from further drinking and from driving. Management policies and programs include limits on cheap drinks and other promotions, support for designated driver programs, strong commitment to server training, and strong support for servers who refuse alcohol to intoxicated patrons. NCHRP (2005, Strategy A2) provides an overview of responsible beverage service. See also Wagenaar and Tobler (2007) and Voas and Lacey (2011; pp. 131-137) for reviews and discussion of the research literature on this issue.

Beginning in the early 1980s, a major effort was undertaken to encourage alcohol servers to comply with laws prohibiting the sale of alcoholic beverages to visibly intoxicated patrons. Since that time, many "server intervention" programs have been developed as a means of securing more responsible behavior on the part of servers. Some States have mandatory programs that require at least some alcohol retail employees to attend a server training course. Other States have voluntary programs that provide incentives for retailers to participate (e.g., liability protection or insurance discounts). The quality of server training programs can vary considerably. Wagenaar and Tobler (2007) note that many server training laws "are not optimally designed, do not ensure quality training, and do not ensure all servers are consistently trained, or retained periodically" (p. 158).

Server training programs are the only segment of responsible beverage service for adults that has been documented and evaluated well. Activities directed at people under 21 are discussed separately in Chapter 1, Sections 6.1 through 6.4.

Use: As of 2005, there were 17 States that had some form of mandatory server training program in place; another 15 States had voluntary programs (Wagenaar & Tobler, 2007).

Effectiveness: The findings on the effectiveness of server training have been mixed. In their systematic review, Shults et al. (2001) found five high-quality evaluations of server training programs. They concluded that "intensive, high-quality, face-to-face server training, when accompanied by strong and active management support, is effective in reducing the level of intoxication in patrons" (p. 80). When server training programs are not intensive and are not supported, they are unlikely to result in greater refusals of service to intoxicated patrons.

Few studies have examined the effect of server training on alcohol-impaired crashes. An evaluation of a statewide server training program in Oregon found a 23% reduction in single-vehicle nighttime injury crashes following the program (Holder & Wagenaar, 1994). However, Molof and Kimball (1994) reviewed the same Oregon program and observed no decline in alcohol-related fatalities.

Costs: A typical alcohol server course takes about four to eight hours. Course costs can be borne by the servers themselves, their employers, or the State.

Time to implement: Server training courses are offered by several private vendors and can be implemented in a few weeks. A statewide requirement for server training or more general responsible beverage service policies would require time to enact any necessary legislation, establish policies, and provide for program administration.

Other issues:

- **Program quality:** The quality of responsible beverage service programs can vary enormously, from excellent to abysmal. Management support can vary from enthusiastic to nonexistent. Shults et al. (2001) clearly limit their conclusions to high-quality programs with strong management support. The Alcohol Epidemiology Program (2000) cites several server training program evaluation studies that found no effect and notes that these programs may have been poorly supported or implemented. Grube and Stewart (2004) emphasize that management policy and its implementation may be at least as important as server training in determining responsible beverage service program effectiveness.
- **Dram shop laws:** As of 2013, there were 41 States that allow people injured by an intoxicated driver to recover damages from the licensed establishment that served or sold the alcohol in at least some situations (NHTSA, 2015). The potential threat of legal liability can provide strong encouragement to retailers to adopt responsible beverage service policies and practices. Research shows the implementation of dram shop laws is associated with reductions in alcohol-related crashes and fatalities (Voas & Lacey, 2011; Scherer, Fell, Thomas & Voas, 2015).
- **Enforcement of responsible beverage service:** Enforcement of alcohol service laws is key, but largely lacking. Mosher et al. (2009) identified three main reasons for this: (1) a lack of societal and political will to address violations; (2) limited resources for enforcement operations; and (3) statutory provisions that make collection of evidence overly burdensome. As a result, action against licensed establishments has historically been limited to case law action involving serious crashes. Although alcohol enforcement by police is almost exclusively directed toward drivers, research has demonstrated that enforcement of alcohol service laws can help ensure alcohol retailers follow responsible serving practices. For example, an enforcement program in Michigan resulted in a three-fold increase in refusals of service to "pseudo-patrons" who simulated intoxication

(McKnight & Streff, 1994).

- **"Last Drink" programs:** The goal of Last Drink programs is to determine where someone who was apprehended for impaired driving consumed their last drink prior to the arrest. This information is then provided to licensing authorities who may issue a warning letter to the retail establishment or take disciplinary action. An evaluation of a last drink program in Washington State found mixed results. No change was observed in retail establishment practices, but there were reductions in impaired-driving arrests and lower BAC levels among arrested drivers in the intervention community (Ramirez, Nguyen, Cannon, Carmona, & Freisthler, 2008). Similar pilot programs have been tried in Australia, Canada, and New Zealand, although effectiveness data is lacking.

5.4 Alternative Transportation

Effectiveness: ☆☆	Cost: $$	Use: Unknown	Time: Short

Overall Effectiveness Concerns: *This countermeasure has only been examined in a few studies. Although some of the studies report reductions in crash rates, there is insufficient evaluation data available to conclude that the countermeasure is effective.*

Alternative transportation describes methods by which people can get to and from places where they drink without having to drive. Alternative transportation supplements normal public transportation provided by subways, buses, taxis, and other means.

Ride service programs transport drinkers home from, and sometimes to and between, drinking establishments using taxis, private cars, buses, tow trucks, and even police cars. Some will drive the drinker's car home along with the drinker. Most operate only for short periods of the year, such as the Christmas and New Year's holidays. Many are free; some charge users a minimal fee; some are operated commercially on a for-profit basis. Ride service programs are relatively inexpensive and easy for communities to implement. Although it can be difficult to measure the effectiveness of these programs, they can play a role in a community's efforts to reduce drinking and driving. For an overview, see Decina, Foss, Tucker, Goodwin, and Sohn (2009) and Neuman, Pfefer, Slack, Hardy, and Waller(2003, Strategy E1).

Use: During the 1980s there were 325 programs in operation in 44 States and the District of Columbia (Harding, Apsler, & Goldfein, 1987). There is limited information on ride service programs currently in operation, although some data is available on the NHTSA Buzzed Driving Facebook page: www.facebook.com/buzzeddrivingisdrunkdriving.

Effectiveness: Three studies have evaluated ride service programs. The first examined one year-round program and one holiday program. Both functioned smoothly and delivered rides, but neither demonstrated any effect on crashes (Molof et al., 1995). The second study examined a year- round program in Aspen, Colorado, and concluded that it reduced injury crashes in the surrounding county by 15% (Lacey, Jones, & Anderson, 2000). Finally, a program using older luxury vehicles in Wisconsin that provided rides to and from bars resulted in a 17% decline in alcohol-related crashes during the first year (Rothschild, Mastin, & Miller, 2006). The program became largely self-sustaining through fares and tavern contributions. These three programs and others are summarized in Decina et al. (2009). After reviewing select programs, Decina et al. (2009) concluded that a model alternative transportation program (i.e., one that reduces alcohol-related crashes) should be continually available, free to users, and convenient and easy to use.

Costs: The major ride service program costs are for the rides that are provided. Short-term ride service programs can be operated largely with donated rides. Year-round programs need enough steady funding to accommodate demand (Neuman, Pfefer, Slack, Hardy, and Waller, 2003, Strategy E1).

Time to implement: Short-term ride service programs can be established and operated informally in a few weeks. Longer-term programs need to establish long-term strategies for funding and managing the program.

5.5 Designated Drivers

Effectiveness: ☆☆	Cost: $	Use: Medium	Time: Short

Overall Effectiveness Concerns: *The countermeasure effectiveness has been examined in a few research studies. There have been some positive research findings in terms of driver awareness of the countermeasure. However, the balance of evidence regarding the effectiveness of this countermeasure in reducing crashes remains inconclusive.*

Designated drivers are people who agree not to drink so they can drive their friends who have been drinking. Formal designated driver programs in drinking establishments provide incentives such as free soft drinks for people who agree to be designated drivers. Usually, though, designated driver arrangements are completely informal. Designated driver programs focus on specific actions taken at drinking establishments, which contrast with designated driver mass media campaigns that seek to raise awareness of this countermeasure and promote its informal use among the general driving population (see Section 5.2)

The designated driver concept has been questioned on two grounds: (1) designated drivers may still drink, though perhaps less than the passengers; and (2) it may encourage passengers to drink to excess. In a national roadside survey, Fell, Voas, and Lange (1997) found self-identified designated drivers were more likely to have a positive BAC in comparison to all drivers on the road. Also, some designated drivers had very high BACs, especially those coming from bars. Apparently, some groups of drinkers had selected the designated driver near the *end* of a night of drinking. To be effective, Voas and Lacey (2011) argue the designated driver must be chosen before the drinking begins, and must be willing to abstain (or substantially limit) his or her drinking.

Use: The designated driver concept is widely understood and accepted. Surveys show that designated driver use is common. In NHTSA's general population survey of 7,000 people, 44% said they had served as a designated driver during the past year, and 33% reported riding with a designated driver (Moulton et al., 2010).

Effectiveness: Because designated drivers are informally determined and somewhat imprecisely defined, it's no surprise there is little data on the impact of designated drivers on crashes. CDC's systematic review found insufficient evidence to determine the effectiveness of designated driver programs (Ditter et al., 2005). A review from Australia concluded that designated driver programs can successfully increase awareness and use of designated drivers, but evidence for changes in alcohol-related crashes is inconclusive (Nielson & Watson, 2009). However, the authors note the lack of supporting evidence "does not necessarily mean that such programs should be discouraged. On the contrary, it highlights the need for them to be better implemented and evaluated" (Nielson & Watson, 2009, p.36).

The "Skipper" designated driver program in Queensland, Australia is a good example of a partially successful program. The program provides free soft drinks to persons who agree to stay sober and serve as designated drivers. The program was pilot tested in 41 venues, and was heavily advertised through radio, earned media, and on-premise promotions. Self-report surveys showed awareness for the program was very high, and the proportion of respondents who reported acting as, or using, a designated driver increased after the program was implemented. However, roadside surveys found no change in the proportion of drivers who had been drinking, and there were no changes in alcohol-related crashes (Watson & Watson, 2014).

Costs: The only costs associated with informal designated driver programs are for publicity. Designated drivers can be promoted independently or can be included with other impaired-driving publicity. Establishments that operate formal designated driver programs have minimal costs for the drinks provided and for publicity.

Time to implement: Designated driver promotion can be implemented in a few weeks and formal programs can be established equally quickly.

6. Underage Drinking and Drinking and Driving

6.5 Youth Programs

Effectiveness: ☆☆	Cost: Varies	Use: High	Time: Medium

Overall Effectiveness Concerns: *This countermeasure has been examined in several research studies. Although there have been some positive research findings, the balance of evidence regarding countermeasure effectiveness remains inconclusive.*

States and communities have conducted extensive youth drinking-and-driving-prevention programs over the past 25 years. These programs seek to motivate youth not to drink, not to drink and drive, and not to ride with a driver who has been drinking. Although some programs use scare tactics, many employ positive messages and methods: providing positive role models that discourage alcohol use, promoting positive norms that do not involve alcohol, and encouraging youth activities that do not involve or lead to alcohol use.

The best-known youth program is associated with SADD, founded in 1981 as Students Against Driving Drunk, then renamed Students Against Destructive Decisions (SADD). SADD currently has nearly 10,000 chapters in the United States, with approximately 350,000 active student members (SADD, 2014). Some States conduct similar activities under different names, such as Students Taking a New Direction (STAND) in Colorado and Stopping Automobile Fatalities Through Youth Efforts (SAFTYE) in Washington State. One specific activity, operated either by a youth program or independently, is Project Graduation, which provides alcohol-free prom and graduation parties for high school students. See Hedlund et al. (2001) for brief examples of State programs.

A more recent type of approach focuses on "social norms" or "normative feedback." Social norms programs are based on studies showing that students often overestimate alcohol use among their peers. By providing students with accurate information about drinking, social norms programs reduce the pressure that light- or non-drinkers feel to drink, and help heavier drinkers realize their drinking is atypical (Perkins, 2002, 2003). Although many social norms programs focus on alcohol or other substance use, a few have addressed drinking and driving. Examples of social norms programs can be found at the National Social Norms Institute (www.socialnorms.org).

Brief interventions involve the use of various therapeutic components for a short duration to potentially reduce DWI, or driving after drinking in young adults and adolescents. An example intervention might include highlighting the perceived costs and benefits of alcohol consumption, providing opportunities to discuss options for moderating alcohol consumption, and providing personalized BAC charts based on the participant's height and weight. For more information on brief interventions, see Chapter 1, Section 5.1.

Use: Youth programs of some type are conducted in most, if not all, States.

Effectiveness: CDC's systematic review found there was insufficient evidence to determine the effectiveness of youth programs (Elder et al., 2005). Two studies have attempted to evaluate SADD's activities and effects. One study, in two schools, found that neither school implemented the model SADD program well and found no evidence of effects on any drinking and driving measure. The second study, in 6 schools, found that SADD activities affected drinking and driving attitudes as well as self-reported drinking and driving (Hedlund et al., 2001).

One study has examined the long-term effects of a social norms program on drinking and driving. Breath samples were taken from students at a large public university as they returned home late at night. Following the social norms program, there was a marginally significant decrease in drivers who registered positive BACs, from 15.3% to 10.8%. Among drivers who had been drinking, self-reported number of drinks consumed and measured BACs decreased, as did the number of drinking-drivers who reported having five or more drinks at one sitting on the night of the survey (Goodwin, 2004).

Costs: Youth program costs can vary substantially depending on the size and nature of the individual activities. States have spent substantial funds, both Federal and non-Federal, on youth drinking-and-driving programs. These funds have been used for a variety of youth education, enforcement, and program activities.

Time to implement: With model programs available and organizations such as SADD and MADD available for assistance, youth programs can be started easily in six months.

Other Issues:

- **Other programs aimed at youths:** There are a wide variety of programs that are directed at youths. To increase the perceived risks of drinking and driving, many schools have employed fatal vision goggles, peer-to-peer programs, role plays, or drunk-driving crash reenactments (e.g., "Every 15 Minutes"). Although popular, the vast majority of these programs have not been evaluated. The few existing studies suggest these types of programs may produce changes in knowledge or attitudes, but have little or no effect on behaviors (Hover, Hover, & Young, 2000; Jewell & Hupp, 2005). Broader community-based programs have had much greater success at reducing drinking and driving among youth than standard education programs (see Chapter 1, Section 6.4).
- **Mandatory education for young offenders:** Young people who violate zero-tolerance or MLDA-21 laws are often required to attend an alcohol or traffic safety education program. Unfortunately, these programs often fail to produce positive outcomes. For example, Rhode Island's *Reducing Youthful Dangerous Driving* program was mandated for youths 16- to 20 years old who received driving citations or who had substance-related offenses. The 20-hour program consisted of four group sessions and two emergency department visits. Twelve months following the program, there was no difference between program participants and a comparison group in terms of high-risk driving behaviors and traffic citation recidivism (Baird, Nirenberg, Longabaugh, & Mello, 2013).

7. Drug-Impaired Driving

7.2 Drug-Impaired-Driving Laws

Effectiveness: ☆	Cost: Unknown	Use: Medium†	Time: Short

†Use for drug per se laws

Overall Effectiveness Concerns: *To date, there have been no evaluations of the effect of drug-impaired-driving laws on the prevalence of drug-impaired driving or crashes.*

Although most States have laws that prohibit the use of impairing drugs by drivers, there is a great deal of variability in how States approach this issue. In some States, impairment-based statutes stipulate that prosecution must prove the driver was impaired (for example, by driving recklessly or erratically). Other States have per se laws in which it is illegal to operate a motor vehicle if there is any detectable level of a prohibited drug in a driver's system. Hence, a positive drug test is sufficient for conviction. This is equivalent to "zero tolerance."

Lacey, Brainard, and Snitow (2010) conducted interviews with law enforcement officers, prosecutors, and other traffic safety professionals in States with per se laws. Most were supportive of such laws. Although they did not believe per se laws made enforcement easier, they reported these laws had a positive effect on the prosecution and conviction of drug-impaired drivers. Moreover, discussions with officers and prosecutors in States *without* per se laws also revealed relatively high conviction rates, with few cases reaching trial (Lacey, Brainard, & Snitow, 2010).

NHTSA's Report to Congress includes a model drug-impaired-driving law (Compton, Vegega, & Smither, 2009). Because the relationship between blood levels of drugs and driving impairment has not been established for drugs other than alcohol, the model law does not include a per se provision. However, NHTSA recommends States include enhanced penalties for drivers who are under the influence of multiple drugs (including alcohol). In addition, NHTSA recommends State statutes provide separate and distinct sanctions for alcohol- and drug-impaired-driving (Compton et al., 2009).

For a detailed discussion of issues related to drug-impaired-driving laws, see DuPont et al. (2012). The authors make a number of recommendations including improvement of drug testing technology, enactment of laws requiring drug testing of all drivers in injury crashes, and adding drug use to underage zero-tolerance laws. See also Reisfeld, Goldberger, Gold, and DuPont (2012) for arguments in favor of per se laws for drug-impaired driving and a discussion of the challenges of establishing impaired drug thresholds equivalent to a .08 g/dL BAC. Finally, see NHTSA (2007) for recommendations to improve the prosecution of drug-impaired-driving cases.

Use: As of 2017, there were 16 States that had per se laws that forbid the presence of any prohibited drug while a driver is in control of a vehicle (GHSA, 2017). In addition, Oklahoma passed an additional per se law provision in 2013 allowing a driver to be charged with impaired driving if any amount of Schedule I chemical or controlled substance or their metabolites or analogs is found in the driver's blood, saliva, urine, or other bodily fluids within two hours of arrest (NCSL, 2014). In addition, North Carolina and South Dakota have per se laws that apply only to those younger than 21, and five States (California, Colorado, Idaho, Kansas, and West Virginia) have made it illegal for drug addicts or habitual drug users to drive vehicles (Lacey, Brainard, & Snitow, 2010). More information about the drug-impaired-driving laws in each State can be found in Lacey et al. (2010), NCSL (2014), and Walsh (2009).

Effectiveness: Lacey et al. (2010) tried to determine whether drug per se laws increased drug-impaired-driving arrests and convictions. However, they were hampered by the fact that States do not record drug-impaired offenses separately from alcohol-impaired offenses. To date, there have been no evaluations of the effect of drug-impaired-driving laws on the prevalence of drug-impaired driving or crashes.

Costs: The costs of drug-impaired-driving laws will depend on the number of offenders detected and the penalties applied to them.

Time to implement: Drug-impaired-driving laws can be implemented as soon as appropriate legislation is enacted, although time will be needed to train law enforcement officers, prosecutors, and judges about the new legislation and to inform the general public.

Other issues:

- ***Per se* laws and prescription medications:** Some States with per se laws for drug-impaired driving exclude prescription medications from the list of prohibited drugs. Others require the driver to provide a valid prescription to avoid being charged or convicted for drug-impaired driving. Using a medication as prescribed, however, can lead to impairments in driving ability. For that reason, it is important that warning labels include information about the risks of using medications while driving. Also, physicians and pharmacists should counsel patients about driving risks, as appropriate. See Chapter 1, Section 7.3 for more information about patient education regarding medications. See also Voas, DuPont, Shea, and Talpins (2013) for a discussion of issues related to per se laws and prescription medications.
- **Drug testing of fatally injured drivers:** Driver drug use is not reported in all fatal crashes. Moreover, laboratories are inconsistent with drugs they test, results they report, and the thresholds for determining a positive test result. To better understand and track the drug-impaired-driving problem in the United States, improved data and data collection on drug-impaired drivers is needed. Logan et al. (2013) describe minimum recommendations for toxicological investigation of fatal motor vehicle crashes.
- **Public support:** There is strong approval among the general public for laws that prohibit drug-impaired driving. A 2013 survey by the AAA Foundation for Traffic Safety found that 80% of drivers support per se laws for marijuana (AAA Foundation, 2014).

7.3 Education Regarding Medications

Effectiveness: ☆	Cost: Unknown	Use: Unknown	Time: Long

Overall Effectiveness Concerns: *This countermeasure has only been examined in a few studies. Although some of the studies report increased awareness by pharmacists of the effects of medication, there is no evidence of increased awareness among drivers. Overall, there is insufficient evaluation data available to conclude that the countermeasure is effective.*

Some medications prescribed by a doctor can pose a risk for drivers. It is important that physicians, pharmacists, and patients receive information about the potential risk of motor vehicle crashes associated with certain medications. Perhaps the simplest way to achieve this would be through clear warning labels on packages. The European Union has developed a warning label system as part of the DRUID program (Driving Under the Influence of Drugs, Alcohol and Medicines). The system has four categories:

0. No warning.
I. Be careful: Read the patient leaflet carefully before driving.
II. Be very careful: Seek advice from a physician or pharmacist before driving.
III. Danger – Do not drive: Seek medical advice before driving again.

Entire classes of drugs may be classified in a particular category. For example, all hypnotic drugs are classified as category III. The system also includes a pictogram on the medication packaging warning the patient not to drive when taking the medication. Any labeling scheme in the United States would need to be systematic. Presently, labeling is inconsistent and dependent on the individual pharmacy/pharmacist.

The International Council on Alcohol, Drugs, and Traffic Safety has developed a categorization system for medicinal drugs that can affect driving performance (ICADTS, 2007). The list was intended for physicians and pharmacists so they could better identify medications that could impair driving skills and look for safer alternatives when possible. In 2008 and 2009, NHTSA convened an expert panel to develop a list of medications (or classes of medications) that may be "safe" for driving; however, the panel found inadequate information about specific medications to develop such a list (Kay & Logan, 2011).

The effects of medications on driving are a particular concern with older drivers. Nearly 70% of people 55 and older use at least one prescription medication that could potentially impair driving (MacLennan, Owsley, Rue, & McGwin, 2009). In addition, research shows that older drivers taking three or more impairing medications are 87% more likely to be involved in a crash (LeRoy & Morse, 2008).

For reviews on medications and road safety, see de Gier (2006) and Vandrevala, Helman, Turner, and Stone (2010).

Use and Effectiveness: There is little information available on how frequently this countermeasure is used in the United States, or how effective it has been in raising awareness, increasing knowledge, or changing behavior. NHTSA has worked with Walgreens, the country's largest drugstore chain, to develop a curriculum for pharmacists on medication-impaired driving.

The curriculum includes modules that cover potentially driver-impairing prescription drugs, laws relating to medication use and DWI, and the role of pharmacists in counseling patients regarding medications and driving risk. A pilot test with 640 pharmacists showed the curriculum was effective in increasing pharmacists' knowledge of medication-related impaired driving (Lococo & Tyree, 2007).

Legrand, Boets, Meesman, and Verstraete (2012) tested several methods of training and administering the DRUID system with pharmacists in Belgium. Following training, more pharmacists reported being aware of the effects of medications on driving, and more pharmacists talked with their patients about driving-related risks. The results were strongest among pharmacists who had the DRUID system integrated into their existing computer software for dispensing medications.

Studies with patients have been less encouraging. Smyth, Sheehan, and Siskind (2013) conducted interviews with patients who were using medications that could influence their driving. Half (49%) did not recall seeing the warning label on the medication. Instead, there was a high level of confidence among patients that they could determine themselves whether it was safe to drive. Monteiro, Huiskes, Van Dijk, Van Weert, & De Gier (2013) investigated the effectiveness of pictograms in communicating the degree of driving risk associated with certain medications. It was apparent that many patients failed to fully understand what was being conveyed by pictograms, and often misjudged how risky it would be to drive while taking the medication.

Costs: Targeted education to physicians and pharmacists (through drug categorization systems) and to drivers (through warning labels) would be needed. The former would likely be the more costly.

Time to implement: Targeted communications could require a year or more to plan, produce, and distribute.

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A2. Seat Belts and Child Restraints

There are no ☆ or ☆☆ countermeasures in this program area.

A3. Speeding and Speed Management

This section provides expanded discussion of the ☆ and ☆☆ countermeasures. Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

The ☆ and ☆☆ countermeasures covered in this section of the Appendix are listed below.

1. Laws

Countermeasure	Effectiveness	Cost	Use	Time
1.2 Aggressive Driving and Other Laws	☆	$	Low	Short

2. Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
2.2 High-Visibility Enforcement	☆☆	$$$	Low†	Medium
2.3 Other Enforcement Methods	☆☆	Varies	Unknown	Varies

† For aggressive driving, but use of short-term, high-visibility enforcement campaigns for speeding is more widespread

3. Penalties and Adjudication

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Penalty Types and Levels	☆☆	Varies	High	Low
3.2 Diversion and Plea Agreement Restrictions; Traffic Violator School	☆	Varies	Unknown	Varies

Effectiveness:

☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Laws

1.2 Aggressive Driving and Other Laws

Effectiveness: ☆	Cost: $	Use: Low	Time: Short

Overall Effectiveness Concerns: *There is currently no evidence that aggressive driving laws in general, or increased penalties in particular, affect aggressive driving and related crashes.*

Aggressive driving actions are covered by specific traffic laws, such as the laws regarding speeding, improper lane changes, and following too closely, or by general laws, such as those that target reckless driving. Most existing reckless driving statues carry relatively minor penalties and may be difficult to prosecute according to NHTSA (NHTSA, 2001a). Aggressive drivers, as distinct from aggressive driving, often can be identified as those who violate traffic laws repeatedly or whose violations lead to crashes producing serious injury or death. Therefore, the primary traffic law strategy to address aggressive driving is to assure that more severe penalties are available for repeat offenders and for violations causing death or serious injuries. Existing statutes, including reckless driving laws, may be strengthened or aggressive driving laws may be enacted.

NHTSA's 1999 Symposium on Aggressive Driving and the Law recommended that States implement laws targeting aggressive drivers by providing for:

- enhanced penalties for repeat offenders, including increased driver's license points, license suspension or revocation, higher fines, and jail or probation; and
- felony charges for violations resulting in serious injury or death (NHTSA, 2001a).

NHTSA also developed a model statute that defines aggressive driving as three moving violations in a single driving incident and a number of States have adopted similar laws; however, aggressive driving violations may be difficult to enforce and prosecute (Flango & Keith, 2004). The NCHRP Aggressive Driving Guide also suggests a strategy of applying increased sanctions and treatment for repeat offenders and serious offenses (Neuman et al., 2003, Strategy A3).

Use: In general, States provide for increased penalties for repeat offenders and for violations with serious consequences. Eleven States have aggressive driving laws (GHSA, 2015a).

Effectiveness: There is as yet no evidence for whether aggressive driving laws in general, or increased penalties in particular, affect aggressive driving and related crashes. See Chapter 3, Section 3.1 for a discussion of the effects of driver improvement actions in general.

Costs: The only immediate costs of the recommended law changes are to publicize the new or altered laws. Additional costs may result as drivers are sentenced to more costly sanctions.

Time to implement: Law changes can be implemented quickly, once legislation is passed and publicized.

Other issues:

- **Public acceptance, enforcement, and publicity:** Law changes by themselves cannot reduce aggressive driving. Traffic laws in general and aggressive driving laws in particular are essential to, but only a part of, a system that includes broad public acceptance, active enforcement, effective adjudication, and publicity (NHTSA, 2001a).
- **Record-keeping:** Information on prior convictions of offenders must be up-to-date and available to prosecutors and court officials so that repeat and flagrant violators may be prosecuted in keeping with the strategy to increase sanctions for these offenders. Providing the technology and ability for patrol officers to obtain up-to-date driver history information at the time of traffic stops is another strategy recommended to deal with drivers with suspended or revoked licenses who continue to violate traffic laws (Neuman, Pfefer, Slack, Hardy, & Waller, 2003b).

2. Enforcement

2.2 High-Visibility Enforcement

Effectiveness: ☆☆	Cost: $$$	Use: Low-Medium†	Time: Medium

† Use is low for aggressive driving, but use of short-term, high-visibility enforcement campaigns for speeding is more widespread

Overall Effectiveness Concerns: *This countermeasure has been examined in several research studies. Overall, the findings regarding countermeasure effectiveness are inconclusive. While some studies suggest that high-visibility, anti-speeding and aggressive driving enforcement campaigns produce some safety-related benefits, other comparable studies show no benefits or even negative outcomes.*

High-visibility enforcement campaigns have been used to deter speeding and aggressive driving through both specific and general deterrence. In the high-visibility enforcement model, law enforcement targets selected high-crash or high-violation geographical areas using either expanded regular patrols or designated aggressive driving patrols. This model is based on the same principles as high-visibility seat belt and alcohol-impaired-driving enforcement: to convince the public that speeding and aggressive driving actions are likely to be detected and that offenders will be arrested and punished (see Chapter 1, Alcohol-Impaired Driving, Sections 2.1 and 2.2, and Chapter 2, Seat Belt Use, Section 2.1).

In the high-visibility enforcement model, officers focus on drivers who commit common aggressive driving actions such as speeding, following too closely, and running red lights. Enforcement is publicized widely. The strategy is very similar to saturation patrols directed at alcohol-impaired drivers (Chapter 1, Section 2.2). Because speeding and aggressive driving are moving violations, officers cannot use checkpoints. Rather, they must observe driving behavior on the road.

NHTSA's *Aggressive Driving Enforcement: Strategies for Implementing Best Practices* (NHTSA, 2000) provides brief descriptions of 12 aggressive driving enforcement programs from around the country. A few examples:

- The Albuquerque, New Mexico, Safe Streets program used saturation patrols in four high-crash and high-crime areas, writing tickets when infractions were observed. At about the midpoint of the program, traffic enforcement focus was shifted from the high crime neighborhoods to high crash corridors and intersections. On freeways, they observed speeding and aggressive driving from a "cherry picker" platform and radioed to patrol officers. See www.nhtsa.gov/people/injury/enforce/safestreets/index.htm for more information including some measures of program effects.
- The greater Washington, DC, area multi-agency Smooth Operator program uses shared publicity and coordinated enforcement waves with marked and unmarked patrol vehicles as well as nontraditional vehicles. This program provides a website link where the public can report observed instances of aggressive driving: (www.smoothoperatorprogram.com/aggressive_reporting.html). Also see the District's web page about the program (http://mpdc.dc.gov/node/208412). The State of Maryland

also participates in Smooth Operator (see Sprattler, 2012).
- The Washington State Patrol's Enforcement Target Zero Program involves State troopers, county sheriff's deputies and city and tribal police officers collaborating to focus on those violations proven to cause fatal or serious injury collisions. The program uses mapping to target resources and experienced officers and training on completing investigations and arrest reports to assist with prosecution. See www.wsp.wa.gov/targetzero/targetzero.htm for more information.

See a few other examples of high-visibility speed and aggressive driving enforcement programs in GHSA's Survey of the States: Speeding and Aggressive Driving (2012), and NHTSA's *Aggressive Driving Programs* (NHTSA, 2001b).

Use: High-visibility speed enforcement campaigns are common, with most States providing some funding for speed equipment (47 States and Guam), overtime enforcement (42 States and Guam), or speed public information campaigns (31 States and Guam) (Sprattler, 2012). Relatively few States fund aggressive driving-related equipment or enforcement (six States; Sprattler, 2012) and it is likely that high-visibility aggressive driving enforcement campaigns are not common. Neuman et al. (2003, Strategy A1) provide a few examples of aggressive driving enforcement programs.

Effectiveness: Moon and Hummer (2010) estimated that 8 to 9% of the total and injury crash reduction effects of around 25% associated with an automated mobile, speed enforcement program in Charlotte, NC, were attributable to media coverage of the program. In addition to results from automated camera enforcement programs (see Section 2.1), which typically incorporate a significant amount of publicity and media coverage (see section 4.1), some crash-based effectiveness evidence comes from NHTSA demonstrations in three communities. All three demonstrations lasted 6 months and included extensive publicity but differed in other respects. Milwaukee was the most successful. Red-light running decreased at targeted intersections. Crashes in the city dropped by 12% in targeted corridors and by 2% in comparison corridors (McCartt, Leaf, Witkowski, & Solomon, 2001). The Indianapolis demonstration was not a success. Average speeds dropped slightly. Total crashes *increased* 32% over the previous year. Crashes increased *more* in the demonstration area than in other areas, and the proportion of crashes involving aggressive driving behaviors also increased in the demonstration areas (Stuster, 2004). Tucson had mixed results. Average speeds dropped moderately. Total crashes *increased* 10% in the demonstration areas and *decreased* in comparison areas. However, the proportion of crashes involving aggressive driving behaviors decreased by 8% in the demonstration areas (Stuster, 2004).

Several studies have reported reductions in crashes or reductions in speeding or other violations attributed to both general and targeted high-visibility speed enforcement campaigns. Although the evidence is not conclusive, the trends are promising. These efforts have included a substantial increase in general traffic enforcement in Fresno, California (Davis et al., 2006), and a community-based high-visibility speed enforcement campaign, entitled *Heed the Speed*, in the Phoenix, Arizona-area that aimed to reduce pedestrian crashes and injuries (Blomberg & Cleven, 2006). No particular publicity measures were noted for the Fresno campaign, but it is likely that the increase from 20 to 84 traffic patrol officers, the addition of 20 new police motorcycles and radar guns, and more than 3-fold increase in citations in two years generated some publicity. Publicity measures for the *Heed the Speed* campaign included street and yard signs, educational material and active participation of neighborhood groups. Speed reductions were greatest in neighborhoods where new vertical traffic calming measures were also installed (Blomberg & Cleven, 2006; also see a *Traffic Tech* summary, NHTSA, 2006).

A recent effort to scale-up the Heed the Speed program to six (out of 25 total) police districts in Philadelphia, met with limited success and some challenges. There were both unique challenges, including State legal restrictions on the use of radar for issuing citations, and other challenges, which the planned use of a new speed enforcement technology was unable to overcome. These other challenges such as competing law enforcement priorities, equipment loss, funding limitations, difficulty engaging public involvement, and gaining message penetration that were experienced in Philadelphia may also be challenges in other large cities. Even without an increase in speeding citations, however, there were decreasing trends in percentages of speeders on 17 of 24 streets over the three years of the program, especially on the streets that received a type of engineering treatment– three-dimensional painted markings that simulate traffic calming devices. Other treatments included ensuring appropriate posting of limits, message-oriented signs with and without speed limit reminders along the roadways, and flyers and other outreach. See also Section 4.1 Communications and Outreach in Support of Enforcement for more information.

A 2008 test of a 4-week, high-visibility enforcement campaign along a 6-mile corridor with a significant crash history in London, U.K., found significant reductions in driver speeding in the enforced area. There was also a halo effect up to two weeks following the end of the campaign (Walter, Broughton, & Knowles, 2011). A crash-based analysis was not conducted. The campaign was covered by print media as well as by billboards and active messaging along the enforced corridor.

High-visibility model programs to target specific aggressive driving actions around large trucks have also been undertaken in several States. The program, known as TACT (Ticketing Aggressive Cars and Trucks) is modeled on the *Click It or Ticket* belt use campaigns. An evaluation found promising results in reducing the number of targeted violations as the program was implemented in Washington State; effects on crashes or injuries were not determined (Nerup et al., 2006; Thomas, Blomberg, Peck, Cosgrove, & Salzberg, 2008). The TACT program was also utilized in Michigan. The evaluation of this program by Kostyniuk, Blower, Molnar, Eby, St. Louis, and Zainer (2014) indicates that TACT messages reminding drivers of the slogan “Leave More Space for Trucks” were successfully received with 40% of drivers being aware of the slogan. However, given the awareness of this slogan, behaviors of both light vehicle drivers did not change when driving around trucks. A unique part of this implementation of the TACT program was the visibility of two of four police vehicles at one time in a relatively small geographical location. From a specific deterrence perspective, because drivers generally revert back to the “old behaviors” once a police car passes by, having a second police car available to follow up once drivers think they can revert back to unsafe behavior increases the likelihood that these violators can be apprehended.

In summary, the evaluation evidence suggests that high-visibility, anti-speeding and aggressive driving enforcement campaigns have promise, but safety benefits are far from guaranteed. Given challenges in administering police enforcement resources, one approach to develop a sustainable and effective campaign may be to randomly target low levels of conspicuous enforcement on an unpredictable basis to a larger share of network roads that account for a significant majority of injury crashes on the entire network (Newstead, Cameron, & Leggett, 2001). Such a program may warrant expanding enforcement coverage to many more roads in a jurisdiction to increase network-wide deterrence. In Queensland, Australia, the Random Road Watch enforcement program aims explicitly to cover a large portion of the road network where serious crashes occur, not just crash black spots, by randomly targeting police enforcement for two hour periods from 6 a.m. to midnight using marked, parked police vehicles. Significant reductions in fatal and all crashes were estimated for the enforced zones that translated into statewide reductions of 12% in all severity of crashes and 15% of the State's fatal road crashes (including non-metro areas). No additional publicity was undertaken; it is unknown how much free publicity the program generated.

Other methods making use of enforcement time halos such as enforcing a corridor or other area for up to 4 weeks as described earlier, and then rotating the enforcement to another zone could also be utilized to maximize enforcement's deterrent effects.

Costs: As with alcohol-impaired driving and seat belt use enforcement campaigns, the main costs are for law enforcement time and for publicity. The Minnesota Speed Management Program cost approximately $3 million, with $2.5 million for increased enforcement, $350 thousand for paid media (primarily radio), and $150 thousand for data collection and evaluation. The Minnesota DOT and State Patrol also made significant in-kind contributions toward project management, sign installation, speed detection equipment, engineering reviews, and fuel and vehicle costs (Harder & Bloomfield, 2007). The Milwaukee demonstration received a $650,000 grant and the other two demonstrations each received a $200,000 grant. Public-private partners (such as those in interests in injury prevention and public health) may be able to assist with publicity.

Time to implement: High-visibility enforcement campaigns may require 4 to 6 months to plan, publicize, and implement.

2.3 Other Enforcement Methods

Effectiveness: ☆☆	Cost: Varies	Use: Unknown	Time: Varies

Overall Effectiveness Concerns: *In general, these technological measures have not been adequately studied to reliably determine their effectiveness.*

Many traffic enforcement operations help to deter speeding and aggressive driving as well as other traffic offenses. In addition to high-visibility enforcement campaigns (Chapter 3, Section 2.2) and automated enforcement (Section 2.1), a number of new technologies have been recommended to address speeding and aggressive driving (NHTSA, 2001). Law enforcement agencies around the country have also conducted innovative and effective aggressive driving enforcement programs (NHTSA, 2000).

Technology: Both external and in-vehicle technologies may help in several ways.

- In-car video equipment in patrol cars allows law enforcement to record aggressive driving actions and can enhance the ability to prosecute and convict offenders (NHTSA, 2001).
- Laser speed measuring equipment can provide more accurate and reliable evidence of speeding (NHTSA, 2001a).
- Unstaffed speed display devices, also known as speed trailers, can show drivers that they are speeding and may encourage some drivers to slow down, but effects may last only as long as the devices are in place (Donnell & Cruzado, 2008). They may also suggest to drivers that speeds are being monitored or enforcement is nearby. Signs that provided either an implication that speeds were being monitored or a social norms message (average speed at the site; your speed) were effective at reducing speeds in a 50 km/h zone although not as much as in earlier studies (Wrapson, Harre, & Murrell, 2006). Other studies have shown that speed trailers or portable changeable message signs, which may include speed feedback plus other messages such as “Slow Down Now” can be effective in reducing speeds in work zones (Brewer, Pesti, & Schneider, 2006; Mattox, Sarasua, Ogle, Eckenrode, & Dunning, 2007) and school zones (Lee, Lee, Choi, & Oh, 2006). Automated speed display monitors also provide a method to collect location-specific travel speed data. Speed feedback devices are likely to be more effective on two-lane highways than multi-lane ones. In addition, they may not provide accurate speed indications if traffic volumes are too high (NCHRP, 2013). Speeds seem to rebound quickly downstream and as soon as the devices are removed (Walter & Broughton, 2011; Hajbabaie, Medina, Wang, Rahim, & Chitturi, 2011).
- In work zones, a combination of a parked police vehicle and speed feedback trailer reduced average and 85th percentile traffic stream speeds and free flow speeds to a similar degree as automated camera enforcement, whereas the effect of speed trailers alone was the same as no treatment. Parked police alone was also effective, but to a lesser extent than the combination of police + trailer or the camera system. The number of speeders above 10 mph over the limit was essentially reduced to zero by both the automated enforcement and police + trailer combination. However, the treatment effects on speeds in work zones disappeared within 40 – 50 minutes of removal (Hajbabaie et al., 2011). See the Ullman et al. (2013) Report 746 for in-depth discussion of advantages,

disadvantages and deployment considerations for various methods of traffic enforcement in work zones. According to this report, which provides state of the knowledge for work zone enforcement, there have been insufficient controlled trials to identify the optimal mix of enforcement types and other treatments for different highway types, geometries, and work zone situations. The report reiterates the importance of work zone speed limits that reflect the situation, including the presence of workers or alignment changes.

- Drone radar – A study of the use of this technology in work zones suggests that it may be effective at reducing overall speed of the traffic stream, with particularly large speed reductions among vehicles equipped with radar detectors (Eckenrode, Sarasua, Mattox, Ogle, & Chowdhury, 2007). Both in-vehicle driver warning systems, as well as traditional cruise control, are widely available technologies that may be well-accepted by drivers to help govern their own speeds (Sivak et al., 2007; Young & Regan, 2007).
- Intelligent Speed Adaptation (ISA) involves in-vehicle devices that "know" the speed limit through accurate digital maps of speed limits and global positioning system (GPS) data of the vehicle location. ISA systems can either warn when the speed limit is being exceeded or apply active controls to slow the vehicle. A recent pilot study was conducted in the United States among a group of repeat violators. (See section 3.1 for information about this study.) The devices have been widely studied in European countries for acceptability and effects on driver behavior with more widespread on-road trials currently underway. (See http://ec.europa.eu/transport/wcm/road_safety/erso/knowledge/Content/20_speed/intelligent_speed_adaptation_isa_.htm for more information.) In Europe, the effects on speeding have been fairly dramatic for both warning and control type ISA systems, decreasing the amount of speeding and narrowing the speed distributions (Carsten, 2012; Lai & Carsten, 2012; van der Pas, Kessels, Veroude, & van Wee, 2014). These are very promising results for potential crash and injury reductions. However, a widespread implementation and trial have yet to be documented. While there remain issues to be resolved, including the extent to which behaviors in international trials are generalizable to the United States, the main roadblock to implementation may be political (Carsten, 2012) rather than safety or technological reasons. Some issues uncovered in recent trials include that serious offenders were more likely to disable or over-ride the devices than other drivers (van der Pas et al., 2014), and may be less likely to adopt ISA use, even with incentives (Chorlton, Hess, Jamson, & Wardman, 2012; De Leonardis, Huey, & Robinson, 2014). It is not clear if drivers' behavior may change after the devices are inactivated, or when they are disabled. Drivers' intentions to speed and actual behaviors were assessed following driving with an Intelligent Speed Adaptation in-vehicle system that provided direct resistance to speeding (Chorlton & Connor, 2012). While measured intentions to speed and impressions of time-savings that could be gained by speeding were decreased among the participants, actual speeding behavior after the system was inactivated returned to pre-exposure levels within 4 weeks.
- According to researchers from the U.K., the devices may potentially be over-ridden where they may be most needed (Lai & Carsten, 2012). Other uncertainties also still exist about driver behaviors or adaptations, and even external forces that may potentially affect the costs and benefits of ISA (van der Pas et al., 2012). Finally, there is a need to provide current and accurate maps of speed limits (Carsten, 2012).
- A study of the effects of in-vehicle warning and monitoring systems was disappointing

with respect to speed control by young teens (Farmer, Kirley, & McCartt, 2010). Even with parental notification (immediate or delayed) and with or without in-vehicle alerts, there was either no reduction in instances of teens exceeding the limit by more than 10 mph or initial declining trends reversed after a few weeks.

- Alerts or speed monitoring combined with rewards may work better than alerts and monitoring alone. Several field tests from Europe have found that drivers exceeded limits less when offered economic incentives such as reduced insurance premiums or discounts (for lease vehicles). Results were positive for lease car drivers in the Netherlands (Mazureck & van Hattem, 2006), young drivers in the Netherlands (Bolderdijk, Knockaert, Steg, & Verhoef, 2011), and members of a large motor club in Sweden (Stigson, Hagborg, Kullgre, & Krafft, 2014).

Many jurisdictions use some of the above technologies. Each has costs for new equipment, maintenance, and training, and perhaps other costs. In the case of ISA, accurate digital maps of speed limits are needed.

3. Penalties and Adjudication

3.1 Penalty Types and Levels

Effectiveness: ☆☆†	Cost: Varies	Use: High	Time: Low

† For general traffic offenses

Overall Effectiveness Concerns: *This countermeasure's effectiveness has been examined in several research studies. The balance of the evidence suggests that these types of countermeasures are ineffective in the long term.*

Penalty types and levels for speeding and the various traffic offenses included under aggressive driving are part of each State's overall driver control system. Penalties typically are low for first offenses that do not produce serious crashes and casualties and include small fines and perhaps a few demerit points assessed against the driver's license. When violations cause a crash producing serious injury or death, the offense may carry criminal charges and sanctions may be more severe. As discussed in Chapter 3, Section 1.2, NHTSA's Aggressive Driving Symposium and NCHRP's Aggressive Driving Guide recommend enhanced penalties for repeat aggressive driving offenders and felony charges for offenses resulting in serious injury or death (Neuman et al., 2003, Strategy A3; NHTSA, 2001a).

States use the demerit point system in an attempt to prevent drivers from committing repeated traffic offenses. As drivers accumulate demerit points, States use various actions and penalties such as warning letters, educational brochures, group counseling meetings, individual counseling, administrative hearings, and driver's license suspension or revocation (Masten & Peck, 2004). Penalty levels and types for speeding and aggressive driving offenses should be considered within the context of a State's overall driver control and problem driver remediation system.

Use: Each State has a system of penalties for traffic offenses. Each system includes more severe penalties for significant individual offenses, such as those producing serious injury or death, and for repeated offenses, often determined through accumulated driver's license demerit points.

Effectiveness: Generally, for penalties to be effective, perceived risk of getting caught must be high. Evidence is mixed about effectiveness of varying severity of penalties. Masten and Peck (2004) reviewed the effectiveness evidence for different driver improvement and driver control actions, including penalty levels and types, from 35 high-quality studies of 106 individual actions and penalties. They found that, taken together, all actions and penalties reduced subsequent crashes by 6% and violations by 8%. Even simple warning letters had some effect on both violations and crashes. The effect increased as the "obtrusiveness" of the action increased, with license suspension or revocation the most effective by far. The authors noted that the threat of license suspension probably is responsible for the effectiveness of the weaker actions such as warning letters. Educational brochures by themselves had no effect. However, administrative penalties imposed by the driver licensing agency were more effective than penalties imposed by the courts.

In Norway, Elvik and Christensen (2007) reported there was a weak tendency for speeding violations to decrease near camera-enforced sites in response to increasing fixed penalties over time. However, there was no general effect of increasing fixed penalties over the road system at large. The researchers thought this was likely due to the overall low risk of detection.

Recent evaluations of the introduction of penalty point systems in European and middle-eastern countries, including Kuwait in 2006, suggest that the introduction of penalty points, including for speeding, have significantly reduced road traffic injuries (Akhtar & Ziyab, 2014). Although the time series analysis may not have been able to control for all confounders, including driver education weeks and the volume of citations, the results of this and other studies suggest that introduction of a penalty system can be an effective safety measure, in conjunction with enforcement and education. However, the long-term effects of penalty systems are somewhat uncertain and likely depend on how they continue to be implemented.

For example, research in Maryland found that various legal consequences for speeding had little impact on future citations for individual drivers (Lawpoolsri, Li, & Braver, 2007). Drivers who received legal consequences had the same likelihood of receiving another speeding citation as drivers who escaped legal consequences. Only fines coupled with probation before judgment (PBJ) was associated with a reduced risk of receiving a subsequent speeding ticket (Lawpoolsri et al., 2007). A follow-on longitudinal study found that the 54% of cited drivers who opted for court appearance to contest their speeding citations were more likely to be involved in future crashes and receive future speeding citations than drivers who accepted a guilty verdict and paid fines by mail (Li et al., 2011). In addition, whether drivers who opted for court appearance received guilty or not-guilty verdicts, or had charges dismissed had little effect on deterrence of future speeding *or* prevention of crashes, even controlling for prior driver histories and other potential confounders. Only suspended types of prosecutions (e.g. probation before judgment or other suspension) were associated with somewhat decreased risk of speeding recidivism and future crashes, but a still higher risk compared to those who paid fines by mail. The two types of suspended prosecutions associated with somewhat reduced future speeding and crash risk both provide some incentive to avoid additional citations that would result in a reinstatement of charges and potential loss of license. Also, many of the drivers receiving suspended judgments may have had reduced exposure owing to having prior alcohol traffic violations and license restriction/suspension.

Similar to the results from Maryland, a U.K. study that examined survey and conviction data found that the immediate threat of being disqualified from driving deterred those with points on their license from further speeding. However, for a subset of drivers, the threat of this sanction did not appear to affect their choice to speed (Corbett, Delmonte, Quimby, & Grayson, 2008).

Most evidence suggests there is at least a subset of drivers for whom sanctions and increasing penalties do not seem to have the desired deterrent effect. Many studies and NHTSA statistics verify the prevalence of young, male driver involvement in speeding crashes. A review of the literature by Fuller et al. (2008) suggests that young males may simply be immature, with incomplete development of self-knowledge, self-control, social responsibility and independence of judgment. Drivers with attention deficit hyperactivity disorder (ADHD) may be particularly at risk because of self-control challenges. In addition, there is evidence of socially deviant speeders for whom speeding is associated with other forms of risk taking. These groups are distinguished from those who speed unintentionally due to failure to perceive risks and adjust accordingly (Fuller et al., 2008).

Repeat offenders: Repeat speeding and aggressive driving offenders may be especially difficult to deter. Recommended methods to reach them include:

- Enhanced penalties, including increased driver's license points, immediate license suspension or revocation, higher fines, and jail or probation, but research described in this section makes clear that the availability of such penalties alone is unlikely to lead to individual deterrence of speeding. See Chapter 3, Sections 1.2 and 3.1, for more information. The certainty of punishment may be more important than the level of penalty (Li et al., 2011; Shinar, 2007). Furthermore, courts may be reluctant to impose the most serious penalties, such as license suspension, for speeding violations, or simply unable to effectively prosecute speeders as charged.
- Improved traffic record systems, to better identify repeat offenders and to allow patrol officers to immediately access a driver's complete driving record (Neuman, Pfefer, Slack, Hardy, & Waller, 2003b; NHTSA, 2001a). There are no studies of the effects of improved record systems on repeat offenders. Costs and implementation time will vary.
- Providing alternate modes of transportation, electronic monitoring, enforced restrictions or limits on mobility through license plate "striping" or vehicle impoundment are other recommendations to address unlicensed drivers, including those who have already received the maximum penalties but continue to drive (Neuman, Pfefer, Slack, Hardy, & Waller, 2003b).

In the future, there may be potential to utilize ISA (vehicle-based speed monitoring and warning or control of speed) systems for repeat offenders. A Maryland pilot study assessed the effects of an ISA warning type system on speeding behavior among 78 volunteer drivers who had at least three speeding violations in the prior three years (De Leonardis, Huey, & Robinson, 2014). Both verbal and red LED light alerts were provided in real time to the drivers any time their speed exceeded the speed limit on a given road by more than 8 miles per hour. Subjects' speeding behavior was monitored for two weeks prior to the systems being activated, for four weeks with the warning systems activated, and for a two-week follow-up period with the alert systems deactivated. Results were promising. Drivers sped more than 8 mph over the limit a small, but significantly lower proportion of the distance driven during the alerting phase (0.43) compared to the baseline phase (0.45). Proportion of speeding also remained somewhat lower (0.44) during the two-week follow-up period when the systems were turned off except among the more habitual speeders, who immediately resumed their normal speeds. However, participants were very concerned about providing driving speed data to insurance or licensing agencies. They anticipated negative consequences, including the potential for revocation of their driver licenses and increased insurance premiums. Such concerns would need to be addressed to encourage drivers to voluntarily use such a system to help control their speed (De Leonardis et al., 2014). In general, the systems seemed to be well accepted by a majority of the drivers, except for the concerns mentioned. Two types of ISA – speed alerting and speed-controlling – were also evaluated among a group of serious speeders in the Netherlands (van der Pas, Kessels, Veroude, & van Wee, 2014). While the devices were active, there was much less speeding, but once inactivated, levels of speeding quickly rebounded to normal levels.

Costs: Costs vary by penalty type. For example, warning letters are very cheap once a record system has been established to identify drivers who should receive letters. Individual counseling and administrative hearings may require substantial staff time. Some costs may be recovered through offender fees.

Time to implement: Most changes in penalty levels can be implemented quickly within a State's overall driver improvement system.

Other issues:

- **Public acceptance, enforcement, and publicity:** Changes in speeding and aggressive driving sanctions by themselves cannot reduce speeding and aggressive driving. To be effective, sanctions must be well known to violators and they must have a high probability of being imposed (Preusser, Williams, Nichols, Tison, & Chaudhary, 2008). Traffic laws, penalty types, and penalty levels are essential to, but only a part of, a system that includes broad public acceptance, active enforcement, effective administration of penalties, and publicity (NHTSA, 2001a).

3.2 Diversion and Plea Agreement Restrictions; Traffic Violator School

Effectiveness: ☆	Cost: Varies	Use: Unknown	Time: Varies

Overall Effectiveness Concerns: *Although there is some research examining the effectiveness of this countermeasure, there is insufficient evidence to conclude that the positive effects outweigh the negative effects that have also been observed.*

In many jurisdictions, drivers who have accumulated a specific number of demerit points on their driver's licenses are given the option of attending Traffic Violator School in order to reduce their punishment. In most instances, if they complete Traffic Violator School, their traffic offenses are dismissed or removed from their driving record (Masten & Peck, 2004).

Negotiated plea agreements are a necessary part of an effective and efficient court system. However, plea agreements may allow offenders to have their penalties reduced or eliminated, for example if a driver is allowed to avoid a driver's license suspension by attending Traffic Violator School.

Use: No data is available on the number of jurisdictions in which Traffic Violator School is available or the number of offenders who use Traffic Violator School to reduce their penalties. Similarly, no data is available on the use of other plea agreements for speeding or aggressive driving violations.

Effectiveness: Masten and Peck's review (2004) included high-quality studies of over 30 group meeting programs, including Traffic Violator School. Taken together, these group-meeting programs reduced subsequent crashes by 5% and violations by 8%. Masten and Peck point out that Traffic Violator School programs in California increased, rather than decreased, crashes because they allowed offenders to escape more severe penalties and start again with a clean driving record. Their review was not able to determine whether other Traffic Violator School programs that dismissed an offender's violation had similar negative effects. These reductions or eliminations of penalties also make it difficult to use driver histories to track and provide serious sanctions to repeat violators.

Costs: Costs for establishing diversion or Traffic Violator School programs will depend on the nature of the program. Costs include developing and maintaining a tracking system, notifying offenders, and administering the Traffic Violator School. Costs for limiting or eliminating diversion programs, plea agreements, and Traffic Violator School can be determined by comparing the per-offender costs of these programs with the costs of the penalties that would otherwise be applied.

Time to implement: Diversion or Traffic Violator School programs will require at least 6 months to establish and implement. They can be modified within a few months.

Other issues:

- **Diversion and plea agreement issues in alcohol-impaired driving:** Diversion and plea agreements have been discussed and evaluated more extensively for alcohol-impaired-driving offenses than for speeding and aggressive driving offenses. See Chapter 1, Section 3.2 for additional discussion.

- **Public acceptance, enforcement, and publicity:** Changes in the adjudication of speeding and aggressive driving infractions, such as limiting or eliminating diversion and plea agreements, by themselves cannot reduce speeding and aggressive driving. Traffic laws and adjudication are essential to, but only a part of, a system that includes broad public acceptance, active enforcement, and publicity (NHTSA, 200la).

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A4. Distracted and Drowsy Driving

This section provides expanded discussion of the ☆ and ☆☆ countermeasures. Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

The ☆ and ☆☆ countermeasures covered in this section of the Appendix are listed below.

1. Laws and Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
1.2 Cell Phone and Text Messaging Laws	☆☆	$	Medium	Short
1.4 General Drowsiness and Distraction Laws	☆	Varies	High††	Short

†† Included under reckless driving; use of explicit drowsiness and distraction laws is low

2. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Drowsy Driving	☆	$$	Unknown	Medium
2.2 Distracted Driving	☆	$$	High	Medium

3. Other Countermeasures

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Employer Programs	☆☆	$	Unknown	Short
3.2 Education Regarding Medical Conditions and Medications	☆	Variable	Unknown	Medium

Effectiveness:

☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise.
See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Laws and Enforcement

1.2 Cell Phone and Text Messaging Laws

Effectiveness: ☆☆	Cost: $	Use: Medium	Time: Short

Overall Effectiveness Concerns: *The effectiveness of laws banning cell phone use has been examined in several research studies. The results across types of phone use are inconsistent. Specifically, research examining prohibitions on hands-free phone use and texting have yielded mixed results in terms of reductions in phone use while driving and reduced crashes. There is some evidence that banning hand-held cellphone use leads to long-term reductions in this behavior; however, many State and Local laws were only recently passed and effectiveness is still being examined. At this time, there is insufficient consensus across research findings to determine that this countermeasure is effective.*

Cell phones have become an essential feature of modern life. In a NHTSA survey of more than 6,000 U.S. residents, 60 percent admitted to answering phone calls while driving and 51% reported making phone calls (Schroeder, Meyers, & Kostyniuk, 2013). Half (50%) of cell phone users reported no differences in their driving when using a cell phone. NHTSA's 2015 national observation survey found 3.8% of drivers on the road at any given moment were using hand-held cell phones (Pickrell, Li, & KC, 2016). The percentage of drivers who were manipulating a hand-held device (e.g., texting or dialing) increased from 0.9% in 2010 to 2.2% in 2015. NHTSA currently estimates that 6.9% of drivers are using some type of phone (hand-held or hands-free) in a typical daylight moment (Pickrell, Li, & KC, 2016). These estimates may underrepresent cell phone use given the inherent difficulty in accurately observing these behaviors.

Many studies have investigated the effects of cell phone use on driving (See Caird, Willness, Steel, & Scialfa, 2008, and McCartt, Hellinga, & Braitman, 2006, for reviews). Experiments on simulators or test tracks indicate that talking on a cell phone has some effect on driving performance, most commonly slowed reaction times, but these experiments cannot measure the impact on crash risk. For reasons outlined in the overview, it can be difficult to determine whether cell phones contribute to individual crashes. Two studies examining cell phone billing records concluded that drivers are four times more likely to be involved in a serious crash when talking on a cell phone (McEvoy et al., 2005; Redelmeier & Tibshirani, 1997). In addition, these two studies and others have found that hands-free phones offer little or no safety advantage over hand-held phones (Caird et al., 2008; Ishigami & Klein, 2009). However, recent studies have questioned the estimates of crash risk and argued the real risk may be much smaller (Farmer, Braitman, & Lund, 2010; Young, 2012). Analyses of crash events using SHRP2 NDS data found that multiple aspects of cell phone use are associated with increased odds of crash events (Dingus et al., 2016). The table below shows the increase in odds and the baseline prevalence of the distraction in terms of the percentage of time drivers engaged in a distracting task while driving. Actions such as dialing and texting show substantially elevated odds of crash events, especially in comparison to more traditional sources of distraction, such as tuning a radio (odds ratio of 2.9) and talking to a passenger (odds ratio of 1.4), which are not shown in the table.

Type of Cell Phone Distraction	Change in Risk (Odds Ratio)	Baseline Prevalence
Total cell (handheld)	*3.6*	*6.4%*
Cell dial (handheld)	12.2	0.1%
Cell text (handheld)	6.1	1.9%
Cell reach	4.8	0.6%
Cell browse	2.7	0.7%
Cell talk	2.2	3.2%

Note: All odds ratios statistically different from 1 at the 0.05 level of significance.
Source: Dingus et al. (2016).

There is less disagreement about the dangers posed by texting while driving. In a study using highly instrumented commercial motor vehicles, texting drivers were 23 times more likely to be involved in a crash, near-crash, or other safety-critical event compared to uneventful baseline driving (Olson et al., 2009). This is supported by experimental studies using driving simulations, which suggest that texting drivers spend up to 400% more time looking away from the road and are more likely to leave their lane than when not text messaging (Drews, Yazdani, Godfrey, Cooper, & Strayer, 2009; Hosking, Young, & Regan, 2009). In the NHTSA survey, only 14% of drivers admitted to sending text messages or emails while driving (Schroeder et al., 2013).

States have been very active in using legislation to address this issue. Since 2000 every State has considered legislation to curtail distracted driving or driver cell phone use. In 2015 legislators in 42 States considered approximately 150 bills related to distracted driving (Teigen, Shinkle, & Essex, 2016). No State completely bans all types of cell phone use for all drivers. Bans on texting are more common than bans on hand-held cell phone use. Overall, public support is high for this legislation. In surveys of the general public, between 70% and 80% favor bans on hand-held cell phone use, and 88% to 97% support bans on texting while driving (AAFTS, 2013; Guarino, 2013; Schroeder et al., 2013).

Use: As of November 2016, talking on a hand-held cell phone was prohibited in 14 States (California, Connecticut, Delaware, Hawaii, Illinois, Maryland, Nevada, New Hampshire, New Jersey, New York, Oregon, Vermont, Washington, and West Virginia) and the District of Columbia (GHSA, 2016; IIHS, 2016). The cell phone bans in each of these States are primary laws. In addition, several local jurisdictions such as Chicago, Illinois and Cheyenne, Wyoming have enacted their own restrictions on cell phones. At present, no State restricts *hands-free* phone use for all drivers.

Most States prohibit text messaging while driving. As of November 2016, 46 States and the District of Columbia prohibit text messaging for all drivers (GHSA, 2016; IIHS, 2016). NHTSA has prepared a sample bill to assist States in crafting new legislation to prohibit texting while driving (NHTSA, 2010).

Effectiveness: Evaluations in New York, Connecticut, the District of Columbia, and in other countries consistently show that cell phone laws reduce hand-held phone use by about 50% shortly after the laws take effect (McCartt et al., 2006). Moreover, these reductions in hand-held cell phone use are maintained 3 to 7 years later (McCartt, Hellinga, Strouse, & Farmer, 2010). However, it is unknown whether these laws lead to increased use of hands-free devices.

The effectiveness of hand-held cell phone bans in reducing crashes is still unclear. Nikolaev, Robbins, and Jacobson (2010) examined driving injuries and fatalities in 62 counties in New York State both before and after a hand-held cell phone ban took effect. Forty-six counties showed a significant decrease in injury crashes following the ban, and 10 counties showed a less-significant decrease in fatal crashes. Although encouraging, the study did not include a control group to account for other factors that may have decreased crashes. A study by the Highway Loss Data Institute (HLDI) investigated State-level automobile insurance collision claims in California, Connecticut, New York and the District of Columbia. When compared to neighboring States, there was no change in collision claim frequency after these jurisdictions implemented hand-held cell phone bans (HLDI, 2009). However, the data from the Highway Loss Data Institute is proprietary and an independent analysis of the data has not been conducted. Also, not all crashes result in a collision claim, so collision claim rates may differ from crash rates.

Four studies have examined the effectiveness of laws prohibiting cell phone use and texting while driving. One study evaluated the effect of a texting ban in Michigan (Ehsani, Bingham, Ionides, & Childers, 2014); another examined insurance collision claims in States with texting bans compared to neighboring States without such bans (HLDI, 2010). Both studies found small *increases* in various types of crashes and collision claims following enactment of texting bans. One possible explanation is that texting drivers attempt to avoid detection by hiding their phones from view, which may result in more time with drivers' eyes off the roadway. Crash increases were also found in a study of crash data in New Jersey (Maher & Ott, 2013). While crashes have declined statewide, cell phone-related crashes increased after a cell phone and texting law was enacted. Additionally, the number of citations issued declined after the first year after the ban took effect, possibly because law enforcement resources are limited and issuing citations for cell phone use may be lower in priority compared with other law enforcement objectives. Finally, a review and synthesis of 11 peer-reviewed articles found that, while such bans are highly effective at reducing cell phone use while driving, the effect on crash outcomes is mixed (McCartt, Kidd, & Teoh, 2014). Some studies showed no change in crash rates for both hand-held cell phone use and texting, while others showed an increase in crashes after the ban (although most of the studies reviewed had limitations that diminish the strength of their conclusions). These findings suggest that the impact on crash rates from cell phone bans is not clear, even though such bans are effective at reducing hand-held cell phone use.

Drivers' attitudes and beliefs about the safety of using a cell phone while driving are incongruous with their actions. Maher & Ott (2013) found that drivers in New Jersey are knowledgeable about the law and assert that the law is necessary; however, a significant portion of these drivers also admitted to having violated the law.

Costs: As with any law, costs are required to publicize and enforce it. A hand-held cell phone law can be enforced during regular traffic patrol because drivers who are using a hand-held phone can be observed relatively easily. However, some States with cell phone bans allow drivers to use a phone for specific purposes while driving (e.g., navigation), which can make enforcement more challenging. As with other traffic safety laws, paid advertising supporting highly visible law enforcement may be necessary to achieve substantial effects (see Chapter 4, Section 1.3).

Time to implement: A cell phone law can be implemented quickly, as soon as it is publicized.

Other issues:

- **Cell phone blockers:** In recent years, several manufacturers have created systems that can block a cell phone from making (or receiving) calls while a person is driving. These systems detect when the phone is in motion. During that time, incoming calls are automatically diverted to voicemail and incoming texts are not shown until the driver has stopped moving. Typically, these systems allow exceptions for phone calls from pre-specified numbers, and all allow emergency calls to 911. Although these systems are potentially applicable to all drivers, they have largely been marketed to parents of teen drivers. Researchers at the Texas Transportation Institute tried to evaluate a cell phone disabling device for teens; however, they encountered difficulty recruiting families and very strong resistance by parents and teens to the device (Benden, Fink, & Stafford, 2012). NHTSA funded a study examining the effect of a filtering/blocking application on the cell phones of 44 Michigan DOT employees. When the application was active, participants placed and answered fewer calls while their vehicle was in motion. However, participants were not very accepting of the application, and the application was not completely reliable (Funkhouser & Sayer, 2013).
- **Voice-to-text technology:** There are several applications that allow drivers to send and receive text messages using voice rather than manual entry. Although the research on these applications is limited, it appears voice-to-text technology may offer little or no safety benefit. In a recent study, 42 participants drove instrumented vehicles on a closed course while texting manually or using one of two voice-to-text applications. In all three conditions, reaction times were slower and drivers spent more time looking away from the roadway (Yager, 2013). More research is needed, but the findings suggest texting impairs driving performance, regardless of what method of texting is used.

1.4 General Driver Drowsiness and Distraction Laws

Effectiveness: ☆	Cost: Varies	Use: High†	Time: Short

† Included under reckless driving; use of explicit drowsiness and distraction laws is low

Overall Effectiveness Concerns: *Laws that specifically target drowsy and/or distracted drivers are not widely used, and this countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Existing laws in each State allow people to be cited and prosecuted if they cause a crash due to distracted or drowsy driving; however, the extent to which States pursue cases of inattentive driving is currently unknown.

Several States have laws that specifically target the issue of drowsy drivers. In 2003, New Jersey enacted "Maggie's Law" under which drivers can be prosecuted for vehicular homicide if they have not slept in 24 hours and they cause a crash in which someone is killed. Arkansas has a similar law – drivers can be charged with negligent homicide if the driver is involved in a fatal crash and has not slept in 24 hours. In 2009, Maine enacted a general distracted driving law. A driver who is involved in a crash or who commits an infraction can be cited for distracted driving if a police officer believes that to be the underlying cause. The law defines distraction as an activity not necessary to the operation of the vehicle that impairs, or could impair, the ability to drive safely. Utah has a law that prohibits "careless driving," which is defined as committing a moving violation (other than speeding) while being distracted by one or more activities unrelated to driving (GHSA, 2011). Potentially distracting activities covered by the law include talking on a hand-held phone, searching for an item in the vehicle, or attending to personal hygiene or grooming.

No studies have evaluated whether general reckless driving laws or specific drowsy or distracted driving laws have any effect (except for cell phone laws: see Chapter 4, Section 1.2). Based on extensive experience in other traffic safety areas, it is likely that these laws will have little or no effect unless they are vigorously publicized and enforced. See Chapter 1, Sections 2.1 on alcohol-impaired driving, Chapter 2, Sections 2.1, 3.1, and 3.2 on seat belt use laws, and Chapter 3, Sections 2.2 and 4.1 on aggressive driving and speeding laws. Enforcement of drowsy or distracted driving laws is likely to be especially difficult because drowsiness and distraction often are difficult to observe, measure, and document. Nevertheless, these laws may increase the impact of communications and outreach efforts to reduce drowsy and distracted driving discussed in Chapter 4, Sections 2.1 and 2.2 (see also Stutts, Knipling, Pfefer, Neuman, Slack, & Hardy, 2005, Strategy C2).

Use: New Jersey, Maine, and Utah are the only States with laws explicitly addressing drowsy driving or distractions other than cell phones (Chapter 4, Section 1.2). Other States include these conditions under their laws regarding reckless driving or similar offenses.

Effectiveness: The effects of any laws on reducing drowsy or distracted driving are unknown.

Costs: Costs are required for publicity and enforcement. Enforcement costs likely will be minimal, as most enforcement likely will be included under regular traffic patrols or combined with enforcement activities directed primarily at other offenses such as alcohol-impaired or aggressive driving. However, special patrols to enforce distracted or drowsy driving laws will entail greater costs, especially if overtime is required for law enforcement officers.

Time to implement: The implementation time is primarily determined by the time required to pass new drowsy or distracted driving laws. Implementation can be begin as soon as it is publicized and law enforcement patrol officers are trained.

2. Communications and Outreach

2.1 Communications and Outreach on Drowsy Driving

Effectiveness: ☆	Cost: $$	Use: Unknown	Time: Medium

Overall Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Drowsy driving typically occurs because drivers don't get enough sleep (Royal, 2003), although certain medical conditions and medications can also cause drowsiness while driving (Colvin & Collop, 2016; Watson et al., 2015). In a NHTSA telephone survey, 66% of the drivers who reported they had nodded off while driving had 6 or fewer hours of sleep the previous night (Royal, 2003). The AAA Foundation conducted a survey in 2015 and found that almost one third of respondents (31.5%) reported having driven when they were so tired that they had a hard time keeping their eyes open in the past 30 days (AAAFTS, 2016). Stutts, Wilkins, and Vaughn (1999) interviewed 467 crash-involved drowsy drivers (reported as "fatigued" or "asleep" by the investigating officer) and 529 other crash-involved drivers who were not drowsy. Half of the drowsy drivers had 6 or fewer hours of sleep the previous night compared to fewer than 10% of the other drivers.

States and national organizations such as the National Sleep Foundation have conducted drowsy driving communications and outreach campaigns directed to the general public (Stutts, Knipling, Pfefer, Neuman, Slack, & Hardy, 2005, Strategy C1; NSF, 2004). Campaign goals usually include:

- raising awareness of the dangers of drowsy driving;
- motivating drivers to take action to reduce drowsy driving; and
- providing information on what drivers can do, either before they start out on a trip or if they become drowsy while driving.

NHTSA and NCSDR (the National Center for Sleep Disorders Research) identified three groups that are over-involved in drowsy driving crashes: drivers in their teens and 20s, shift workers, and people suffering from sleep apnea or narcolepsy (NHTSA, 2001). The joint NHTSA-NCSDR Report to Congress on drowsy driving recommended that communications and outreach on drowsy driving be directed to these groups, especially to young drivers (NHTSA, 1999). This information can be delivered in several ways. Driver education programs can include information on both drowsy and distracted driving, and the new model curriculum developed by NHTSA and the American Driver and Traffic Safety Education Association includes both (www.adtsea.org/ADTSEA%20Curriculum%20Free%20Download.html). NHTSA's 2015 Drowsy Driver Symposium identified a short-term goal of improving messaging and developing new materials (especially for high-risk groups) that cover multiple aspects of drowsy driving, including: intensity and risk, prevention measures, danger signs, and responses to danger signs (www.nhtsa.gov/nhtsa/symposiums/november2015/index.html). See Chapter 4, Sections 3.1 and 3.2, for additional discussion of shift workers and medical conditions, respectively.

The ultimate goal of drowsy driving communications and outreach is to change driver behavior; however, there are substantial obstacles. As discussed in other chapters, communications and outreach by themselves rarely change driving behavior (Chapter 1, Section 5.2; Chapter 2, Sections 3.1 and 3.2; Chapter 3, Section 4.1; see also Stutts, Knipling, Pfefer, Neuman, Slack, & Hardy, 2005, Strategy C1). To have any chance of success, stand-alone campaigns must be carefully pre-tested, communicate health information not previously known, be long-term, and have substantial funding (Williams, 2007).

An additional barrier is that, for many drivers, drowsy driving is a byproduct of busy lifestyles that do not include enough sleep. The only truly effective method to prevent drowsy driving crashes in these cases is to get enough sleep (Nguen, Jauregui, & Dinges, 1998; NHTSA, 2001). Traffic safety messages urging enough sleep may be overwhelmed by the other demands on a driver's time that are responsible for insufficient sleep. Focus group discussions with young men and shift workers, two groups at high risk of drowsy driving, supported this conclusion (Nelson, Isaac, & Graham, 2001). Most shift workers and many young men understood well the risks caused by lack of sleep. Many had crashed or almost crashed after falling asleep at the wheel or had friends who had crashed. But neither their knowledge nor their crash experience changed their sleep habits. They sacrificed sleep for the demands of their work, families, and social lives. Campaigns directed to young drivers also must overcome the higher risk-taking behavior and overall immaturity of young drivers discussed in Chapter 6. The GHSA's (2016) report on drowsy driving for States identifies online resources developed by organizations such as AAA, National Sleep Foundation, and the American Academy of Sleep Medicine for providing information and training on drowsy driving.

In Greece, a national communication campaign was implemented in 2008-2009 to curb drowsy driving. Entitled "Sleep, but not at the wheel," the campaign was designed to raise awareness of the risks of driving while tired, and to increase knowledge of effective countermeasures to reduce fatigue (e.g., taking short breaks while driving). The campaign included thousands of TV and radio messages, as well as posters and leaflets distributed across the country (Adamos, Nathanail, & Kapetanopoulou, 2013).

Use: Multiple States, including Iowa, Texas, New York, and Utah have conducted drowsy driving campaigns for the general public (GHSA, 2016). In addition, several States including California, Florida, Michigan, Pennsylvania, and Washington have instituted a drowsy or distracted driving awareness week/month.

Effectiveness: The communication campaign in Greece was shown to increase awareness for the causes and effects of fatigue on drivers, and there was a small self-reported increase in the percentage of drivers who reported stopping and resting when they got tired (Adamos et al., 2013). The effect of the program on drowsy driver crashes is unknown. Beyond this, there are no other studies of any campaign's effects on driver knowledge, attitudes, or behavior.

Costs: A high-quality campaign will be expensive to develop, test, and implement.

Time to implement: A high-quality campaign will require at least 6 months to plan, produce, and distribute.

2.2 Communications and Outreach on Distracted Driving

Effectiveness: ☆	Cost: $$	Use: High	Time: Medium

Overall Effectiveness Concerns: *Based on NCHRP research, there are no studies of any campaign's effects on driver knowledge, attitudes, or behavior (Stutts, Knipling, Pfefer, Neuman, Slack, & Hardy, 2005, Strategies C1 and D2).*

Distracted driving communications and outreach campaigns for the general public face different, but equally difficult, obstacles than drowsy driving campaigns. Drivers "know" at some level that they should be alert. However, as discussed in the Overview, distractions come in many forms. Distractions outside the car are not under the driver's control. Many distractions inside the car also cannot be controlled easily (conversations, children), or are intentional (listening to the radio or CD player, eating). They may in fact be useful, to keep drivers alert on a long trip.

There is strong public support for communications and outreach to reduce distracted driving. For example, 80% of respondents in a Canadian survey agreed that greater awareness and education efforts are needed to alert drivers to the problem of distracted driving (Vanlaar et al., 2007). Many organizations have developed or conducted distracted driving communications and outreach campaigns directed to the general public. Some carry a general "pay attention" message, while others are directed at specific behaviors such as cell phone use. Examples of communications and outreach:

- "U Drive. U Text. U Pay." A program released by NHTSA in 2014 in support of texting ban enforcement during Distracted Driving Awareness Month (www.ghsa.org/html/issues/distraction/april2014.html)
- "Put It Down." A national campaign by the U.S. Department of Transportation to discourage the public from driving distracted
- "Faces of Distracted Driving." A national campaign created by DOT that tells the stories of families who are victims of crashes involving a distracted driver
- "No Phone Zone" by Oprah Winfrey
- "On the Road, Off the Phone" by the National Safety Council
- "Decide to Drive" by the American Academy of Orthopaedic Surgeons/Alliance of Automobile Manufacturers
- "Texting While Driving: It Can Wait" by AT&T

Driving while distracted is a particular concern for teenage drivers (Foss & Goodwin, 2014; NHTSA, 2012). GDL passenger and cell phone restrictions directly address two sources of distractions, as discussed in Chapter 4, Section 1.1. Broader communications and outreach efforts for young drivers regarding distracted driving also have been proposed. For example, a growing number of States are including distracted driving as a required component of driver education, the State's driver license test, or information provided in the driver license manual (GHSA, 2013). Some States have also developed their own education materials and programs aimed at teen drivers. See GHSA (2013) for links to these materials.

A campaign at the University of Kansas combined traditional media (e.g., newspaper ads), social media (e.g., Facebook, Twitter), and "guerilla marketing" strategies to increase awareness about the dangers of texting and driving, and to foster a negative view of texting and driving among the college community (Atchley & Geana, 2013a). The campaign promotes a "TXT L8R. Drive Safer" message. A survey of students at the University of Kansas found 75% had seen the TXT L8R message, and a third (32%) reported talking with a friend during the last month about the risks of texting while driving (Atchley & Geana, 2013b). See Atchley and Geana (2013a) for more information about the TXT L8R campaign.

The ultimate goal of these campaigns is to change driver behavior, but they face substantial obstacles. As discussed in other chapters, communications and outreach by themselves rarely change driving behavior (Chapter 1, Section 5.2; Chapter 2, Section 3.1; Chapter 3, Section 4.1; see also Stutts, Knipling, Pfefer, Neuman, Slack, & Hardy, 2005, Strategy C1). To have any chance, stand-alone campaigns must be carefully pre-tested, communicate health information not previously known, be long-term, and have substantial funding (Williams, 2007). A broad "stay alert" message may be too general to have any impact. Also, commonly used fear appeals are generally ineffective and in some cases may actually encourage *greater* distracted driving, especially among young adults (Lennon, Rentfro, & O'Leary, 2010). This "boomerang effect" of fear appeals is thought to occur because people deny the threat or feel their personal freedom is threatened, making the undesirable behavior even more attractive (Lennon et al., 2010).

Use: A recent survey by GHSA found that 47 States and the District of Columbia have implemented public information/education campaigns to address distracted driving (GHSA, 2013). In addition, a number of States have developed distracted driving PSAs.

Effectiveness: Based on NCHRP research, there are no studies of any campaign's effects on driver knowledge, attitudes, or behavior (Stutts, Knipling, Pfefer, Neuman, Slack, & Hardy, 2005, Strategies C1 and D2). A scan of documents through February 2017 found no evaluations for the effectiveness of stand-alone outreach campaigns.

Costs: A high-quality campaign will be expensive to develop, test and implement.

Time to implement: A high-quality campaign will require at least 6 months to plan, produce and distribute.

Other issues:

- **Non-traditional communication channels:** At least 36 States as well as NHTSA now use social networking sites to educate motorists about distracted driving (GHSA, 2013). Sites such as Facebook, Twitter, and YouTube can effectively and inexpensively reach large numbers of people. Social networking sites are especially popular among young people, who are often a primary target of distracted driving campaigns.

3. Other Countermeasures

3.1 Employer Programs

Effectiveness: ☆☆	Cost: $	Use: Unknown	Time: Short

Overall Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Drowsy driving is closely related to a person's employment. In 2008 the National Sleep Foundation conducted a survey of 1,000 U.S. residents who were employed full time. Those who work 50 or more hours per week were three times as likely to report driving drowsy on a weekly basis compared to those who work 30 to 40 hours per week (Swanson, Drake, & Arnedt, 2012).

Shift workers are one employment group at high risk for drowsy-driving crashes. Shift workers include people who work long or irregular hours or who work at night, including many law enforcement officers (Stutts, Knipling, Pfefer, Neuman, Slack, & Hardy, 2005, Strategy D6). Another at-risk group for drowsy driving crashes is medical interns, who frequently work extended shifts of 24 hours or more. Barger et al. (2005) collected monthly reports from 2,737 interns. Interns were 2.3 times more likely to report a crash and 5.9 times more likely to report a near miss after an extended shift than a shorter shift. Each extended shift in a month increased the monthly risk of a crash during the commute from work by 16%. NHTSA and the National Center on Sleep Disorders Research have produced a comprehensive workplace education program for shift workers. It includes information on sleep habits in general and drowsy driving in particular. Program material that includes a video, posters, brochures for workers and their families, tip cards, a PowerPoint training session, and an administrator's guide are available at www.nhtsa.dot.gov/people/injury/drowsy_driving1/human/drows_driving/. Employer programs can also include medical condition testing/education. See Section 3.2 for more information about medical conditions, medications, and drowsy driving.

There are many ways States can work with employers to address distracted and drowsy driving. Some States, such as Delaware and Kentucky, have corporate outreach program staff related to distracted driving (GHSA, 2013). The programs usually involve dissemination of traffic safety materials to employers, or sometimes directly to the employees themselves. States can also assist employers in promoting and enforcing policies to reduce distracted driving. Legally, employers can be held accountable for employees who are using a cell phone (or otherwise distracted) and who are involved in a crash as part of their work (NSC, 2012). Employers can protect themselves by implementing policies that prohibit distracted driving and by monitoring compliance. New Jersey has developed a sample cell phone use policy for businesses, available at www.nj.gov/lps/hts/downloads/Sample_Cell_Phone_Policy.pdf. The National Safety Council has developed a policy kit to assist employers with implementing or strengthening a cell phone ban, available at safety.nsc.org/cellphonekit.

Use: At least 17 States and the District of Columbia work with employers in their State to develop distracted driving policies (GHSA, 2013). The number of employers who use the NHTSA/NCSDR program is not known.

Effectiveness: The NHTSA/NCSDR program was tested by more than 20 U.S. companies and was well received by workers and management. It has not been evaluated further (Stutts, Knipling, Pfefer, Neuman, Slack, & Hardy, 2005, Strategy D3). No other employer distracted or drowsy driving program has been evaluated.

Costs: Since a comprehensive program is available at no cost, program costs will consist only of material production and employer time for training.

Time to implement: An employer program can be implemented within 3 months.

3.2 Education Regarding Medical Conditions and Medications

Effectiveness: ☆	Cost: Variable	Use: Unknown	Time: Medium

Overall Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

A number of chronic medical conditions and sleep disorders can potentially compromise sleep and elevate feelings of fatigue (Smolensky, Di Milia, Ohayon, & Philip, 2011). Three disorders, in particular, can cause drivers to fall asleep at the wheel:

- Insomnia is the subjective experience of having difficulty falling asleep or staying asleep. It affects an estimated 11% of the U.S. population (NSF, 2008). People suffering from insomnia often report daytime sleepiness that interferes with their daily activities.
- Sleep apnea is a breathing disorder characterized by brief interruptions of breathing during sleep, perhaps as many as 20 to 60 per hour (NSF, 2009a). By fragmenting nighttime sleep, sleep apnea produces daytime sleepiness. NSF estimates that about 4% of men and 2% of women are affected by sleep apnea. It can be treated by physical or mechanical therapy or by surgery.
- Narcolepsy is a disorder of the central nervous system's sleep-wake mechanism that can cause narcoleptics to fall asleep suddenly at any time (NSF, 2009b). It is quite rare, affecting about one person in 2,000. It can be treated with medications.

Several studies suggest that people suffering from insomnia are 2 to 3 times more likely to be involved in motor vehicle crashes compared to those without insomnia (Smolensky et al., 2011). Similarly, research also shows that people with sleep apnea are up to 6 times more likely to be involved in a crash (Teran-Santos, Jiminez-Gomez, & Cordero-Guevara, 1999). It has been estimated that crashes among people with sleep apnea cost approximately 16 billion dollars each year (Sassani et al., 2004). The number of crashes resulting from narcolepsy is not known.

Most cases of sleep apnea or narcolepsy are undiagnosed and untreated (Stutts, Knipling, Pfefer, Neuman, Slack, & Hardy, 2005, Strategy D6; NHTSA, 1998). Indeed, falling asleep at the wheel may be one of the main ways to raise the possibility of a sleep disorder and motivate a driver to seek medical attention (NHTSA, 1998). Once treated, people with sleep apnea have crash rates that are no higher than the general population (George, 2001).

There are many other medical conditions that can potentially compromise sleep or increase daytime feelings of fatigue such as asthma, chronic obstructive pulmonary disease, and rheumatoid or osteoarthritis. For a review of medical disorders and conditions that may affect sleep and driving risk, see Smolensky et al. (2011).

Many common prescription and over-the-counter medications can also cause drowsiness. Warning labels on the medications note this and caution users against driving or other activities that could be affected by drowsiness. For more information about how medications can impair drivers, see Chapter 1, Section 7.3.

The principal countermeasures to address sleep apnea, narcolepsy, and medication effects are

(NCHRP, 2005, Strategy D6):

1. Communications and outreach on sleep disorders to increase overall awareness of their symptoms, consequences, and treatment.
2. Efforts with driver licensing medical advisory boards to increase their awareness of these conditions as they review driver fitness for licensing.
3. Efforts with physicians to increase their awareness of these conditions and their potential effects on driving, to treat these conditions as appropriate, and to counsel their patients to take steps to reduce the risk of drowsy driving.

Additionally, it is important that pharmacies and drug makers include patient education about the potentially impairing effects of certain medications on driving (see Chapter 1, Section 7.3).

Use and Effectiveness: There is no known information available on how frequently these countermeasures are used or on how effective they have been in raising awareness, increasing knowledge, or affecting behavior.

Costs: Targeted communications and outreach to drivers (through driver licensing handbooks or flyers in license renewal material) or to physicians (through medical associations) would be relatively inexpensive. A communications and outreach campaign directed at all drivers will be expensive to develop, test and implement. See Chapter 1, Section 5.2 and Chapter 2, Sections 2.1 and 3.1, for additional discussion.

Time to implement: Either targeted or general communications and outreach activities will require at least 6 months to plan, produce, and distribute. Efforts with driver licensing medical advisory boards could be implemented quickly.

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A5. Motorcycle Safety

This section provides expanded discussion of the ☆ and ☆☆ countermeasures. Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

The ☆ and ☆☆ countermeasures covered in this section of the Appendix are listed below.

1. Motorcycle Helmets

Countermeasure	Effectiveness	Cost	Use	Time
1.2 Helmet Use Promotion Programs	☆	Varies	Low	Varies
1.3 Helmet Law Enforcement; Noncompliant Helmets	☆	$	Unknown	Medium

2. Alcohol Impairment

Countermeasure	Effectiveness	Cost	Use	Time
2.2 Alcohol Impairment: Communications	☆	$$	Medium	Medium

3. Motorcycle Rider Licensing and Training

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Motorcycle Rider Licensing	☆	$	High	Medium
3.2 Motorcycle Rider Training	☆☆	$$	High	Varies

4. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Conspicuity and Protective Clothing	☆	Varies	High	Medium
4.2 Motorist Awareness of Motorcyclists	☆	Varies	High	Medium

Effectiveness:

☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Motorcycle Helmets

1.2 Motorcycle Helmet Use Promotion Programs

Effectiveness: ☆	Cost: Varies	Use: Unknown	Time: Varies

Overall Effectiveness Concerns: *There appear to be no formal evaluations of the effect of helmet use promotion programs in States without universal helmet laws* (Raborn et al., 2008).

Several States without universal motorcycle helmet use laws promote helmet use through communications and outreach campaigns. To date, there is little evidence that these efforts to educate and promote helmet use among motorcyclists in the absence of universal helmet laws are effective, unless the publicity helps to gain enactment of such laws (Raborn et al., 2008). A parallel experience is evident in the efforts to increase seat belt use through educational and promotional efforts prior to the enactment of laws requiring seat belt use. Years of educational and promotional campaigns did little to increase seat belt use. It was only after laws requiring use were enacted that seat belt use began to rise substantially (Raborn et al., 2008).

The MSF, GHSA, NHTSA, and other groups encourage helmet use. NHTSA has developed helmet use promotion brochures, flyers and public service announcements suitable for television and radio that are available online. Raborn et al. (2008) describes elements that should be included in a campaign should one be undertaken.

Use: Baer, Ayotte, and Baldi (2010) distributed self-report surveys to States on their motorcycle safety programs and received responses from 45 States. Thirty-three of the 43 States that responded to a question on helmet use promotion, both with and without helmet laws, indicated they actively promote helmet use, but the nature and extent of these promotions is unknown. Only one State reported using paid broadcast media spots.

Effectiveness: There appear to be no formal evaluations of the effect of helmet use promotion programs in States without universal helmet laws (Raborn et al., 2008). However, helmet use remains substantially lower in States without universal helmet laws than in States with such laws (Pickrell & Li, 2016).

Costs: Good communications and outreach campaigns can be expensive to develop and implement: see Chapter 2, Section 3.1. Helmet use promotion material is available from various sources including MSF, NHTSA (2003), and from States that have conducted these campaigns.

Time to implement: A proper campaign, including market research, material development, and message placement, will require at least 6 months to plan and implement. Baseline data and post-campaign evaluation can require an additional 6 months or longer.

1.3 Motorcycle Helmet Law Enforcement: Noncompliant Helmets

Effectiveness: ☆	Cost: $	Use: Unknown	Time: Medium

Overall Effectiveness Concerns: *The effectiveness of an enforcement program on noncompliant helmet use has not been evaluated.*

Law enforcement officers in universal helmet law States easily can observe and cite motorcycle riders who are not wearing helmets. This deterrent to non-use likely explains why helmet use rates are high in universal helmet law States (Chapter 5, Section 1.1). In addition, many States require motorcyclists to wear helmets that comply with FMVSS 218, and Federal regulations require all motorcycle helmets sold in the United States to meet or exceed the FMVSS 218 standards. Helmets that do not meet the FMVSS 218 performance requirements are considered noncompliant. The prioritized recommendations of the National Agenda for Motorcycle Safety lists effective strategies to increase the use of FMVSS 218-compliant helmets as a high priority item (NHTSA, 2013). Use of noncompliant helmets by all riders increased from 5% in 2014 to 11% in 2015 according to a nationally representative observational survey of helmet use (Pickrell & Li, 2016). Use of compliant helmets decreased to 61%.

Motorcycle riders wearing noncompliant helmets are essentially no safer than if they wore no helmets at all. NHTSA tested a number of non-compliant helmets and found that the energy allowed to transfer to the head by the non-compliant helmet gave a 100% probability of fatal head injuries (NHTSA, 2007b). In addition to offering no energy-absorbing materials, a noncompliant helmet often covers only a portion of the rider's head and has inadequate or unused chin straps so the helmet is not likely to stay on the rider's head in a crash (NHTSA, 2007b). A recent study also found that not all compliant helmets provide the same level of protection. Brewer et al. (2013) found a reduced risk of injury to motorcyclists wearing full face helmets compared to other types of DOT-compliant helmets.

The challenge of motorcycle helmet law enforcement in States requiring FMVSS 218-compliant helmets is to actively identify and cite motorcycle riders wearing noncompliant helmets. Identifying a noncompliant helmet is easier than proving that it is noncompliant. Some noncompliant helmets have spikes or other protrusions, making them fairly easy to identify as noncompliant. Compliant helmets are formally identified by a DOT label on the back of the helmet. However, counterfeit DOT stickers are easily available and are found on many noncompliant helmets (although some noncompliant helmets may have labels that say they are novelty helmets and not motorcycle helmets). As a result of these stickers, it is difficult to enforce a noncompliant helmet citation in some courts (Raborn et al., 2008, Strategy E1). In May 2011, NHTSA issued a Final Rule (which came into effect in May 2013) to strengthen helmet labeling requirements and to make it easier to prove that a helmet is noncompliant. For helmet laws to be effective, such laws must be vigorously enforced, extensively publicized, and adequately funded. NHTSA prepared a video clip for motorcyclists and law enforcement demonstrating how to identify compliant and noncompliant helmets and how to choose a helmet that fits properly (NHTSA, 2006b). NHTSA also produced a brochure on how to identify noncompliant helmets (NHTSA, 2004).

Use: Sixteen of 43 States that reported to Baer, Ayotte, and Baldi (2010) indicated that they conduct law enforcement activities to identify and cite noncompliant-helmet wearers, but only States having universal helmet laws would implement such programs (19 States and the District of Columbia as of November 2016; GHSA, 2016; IIHS, 2016). In 2007, the New York State Police pilot-tested a motorcycle safety checkpoint enforcement program. In the pilot effort, 225 motorcycles of 280 passing through the checkpoint were inspected. Traffic citations were issued to 104 motorcyclists; the most common citation (41 issued) was for operating with a non-compliant helmet (Salmon, 2008).

Effectiveness: The effectiveness of an active helmet law enforcement program on noncompliant helmet use has not been evaluated.

Costs: Since helmet laws can be enforced during regular traffic patrols, the costs will be for training law enforcement officers, prosecutors, and judges to identify noncompliant helmets.

Time to implement: An active helmet-law enforcement program requires planning an effective enforcement strategy, training law enforcement officers to identify noncompliant helmets and to carry out the enforcement, and training for prosecutors and judges to assure that citations will be prosecuted and adjudicated. This training can require 4 to 6 months to implement. Publications are available to help with non-compliant helmet identification, but other program aspects and training may need to be developed or adapted. These elements may require 6 months or longer.

2. Alcohol Impairment

2.2 Alcohol-Impaired Motorcyclists: Communications and Outreach

Effectiveness: ☆	Cost: $$	Use: Medium	Time: Medium

Overall Effectiveness Concerns: *A literature search found no evaluations of the safety effectiveness of any drinking and riding campaigns.*

Many States have conducted communications and outreach campaigns directed at drinking and riding. See NHTSA (2006a) and Raborn et al. (2008, Strategy B1) for more information and links. Organizations including AMA and MSF have produced campaigns and material on drinking and riding. See NHTSA (2006a) and Raborn et al. (2008) for strategies for implementation, examples, and links to materials. There are few evaluations of the effectiveness of any of these campaigns at any level, from awareness to knowledge and attitude change to any effect on motorcyclists' drinking and riding behavior. The experience of drinking and driving campaigns directed at all drivers suggests that they are unlikely to have a positive effect unless they are carefully researched and planned, well-funded, well executed, achieve high levels of target audience exposure (perhaps using paid advertising), use high-quality messages that are pre-tested for effectiveness, and are conducted in conjunction with enforcement activities directed at impaired motorcyclists. See Chapter 1, Section 5.2, for further discussion.

A focus group study (Becker et al., 2003) examined motorcyclists' attitudes, beliefs, and behaviors regarding drinking and riding. It concluded that many motorcyclists have strong feelings of freedom, independence, and individual responsibility and believe that drinking motorcyclists endanger only themselves. Consequently, they believe that government efforts to discourage drinking and riding are inappropriate. These beliefs also limit some motorcyclists' willingness to take actions to prevent others from riding while impaired.

A program, "Riders Helping Riders," targets the expressed willingness of some motorcycle riders to help other riders by encouraging them to intervene to prevent other motorcycle riders from riding impaired and to create a stronger safety culture among motorcyclists. This program is based on the beliefs and attitudes of riders from focus group research (McKnight & Becker 2007a, 2007b; McKnight, Becker, & Tippetts, 2008), and is available on a CD for individual and group use. The material was pilot-tested in Georgia. Riders' attitudes and intentions toward intervening seemed to improve based on surveys taken before and immediately after training. Longer-term evidence of attitude change, interventions actually carried out, or definitive safety effects from behavioral changes will require exposure to large numbers of riders and longer follow-up of crashes (McKnight et al., 2008; McKnight, Becker, & Tippetts, 2008).

Another program called "Green-Yellow-Red" was recently developed and tested in Wisconsin (Aguilar & Delehanty, 2009). The campaign sought to educate motorcycle riders about the dangers of drinking and riding, encourage them to make safer choices, and provide impaired motorcycle riders with secure storage of their motorcycles so that they could find safe transport home. A coalition was established that included motorcycle riders, tavern owners, law enforcement, and local businesses, and substantial media attention was obtained at the program kick-off. While there is evidence that riders were willing to leave their motorcycles in secure storage containers, only small changes in rider behavior and alcohol-related motorcycle crashes were observed following the program (Aguilar & Delehanty, 2009).

Rider groups can play critical roles in planning and implementing activities to reduce drinking and riding. Some State and local rider groups sponsor alcohol-free events or adopt alcohol-free policies. As examples, the Fox Valley, Wisconsin, Harley Owners Group (H.O.G.) chapter has an alcohol-free policy for all organized rides and Illinois American Bikers Aimed Toward Education (ABATE) sponsors alcohol-free rides (NHTSA, 2006a, Section 1).

Use: Many States have conducted anti-drinking-and-riding campaigns (NHTSA, 2006a; Raborn et al., 2008, Strategy C1), but the total number of States that have done so is unknown. Some examples of States campaigns include Connecticut's "Open the Throttle, Not the Bottle" and Minnesota's "Drinking and Riding: A Really Bad Idea." Many other States have brochures and other material. It also is not known how many States have included messages directed to motorcyclists in their overall alcohol-impaired-driving campaigns. However, motorcycle riders are now included in the *Drunk Driving. Over the Limit. Under Arrest* paid media spots. NHTSA administers incentive grants for States that apply and meet regulatory criteria for programs that prevent impaired riding.

Effectiveness: There are no evaluations of the safety effectiveness of any drinking and riding campaigns.

Costs: A good campaign will require substantial funds to conduct market research, design and test messages, and place campaign material where it will reach motorcyclists frequently.

Time to implement: A substantive campaign will require at least 12 months to research, design, test, and implement. A vigorous implementation will require a significant duration.

3. Motorcycle Rider Licensing and Training

3.1 Motorcycle Rider Licensing

Effectiveness: ☆	Cost: $	Use: High	Time: Medium

Overall Effectiveness Concerns: *Although this countermeasure is widely used, the effectiveness of current licensing and testing on crashes and safety has not been evaluated.*

All 50 States, the District of Columbia, and Puerto Rico require motorcycle riders to obtain a motorcycle operator license or endorsement before they ride on public highways (MSF, 2012). The goal of licensing is to assure that motorcycle riders have a minimum skill level needed to operate motorcycles safely (NHTSA, 2000).

State motorcycle licensing practices vary substantially. Most States have learner's permits requiring only vision and/or knowledge tests. A motorcycle rider with a learner's permit can ride only in restricted circumstances, typically some combination of no passengers, only during daylight hours, and only with the supervision of a fully licensed motorcyclist. A riding skills test is required for full licensure (Alabama does not require a skills test for licensure). Two-thirds of the States use one of three tests developed by the MSF and American Association of Motor Vehicle Administrators, while one-third use their own test. Most States will waive the skills test, and sometimes the knowledge test, for motorcyclists who have completed approved motorcycle rider training courses, if the student passes the knowledge and skills tests administered at the conclusion of the course. See Motorcycle Safety Foundation (2012) for a summary of each State's licensing requirements and procedures and Raborn et al. (2008, Strategy C1) for brief summaries of the major skills tests currently in use.

The effectiveness of motorcycle operator licensing is not known. This is perhaps not surprising given the variability of licensing tests and procedures. NAMS recommends research to "ensure that licensing tests measure skill and behaviors required for crash avoidance" (NHTSA, 2000). Raborn et al. (2008, Strategies C2 and C3) describes strategies to couple training and licensing to help ensure that riders are both trained and obtain the necessary endorsements, but notes that there are no evaluations of whether increasing the proportion of motorcycle riders who are validly licensed would reduce motorcycle crashes or injuries.

Despite State requirements, many motorcycle riders are not properly licensed. In 2015, 27% of motorcycle riders involved in fatal crashes did not have valid motorcycle licenses, compared to 13% of passenger vehicle drivers involved in fatal crashes who were not properly licensed (NCSA, 2017). Licensing systems in some States provide no incentive to become fully licensed because learner's permits may be renewed indefinitely (Raborn et al., 2008, Strategy C3; MSF, 2012).

The prioritized recommendations of the NAMS (NHTSA, 2013) recommends the following approaches to encourage full licensure:

- Merge rider education/training and licensing into one-stop operations (Medium Priority)
- States issue motorcycle endorsements immediately upon course completion (Medium

priority)
- Identify and remove barriers to obtaining a motorcycle endorsement (Low Priority)
- Enforce penalties for improperly licensed riders (Low Priority)
- Insurance policies should not be valid for improperly licensed riders (Low Priority)
- Train license examiners in motorcycle issues (Medium Priority)
- Develop and evaluate enhanced licensing model using graduated licensing concepts (Medium Priority)
- Research to assure that licensing tests measure crash avoidance skills, behaviors (Low Priority)

The Raborn et al. (2008, Strategy C3) describes how Maryland and Minnesota used some of these strategies to increase proper licensing for motorcycle riders. Maryland used the additional strategy of comparing their vehicle registration and driver licensing files. A letter was sent to each owner of a registered motorcycle who did not have a motorcycle operator’s license. The letter reminded each registered owner that a motorcycle endorsement was required of anyone operating the registered motorcycle. This quick and inexpensive strategy caused 1,700 owners to become licensed within 4 months. A randomized controlled experiment of this intervention suggested that while the method did increase licensure, a large percentage remained unlicensed (Braver et al., 2007). California also tried this approach with similar licensure results (Limrick & Masten, 2013). Effective July 22, 2007, the State of Washington added an authorization to impound vehicles operated by drivers without a proper endorsement (including, but not limited to, motorcycles). However, an evaluation of the effects of this law did not find a significant impact on new or total motorcycle endorsements following implementation of the law (McKnight, Billheimer, & Tippetts, 2013).

Maryland and Pennsylvania have “one-stop shops” that provide a motorcycle endorsement immediately upon successful completion of a State-approved motorcycle rider training course or test, without having to wait after receiving a permit. For Pennsylvania’s procedures, see www.pamsp.com/CourseInfo_Basic.aspx.

Baer, Cook, and Baldi (2005) reviewed and summarized each State’s motorcycle education and licensing programs and practices. A companion report (Baer, Baldi, & Cook, 2005) describes training and licensing programs and actions to promote training and licensing. Under a cooperative agreement with NHTSA, AAMVA has updated its *Motorcycle Operator Licensing System* and *Integrating Motorcycle Rider Education and Licensing* manuals, by publishing the *Guidelines for Motorcycle Operator Licensing* (GMOL). The GMOL provides guidelines for State motorcycle licensing programs (Hanchulak & Robinson, 2009).

Use: All States require motorcycle riders to obtain a motorcycle license or endorsement to ride on public highways. Less than half of responding States indicated that they enforce laws relating to improperly licensed motorcyclists (Baer et al., 2010).

Effectiveness: The effectiveness of current licensing and testing on crashes and safety has not been evaluated. An evaluation of a California program to increase licensure among improperly licensed motorcycle owners through DMV letters found that while the letters did increase licensure, there was no identifiable causal effect on crash involvements or traffic violations (Limerick & Masten, 2013).

Costs: Most States charge a small fee for the motorcycle licensing tests (MSF, 2012). The costs of changing the licensing tests and procedures depend on the extent of changes and the amount of retraining needed for licensing examiners as well as what portion of costs are covered by licensing fees.

Time to implement: Developing new policies to encourage higher rates of full motorcycle licensure (including limiting the number of times a provisional license may be renewed, administrative practices such as adding testing times and locations, or training motorcycle license examiners), or procedures such as waiving the skills test for those who have passed an approved training course, would likely require 6 to 12 months to implement. Enforcement of motorcycle licensing requirements could occur more readily, if requirements for full licensure are clear enough to enforce.

Other issues:

- **Graduated driver licensing (GDL):** The NAMS recommended that States enhance motorcycle licensing practices by incorporating and evaluating use of GDL concepts (NHTSA, 2000) and ranked it as a medium priority item in the Prioritized Recommendations of the NAMS (NHTSA, 2013). Additionally, the United States Government Accountability Office recommended graduated licensing for motorcyclists as a high priority research item in a 2012 Report to Congress (GAO, 2012).

  Most States employ graduated driver licensing for beginning automobile drivers. Under GDL, new drivers must pass through learner's permit and provisional license stages before becoming fully licensed. A learner's permit allows driving only while supervised by a fully licensed driver and a provisional license prohibits unsupervised driving under certain conditions, such as at night or with passengers. GDL programs for automobile drivers have been shown to be effective in reducing crashes (Hedlund, Shults, & Compton, 2003, 2006; Williams, Tefft, & Grabowski, 2012). Evaluations in New Zealand and evidence from Quebec suggest that the same may be true for motorcyclists (Mayhew & Simpson, 2001). NHTSA's *Guidelines for Motorcycle Operator Licensing* includes a model graduated licensing program for motorcycle riders (Hanchulak & Robinson, 2009).

  Many States currently place restrictions on motorcycle riders with a learner's permit or younger than a specified age (MSF, 2012). For example, California GDL prohibits passengers, freeway riding, and nighttime riding during the learner permit stage and requires all people under 21 to complete a motorcycle rider training course offered by the California Highway Patrol. In Utah, motorcycle endorsements are restricted to motorcycles no larger than the size of the motorcycle used for the skills test, or used during the approved State training course (substitute). The endorsement can be changed by testing on a larger size motorcycle.

3.2 Motorcycle Rider Training

Effectiveness: ☆☆	Cost: $$	Use: High	Time: Varies

Overall Effectiveness Concerns: *This countermeasure's effectiveness has been examined in several research studies. Although there have been some positive research findings, the balance of evidence regarding countermeasure effectiveness remains inconclusive.*

As of 2015, all 50 States offered rider education (MSF, 2016). Sixty percent of the 44 States that responded to a survey question from Baer et al. (2010) reported they were able to accommodate all riders seeking training within a calendar year. Training also is provided by some rider organizations (for example, some ABATE and Gold Wing groups), manufacturers (Harley-Davidson), the U.S. Military, and others. Many States encourage training either by requiring it for all motorcycle operators or those under a specified age, or by waiving some testing requirements for motorcycle riders who complete and pass an approved training course (Baer, Cook, & Baldi, 2005). Most entry-level training uses the *Basic RiderCourse* curricula developed by the Motorcycle Safety Foundation. The *Experienced RiderCourse* suite (ERC) is offered to riders with some previous experience or for seasoned riders who want additional training; however, the ERC represents a very small part of total training provided.

Although training is available, it is not at all clear what constitutes appropriate rider education and training, or whether current training reduces crashes. Evidence suggests that in addition to teaching motorcycle control skills, programs would better prepare riders if they trained riders to recognize potentially hazardous riding situations and encourage riders to assess their own abilities and limitations, and to ride within those constraints (e.g., Clarke, Ward, Bartle, & Truman, 2007; Elliott, Baughan, & Sexton, 2007). NHTSA supported the development of Model National Standards for Entry Level Rider Training, released in August 2011. These Model Standards recommend content for motorcycle rider training courses. States are encouraged to go beyond the standards to address State-specific crash needs (NHTSA, 2011).

The NAMS encourages training (NHTSA, 2000). NHTSA's Motorcycle Safety Program Plan recommends that States conduct frequent and timely education and training at sites that are accessible throughout the State (NHTSA, 2006b). Raborn et al. (2008, Strategy C2) further recommends that States evaluate crash experience, compare data and crash scenarios with training and licensing practices, and make adjustments as needed to ensure practices are effectively targeting crash problems. This effort requires cooperation on the part of multiple agencies, including those responsible for collecting and analyzing crash data and those responsible for training and licensing.

States should provide motorcycle training on a timely basis to those who wish to take it. See Baer, Baldi, and Cook (2005) and NHTSA (2006a) for examples of successful methods to use training capacity more effectively, including creative scheduling, centralized on- line registration systems, and use of private providers.

Use: Most States offer training to both experienced and beginning motorcycle riders. For more information about the features of training and education programs offered by the States, see Baer, Ayotte, and Baldi (2010).

Effectiveness: Kardamanidis, Martiniuk, Stevenson, and Thistlethwaite (2010) evaluated the results of 23 studies for a Cochrane Review and found conflicting evidence with regard to the effectiveness of motorcycle rider training in reducing crashes or offenses. Due to the poor quality of available studies (most of the studies had selection and detection bias) the authors were unable to draw any conclusions about its effectiveness. However, data suggests that having mandatory pre-license training for motorcyclists may reduce crashes and offenses by discouraging motorcycle riding, thus limiting exposure.

While there have not been many positive studies regarding motorcycle rider training up to this point, a study conducted by Boele and de Craen (2014) investigated the possibility of training higher order motorcycle skills with 'risk' training. Specifically, their study investigated if the training had an effect on motorcyclists' safe riding behavior and their hazard perception in the short term (a few months after training) and long term (12 to 18 months after training). Training participants were divided into experimental and control groups. Riders in both groups participated in a pre-test, which included a questionnaire and on-road ride. They also completed a short-term post-test, which included the same pre-test questionnaire and on-road ride as well as a hazard perception test. Finally, this was followed by a long-term post-test, which included the same pre-test questionnaire and on-road ride, and a hazard perception test. Participants in the experimental group received the 'risk' training between the pre-test and the short-term post-test activities. In terms of observed riding behavior, results indicated that participants in the experimental ('risk' training) group demonstrated more safe riding behaviors compared to those in the control group. In terms of hazard perception during the short term, post-test results indicated that participants in the experimental ('risk' training) group identified more hazards than participants in the control group. This same result was found for the long-term post-test; however, it was not statistically significant indicating that the impact on hazard perception was not sustained in the long term.

Although the results of the Boele and de Craen (2014) study are positive, the authors are quick to caution the idea of implementing this training on a large scale. Specifically, they attribute retention of the training's effect to following the design and curriculum closely as well as the didactic and substantive quality of trainers, which need to be considered with any implementation of this training.

Costs: Rider training programs are funded in part by the States and in part by fees paid by the students who take them. Many States offset some or all of their costs through motorcycle license or student registration fees.

Time to implement: Rider training currently is conducted in all States. Training capacity is limited by the number of available training sites (a broad expanse of paved surface such as a school parking lot is required), qualified instructors, and motorcycles and helmets for students to use during training. Some measures to increase capacity can be implemented quickly while others may take 6 to 12 months.

Other issues:

- **Training for other motorcycle configurations (three-wheeled motorcycles and motorcycles pulling trailers**): Several motorcycle organizations offer courses that address these special motorcycle configurations. These courses have not been evaluated.

4. Communications and Outreach

4.1 Communications and Outreach: Conspicuity and Protective Clothing

Effectiveness: ☆	Cost: Varies	Use: High	Time: Medium

Overall Effectiveness Concerns: *This countermeasure is widely used, but it has not been extensively studied. There is some evidence that certain approaches may lead to limited positive outcomes; however, there is insufficient evaluation data to determine the extent of effectiveness*.

Motorcycle riders should wear clothing that provides both protection and visibility. FMVSS 218 helmets (Chapter 5, Sections 1.1-1.3) with face shields protect the eyes from wind and foreign objects in addition to protecting the head in a crash (Brewer et al., 2013). Well-constructed jackets, pants, boots, and gloves can prevent abrasions and bruises. If made of impact-resistant material, they even may prevent arm and leg fractures or serious torso and spinal cord injuries (NHTSA, 2000). The benefits of protective clothing, in particular protective clothing equipped with body armor, was further confirmed by a series of studies of Australian motorcyclists involved in crashes (de Rome et al., 2011; de Rome et al., 2012).

A common perception among riders is that a frequent cause of motorcycle crashes involving other vehicles is that other vehicle drivers do not see the motorcycle. The 1981 Hurt et al. (1981) study from the United States and a 2007 study from the U.K. (Clarke, Ward, Bartle, & Truman, 2007) report that right-of-way collisions involving other motorists are more frequently the fault of the other motorist. Failure of the other motor vehicle driver to perceive the motorcyclist seems to occur in a significant portion of these types of crashes (Clarke et al., 2007). One easy way to increase motorcycle conspicuity is through continuous headlight use. Most motorcycles manufactured since 1979 have headlights that turn on automatically when the vehicle is started (Raborn et al., 2008, Strategy D2). Additionally, 24 States require daytime headlight use for all motorcycles manufactured after a certain date (all at least 20 years ago) (MSF, 2014). However, the increasing prevalence of passenger vehicles using continuous headlights may reduce the visibility and effectiveness of motorcycle headlights (Cavallo & Pinto, 2012).

A second way to increase conspicuity is to wear brightly colored clothing, use white or bright-colored helmets (for increased visibility during daylight), and incorporate retro-reflective materials or devices (for increased visibility at night). Research studies confirm that motorcyclists wearing conspicuous clothing or helmets are less likely to be involved in a crash (Wells et al., 2004; Raborn et al., 2008, Strategy D1). However, many riders choose not to wear brightly colored clothing or riding gear.

As discussed in the introduction of this chapter, auxiliary head and brake lights, flashing headlights, and other vehicle technologies enhance conspicuity, but the effects on crashes have not been studied. Adoption of these technologies may be useful to promote among the motorcycling community, may require changes in laws if visibility enhancing technologies are restricted by States, and may also involve working with manufacturers and producers of motorcycles and auxiliary devices (Raborn et al., 2008).

There are no data on how many motorcycle riders wear various types of protective clothing (other than helmets) or use auxiliary devices. Helmet manufacturers and distributors report that more than half the helmets sold for street use are black and the predominant color of motorcycle clothing is black (Raborn et al., 2008, Strategy D1).

Communications and outreach campaigns promoting protective and conspicuous clothing have been conducted by States and by motorcyclist organizations. Some States also teach the benefits of using high-visibility clothing in their training programs. The Raborn et al. (2008, Strategy D1) provides examples of material from Oregon and the MSF and references to additional material from the SMSA, and the Gold Wing Road Riders Association.

Use: Of the 44 States responding to a survey question, 33 reported encouraging conspicuity-enhancing clothing and helmets to enhance motorcyclists' visibility (Baer et al., 2010). The extent or nature of these efforts is unknown.

Effectiveness: The use of high-visibility clothing and protective gear enhances safety. There is some limited evidence to suggest that a program aimed at increasing conspicuous and protective clothing would be successful. An Australian study found that the observed proportion of riders wearing full body protection increased in the month following an enforcement/educational campaign with an emphasis on conspicuous and protective clothing (among other safety issues). However, it is unclear whether any real safety benefits were sustained (Baldock et al., 2012).

Costs: Good communications and outreach campaigns can be expensive to develop and implement: see Chapter 2, Section 3.1. Information promoting protective and conspicuous clothing is available from various sources including MSF, other motorcyclist organizations, and States that have conducted these campaigns (Raborn et al., 2008, Strategy D1).

Time to implement: A proper campaign, including market research, message development and testing, and implementation, will require at least 6 months to plan and implement.

4.2 Communications and Outreach: Motorist Awareness of Motorcyclists

Effectiveness: ☆	Cost: Varies	Use: High	Time: Medium

Overall Effectiveness Concerns: *Although this countermeasure is widely used, no evaluations of the effectiveness of campaigns to increase driver awareness of motorcyclists are available.*

In multi-vehicle motorcycle crashes, the other vehicle driver is frequently cited for having violated the motorcyclist's right-of-way (Clarke et al., 2007; Elliott et al., 2007; Raborn et al., 2008, Strategy F3; NHTSA, 2000). Motorcycles and motorcyclists are smaller visual targets than cars or trucks, resulting in low conspicuity (see Chapter 5, Section 4.1). Also, drivers may not expect to see motorcycles on the road (Raborn et al., 2008, Strategy F3; NHTSA, 2000). Clarke et al. (2007) reported that even when motorcyclists were using headlights and high-conspicuity clothing drivers sometimes failed to notice them.

Several States have conducted communications and outreach campaigns to increase motorists' awareness of motorcyclists. Typical themes are "Share the Road" or "Watch for Motorcyclists." Some States build campaigns around "Motorcycle Awareness Month," often in May, early in the summer riding season. Many motorcyclist organizations, including MSF, SMSA, the Gold Wing Road Riders Association, and State and local rider groups, have driver awareness material available. See NHTSA (2006a, Section 5) and Raborn et al. (2008, Strategy F3) for links and references. Some organizations also make presentations on drivers' awareness of motorcyclists to driver education classes.

NHTSA developed model language on sharing the road safely with motorcyclists. The model language is appropriate for traffic safety education courses, driver manuals, and other communication and outreach activities (NHTSA, 2007a). NHTSA developed a "Share the Road" program planner for use by States, communities, and the motorcycling community (see www.trafficsafetymarketing.gov/ShareTheRoad).

Use: Thirty-six of 44 States that responded to a survey question reported that they communicate about ways for drivers to increase their awareness of motorcycles and motorcyclists (Baer et al., 2010). NHTSA (2006a, Section 5) and Raborn et al. (2008, Strategy F3) provide examples or links to campaigns from a dozen States.

Effectiveness: There are no evaluations of the effectiveness of campaigns to increase driver awareness of motorcyclists (Raborn et al., 2008, Strategy F3).

Costs: Good communications and outreach campaigns can be expensive to develop and implement: see Chapter 2, Section 3.1. Motorcyclist awareness material is available from various sources including the MSF, other motorcyclist organizations, and States that have conducted these campaigns (Raborn et al., 2008, Strategy F3).

Time to implement: A proper campaign, including market research, message development and testing, and implementation, will require at least 6 months to plan and implement.

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A6. Young Drivers

This section provides expanded discussion of the ☆ and ☆☆ countermeasures. Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

The ☆ and ☆☆ countermeasures covered in this section of the Appendix are listed below.

1. Graduated Driver Licensing

Countermeasure	Effectiveness	Cost	Use	Time
1.5 Cell Phone Restrictions	☆☆	$	Medium	Medium
1.6 Belt Use Requirements	☆☆	$	Low	Medium
1.7 Intermediate – Violation Penalties	☆	$	High	Medium

2. Driver Education

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Pre-Licensure Driver Education	☆☆	$$$	Medium	Long
2.2 Post-Licensure Driver Education	☆	$$$	Low	Long

3. Parents

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Parent Roles in Teaching and Managing	☆☆	$$	Medium	Short

Effectiveness:

- ☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results
- ☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise.

See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies

1. Graduated Driver Licensing

1.5 GDL Cell Phone Restrictions

Effectiveness: ☆☆	Cost: $	Use: Medium	Time: Medium

Overall Effectiveness Concerns: *This countermeasure is widely used. Its effectiveness has been examined in a few research studies. Although there have been some positive research findings, the balance of evidence regarding countermeasure effectiveness remains inconclusive.*

As discussed in Chapter 4, Section 1.2, young drivers are at a greater risk of crashing when they engage in distracting behaviors (Ferguson, 2003; Klauer et al., 2014). Specifically with regards to cell phone use, young drivers are at higher risk of crashing when they reach for a cell phone, dial a cell phone, or text while driving compared to when they do not engage in these behaviors (Klauer et al., 2014). To reduce this risk, a growing number of States include cell phone restrictions in their GDL laws. See Chapter 4, Section 1.2 for a discussion of cell phone laws applying to all drivers.

Use: As of August 2014, 38 States and the District of Columbia prohibit cell phone use for young drivers. These bans cover *all* cell phone use, not just hand-held phones. In some States the cell phone restrictions cover teenagers holding a learner’s permit and intermediate license; in other States the restrictions cover all drivers under a certain age, such as 18 or 19 (GHSA, 2014a; IIHS, 2014a). Fourteen States and the District of Columbia prohibit hand-held cell phone use for all drivers. In addition, 44 States and the District of Columbia prohibit text messaging for all drivers and 4 States ban text messaging among young drivers (see Chapter 4, Section 1.2).

Effectiveness: There is conflicting evidence regarding the effectiveness of cell phone restrictions on young drivers’ behaviors and crash outcomes. In 2009, a study examined the short-term effects of a teenage driver cell phone restriction in North Carolina, and found that 5 months after a ban on cell phones took effect, the proportion of teens using cell phones while driving was unchanged (Foss, Goodwin, McCartt, & Hellinga, 2009). A follow-up study evaluated the long-term effect of North Carolina’s cell phone restriction two years after the law went into effect (Goodwin, O’Brien, & Foss, 2011). Teenagers were observed at high schools in North Carolina and also in South Carolina, which did not have a cell phone restriction. In both States, there was a decrease in cell phone use. However, the decrease in cell phone use did not significantly differ between the two States, despite increased awareness of the restriction among licensed teens in North Carolina (Goodwin et al., 2011).

Two studies have examined the effects of cell phone bans on young driver crashes (Lim & Chi, 2013; Ehsani, Bingham, Ionides, & Childers, 2014). Lim and Chi (2013) examined the relationship between cell phone bans and fatal crashes among drivers 20 years old and younger. They compared States across the United States that had no cell phone restrictions, cell phone restrictions that applied only to young drivers, and cell phone restrictions that applied to all drivers regardless of age. They found that cell found restrictions that applied to all drivers regardless of age were associated with a decrease in fatal crashes among young drivers. However, States that had cell phone restrictions that only applied to young drivers had no significant effect. Conversely, Ehsani et al. (2014) examined the effects of Michigan's universal texting law on crash types among 16- and 17-year-old drivers and found a slight increase in more serious types of crashes including fatal/disabling injury crashes and non-disabling injury crashes. However, they found a slight decrease in less severe crashes (e.g., possible injury/PDO crashes).

Costs: Once GDL is in place, a cell phone restriction can be implemented at very little cost.

Time to implement: GDL requirement changes typically require about 6 months to notify the public and implement the changes.

1.6 GDL Belt Use Requirements

Effectiveness: ☆☆	Cost: $	Use: Low	Time: Medium

Overall Effectiveness Concerns: *To date, there has been only one evaluation of the effects of explicit seat belt use requirements in GDL laws. This evaluation found no evidence that the countermeasure had any effect on teen driver belt use (Freedman & Levi, 2008).*

Properly worn seat belts can dramatically reduce the risk of injury or death to vehicle occupants in the event of a crash (NHTSA, 2001; NCSA, 2015). Seat belts are particularly important for teenage drivers because of their elevated crash risk. Nonetheless, teenage drivers and passengers have lower seat belt use rates than older drivers and passengers (NHTSA, 2009). Belt use is particularly low among teenagers who are male, drive pickup trucks, and live in rural areas (Kim, Depue, Spence, & Reine, 2009).

Young drivers are covered by seat belt laws in all States (with the exception of New Hampshire, which only requires seat belts for people under 18) (GHSA 2014b; IIHS, 2014b). Some States explicitly require belt use under their GDL laws. An explicit belt use requirement in a State's GDL law may have more influence on beginning drivers than the State's overall belt use law, especially in States where a GDL belt use requirement is coupled with primary enforcement for young drivers and in States where seat belt violations result in delayed graduation to the next GDL stage.

Use: In 2005, GDL laws in 15 States explicitly required seat belt use (AAA, 2005). Sanctions for violating this requirement varied across the States.

Effectiveness: To date, there has been only one evaluation of the effects of explicit seat belt use requirements in GDL laws. Tennessee and Wisconsin both have a seat belt restriction within their States' GDL program. Evaluations of the restrictions in these two States found little, if any, effect on teen driver belt use (Freedman & Levi, 2008). One problem is that teens (and parents) may not be aware when seat belt laws are part of a State's GDL system. For example, surveys in North Carolina have shown very high awareness for the State's nighttime and passenger restrictions, but only 3% of teens and 5% of parents were aware of the special GDL provision concerning seat belts (Goodwin & Foss, 2004).

Costs: Once GDL is in place, a belt use requirement can be implemented at very little cost.

Time to implement: GDL requirement changes typically require about 6 months to notify the public and implement the changes.

1.7 GDL Intermediate License Violation Penalties

Effectiveness: ☆	Cost: $	Use: High	Time: Medium

Overall Effectiveness Concerns: *The few evaluations of early stand-alone probationary license systems generally found no substantial benefits (McKnight & Peck, 2003; Simpson, 2003). No recent evaluations have attempted to separate out the effect of penalties for GDL or other traffic law violations from the overall effects of GDL. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

A probationary feature is included in the intermediate phase of many graduated licensing systems, which is commonly referred to as contingent advancement. Typically, contingent advancement means that an intermediate license holder must maintain a violation free driving record for a specified amount of time before they can obtain a full license.

Use: Almost all States penalize some GDL or traffic law violations by delaying full licensure (IIHS & TIRF, 2004).

Effectiveness: The few evaluations of early stand-alone probationary license systems generally found no substantial benefits (McKnight & Peck, 2003; Simpson, 2003). No recent evaluations have attempted to separate out the effect of penalties for GDL or other traffic law violations from the overall effects of GDL.

An enforcement/education program dubbed "*Ticket Today = License Delay*" (the equals sign is not pronounced) highlighted the resulting delay in licensure for teenagers who are convicted of a moving violation, seat belt violation or GDL violation. Although teens and their parents clearly perceived the increased enforcement, the program had only minimal effects on seat belt use and compliance with GDL restrictions (Goodwin, Wells, Foss, & Williams, 2006). In general, it appears that awareness of penalties for license violations among parents and teens is relatively low, enforcement is rare, and licensing delays are not always applied even when violations are enforced (Goodwin & Foss, 2004; Steenbergen et al., 2001; Williams, 2007).

Costs: Once GDL is in place, penalties for violating its provisions can be changed at very little cost.

Time to implement: GDL requirement changes typically require about 6 months to notify the public and implement the changes.

2. Driver Education

2.1 Pre-Licensure Driver Education

Effectiveness: ☆☆	Cost: $$$	Use: Medium	Time: Long

Overall Effectiveness Concerns: *This countermeasure is used in many States. Its effectiveness has been examined in several research studies. The balance of the evidence suggests that these types of countermeasures are ineffective in the long term.*

Driver education has long been advocated and used to teach both driving skills and safe driving practices. Driver education in high schools grew in popularity in the 1950s, using a standard curriculum of at least 30 hours of classroom instruction and 6 hours of on-the-road driving practice. By about 1970, approximately 14,000 high schools taught driver education to about 70% of all eligible teenagers. Many States and insurance companies encouraged driver education: States licensed graduates at an earlier age and insurance companies reduced auto insurance premiums for graduates. During the 1980s driver education offerings decreased as State and Federal funding for driver education decreased. By the early 1990s fewer than half of all high schools offered driver education and the majority of beginning drivers did not take driver education. See Smith (1994), Mayhew (2007), or Williams, Preusser, and Ledingham (2009) for a concise review of the history of driver education in the United States, and see Beanland, Goode, Salmon, and Lenné (2013) for a recent review of the effectiveness of driver training programs.

The study most well known in the United States for evaluating the effect of driver education on crash rates is the extensive NHTSA-sponsored study in DeKalb County, Georgia, in the late 1970s. Over 16,000 students were randomly assigned to three groups: standard driver education; an 80-hour long course including classroom, simulation, driving range, and on-the-road components; and a control group of no formal driver education. The initial analysis found no significant difference in crashes or traffic violations among the three groups (Smith, 1994). A second analysis, which tracked the students' driving records for a longer period of time, found a slight crash reduction for standard course graduates during their first months of driving only, and no difference between the long course and no course graduates (Smith, 1994). See Vernick (1999) or Williams et al. (2009) for brief summaries of all DeKalb study analyses.

Roberts et al. (2006) concluded from three well-designed evaluations in Australia, New Zealand, and the United States that driver education may lower the age at which teenagers become licensed but does not affect their crash rates once they do become licensed. The net effect of driver education may increase crashes because it puts more young drivers on the road. Vernick et al. (1999) reached the same conclusion from a review of 9 studies, 8 from the United States and 1 from Australia. It has been suggested that crash outcomes are not appropriate or fair measures for driver education, and are unrealistic to expect (Waller, 2003). A study in New Zealand found that newly licensed drivers who had received their full license sooner for completing a defensive driving course were more likely to receive a citation for committing a traffic offense when controlling for other factors (Begg, 2015).

In contrast, a recent archival study concluded there is a decrease in crash risk associated with driver education (4.3%, AAA, 2014), but this reduction is modest compared with those associated with GDL. This result is consistent with the suggestion that it may be unreasonable to expect pre-licensure driver education to produce sizable changes in crash risk given the amount of time and resources dedicated to it (Waller, 2003). Given that an effect of this size would require research that includes over 140,000 students to reliably detect differences in crash rates between students who do and do not complete driver education, it is unsurprising that most previous evaluations have failed to detect any effect of driver education.

Based primarily on results that indicated no consistent notable effect of driver education, NHTSA concluded that driver education should be integrated into State GDL programs (Compton & Ellison-Potter, 2008; Thomas et al., 2012a). It also concluded that driver education should be "distributed over time." NHTSA proposed a two-stage driver education system, both pre-licensure and post-licensure. (See Chapter 6, Section 2.2 for further discussion.) In addition, NHTSA and the driver education community has developed national administrative standards to enhance driver education delivery in the States (NHTSA, 2010). NHTSA offers a State Assessment Program to assist States in meeting those standards. At the request of a State, NHTSA will send a team of experts who will analyze and make recommendations for improving the driver education program.

Many States offer incentives for taking driver education. Twenty-Five States encourage driver education by allowing teens to get unrestricted licenses at an earlier age if they complete driver education, and 18 States offer other incentives such as reducing the required number of supervised driving hours, waiving portions of licensing tests, or lowering the minimum permit age (Thomas et al., 2012a). Research shows that driver education "discounts" increase, rather than reduce, crashes (Mayhew, 2007). For example, a study in British Columbia found that crash rates were 27% higher for driver education graduates who reduced their learner's permit holding period by 3 months, than for non-graduates (Wiggins, 2004).

Use: NHTSA recently completed an investigation of driver education requirements in the United States and found that 23 States and the District of Columbia require some form of driver education before licensure for anyone younger than 18 (Thomas et al., 2012a). Most commonly this includes 30 hours of classroom instruction and 6 hours of behind-the-wheel practice, although requirements vary considerably across States. For example, 15 States now accept online driver education in lieu of standard in-person classroom-based instruction (Thomas et al., 2012b). Most States offer both commercial and high school driver education programs (Thomas et al., 2012a).

Effectiveness: Driver education leads to earlier licensure in some States and does not reduce crash rates (Mayhew, 2007; Roberts et al, 2006; Thomas et al., 2012a; Vernick et al., 1999; Williams et al., 2009). Nonetheless, there has been a growing interest in improving and evaluating driver education. Future directions for driver education were summarized in a research circular by the Transportation Research Board (TRB, 2006). In addition, the AAA Foundation for Traffic Safety has produced a series of publications that provide practical information on how to conduct evaluations of driver education (Clinton & Lonero, 2006), and NHTSA conducted a feasibility study on evaluating driver education curriculum (Williams et al., 2009).

In addition, there have been recent advances in the development in new types of driver education programs (summarized in Thomas et al., 2012a). Given that visual scanning, attention maintenance, and speed management are likely responsible for many crashes among young drivers, a number of new programs have been developed that focus on teaching these higher-order knowledge and skills, generally using computer simulation. Although many of these programs have demonstrated short-term training effects, it is still unknown how long the training effects are maintained. More importantly, it is unknown if the training effects will carry over into real world driving environments and result in crash reductions among young drivers (Thomas et al., 2012a).

Costs: Even a minimal driver education course of 30 hours in the classroom and 6 hours on the road requires extensive funds. Driver education also requires students to find time for it in their schedules of high school classes, extracurricular and summer activities, and jobs.

Time to implement: A driver education course requires at least a year to plan and implement.

Other issues:

- **Parent involvement:** There has been a growing interest in integrating parents into driver education. For example, three States (Connecticut, Massachusetts, and Montana) and four counties in Northern Virginia require parents to attend a parent information/orientation session as a part of their teen's driver education requirements (GHSA, 2013). Virginia passed legislation in 2009 requiring a minimum of 90 minutes of parent participation in the in-classroom portion of driver education. Similarly, Massachusetts and Connecticut require a parent to attend a 2-hour driver education orientation program. In 2012, Montana revised their Traffic Education Standards to include a provision that parents of teens in driver education must attend a mandatory session and the State specified the content that must be included in the information session. Parents appear to support these requirements. In a recent national survey, a majority (70%) of parents reported that orientation courses should be required (Williams et al., 2011). Nonetheless, research has not yet determined the most effective way to involve parents in the driver education process (GHSA, 2013).

2.2 Post-Licensure or Second-Tier Driver Education

Effectiveness: ☆†	Cost: $$$	Use: Low	Time: Long

†Post-licensure driver education received a one star rating because its effectiveness has not yet been evaluated

Overall Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

As discussed in Chapter 6, Section 2.1, standard pre-licensure driver education leads to earlier licensure but does not reduce crash rates. Based on this conclusion, driver education research has sought to develop post-licensure driver education curricula and to integrate driver education with GDL (Smith, 1994). These “second-tier” post-licensure courses teach safety-related information, building on the on-road experience that the students have acquired in their initial months of driving. They should not be confused with “advanced driving performance” courses that teach driving skills such as panic braking, skid control, and evasive lane-changing maneuvers.

Previous post-licensure driver education courses were remedial, directed at drivers who had accumulated enough violations or crashes to warrant some attention. For this audience, post-licensure driver education had no effect (Ker et al., 2005, 2006).

Initiatives in Australia and Europe may provide insight on potential approaches for post-license training for beginning drivers (Senserrick, 2007; Twisk & Stacey, 2007). Christie and colleagues have developed a model “best practice” curriculum for intermediate license drivers with at least 6 months of driving experience in Australia (Christie, Harrison, & Johnston, 2004). The 8-hour curriculum consists of eight modular sessions with a mentor or coach, including one-on-one driving and discussion, group observation and discussion of driving behavior, and telephone follow-up. However, this curriculum has yet to be evaluated.

NHTSA has completed a feasibility study in anticipation of a major evaluation of the benefits of an integrated driver education and GDL program (Hedlund & Compton, 2005).

Use: Post-licensure driver education is still under development. Michigan is the only State that has adopted a two-stage system of driver education (Mayhew, 2007).

Effectiveness: Post-licensure driver education has not yet been evaluated.

Costs: If a post-licensure driver education program proves to be effective, it likely will require substantial funds to implement.

Time to implement: Any course requires at least a year to plan and implement.

3. Parents

3.1 Parental Role in Teaching and Managing Young Drivers

Effectiveness: ☆☆	Cost: $$	Use: Medium	Time: Short

Overall Effectiveness Concerns: *This countermeasure has been examined in several research studies. Although there have been some positive research findings, particularly in terms of behavioral changes, the balance of evidence regarding countermeasure effectiveness remains inconclusive.*

Most parents are heavily involved in teaching driving skills to their beginning teenage drivers and supervising their driving while they have a learner's permit. Parents are in the best position to enforce GDL restrictions for intermediate drivers and to impose additional driving restrictions on their teenagers. Parents strongly support GDL; however, many parents do not understand the dangers of high-risk situations, such as driving with teenage passengers. Parents could use guidance and assistance in during this process (Hedlund et al., 2003; Goodwin, Foss, Sohn, & Mayhew, 2007, Strategies C1-C3). For summaries of the research on parent involvement in teen driving, see Simons-Morton and Ouimet (2006) or Simons-Morton, Ouimet, and Catalano (2008). For a recent review of promising parent programs, see GHSA (2013).

The majority of States provide some form of guidance materials to parents of teen drivers in the form of booklets/brochures and/or videos, and many of the materials are provided online. However, it has been demonstrated that passive dissemination of information to parents is not an effective method to change parents' behaviors and ultimately reduce teen driver crashes (Chaudhary, Ferguson, & Herbel, 2004; Goodwin, Waller, Foss, & Margolis, 2006). In hopes of better equipping parents to supervise and manage their teens' driving, there has been a growing interest in programs that involve direct interaction and engagement with parents. Although many such programs have been developed, the following four programs are highlighted because they have been evaluated and shown promising results: *Checkpoints*, *Green Light for Life, Steering Teens Safe*, and *Teen Driving Plan.*

Checkpoints: The original *Checkpoints* program, developed by Simons-Morton and colleagues at the National Institute of Child Health and Human Development, is a program that uses videos and periodic newsletters to reinforce the need for parents to limit their newly licensed teens' driving under risky conditions. A central feature of the program is a written agreement that parents and teens review and sign. The agreement limits teens' driving under various high-risk situations, such as driving at night, with other teens in the car, or in bad weather (Simons-Morton & Hartos, 2003). The facilitated *Checkpoints* program has been adapted from the original version to include a 30-minute in-person session to introduce teens and parents to the Checkpoints program, and to have them work in pairs to begin developing a parent-teen driving agreement (Zakrajsek, Shope, Ouimet, Wang, & Simons-Morton, 2009).

Green Light for Life (GLL): This program has been implemented in Israel since 2005 (Taubman & Lotan, 2011; Toledo, Lotan, Taubman, & Grimberg, 2012). From 2005- to 2008 approximately 130,000 families participated in the program. GLL consists of an in-person, 45-

minute meeting with a parent and their young driver prior to entering the accompanied driving phase, otherwise known as the learner's permit stage in the United States During the meeting, parents and teens are encouraged to get as much supervised driving practice as possible in a variety of conditions. Parents are encouraged to share their hazard perception knowledge and skills with their teen driver. Strategies for dealing with in-vehicle dynamics between the teen and parent are also discussed. Families are given a booklet and CD to take home.

Steering Teens Safe: This is a 45-minute in-person program that focuses on improving parents' communication skills by teaching them to use motivational interviewing techniques to talk to their teens about safe driving. Parents receive a DVD and a workbook with 19 safe driving lessons to help parents to discuss, demonstrate, and practice safe driving behaviors and skills with their teens. *Steering Teens Safe* is intended for parents of teens who are in the learner permit phase (Peek-Asa et al., 2014; Ramirez et al., 2013).

Teen Driving Plan: This is a web-based program for parents to use during the learner permit phase to increase the quantity and quality of their supervised driving practice. The *Teen Driving Plan* includes 53 web-based videos, a web-based planner to help teens and parents structure their practice sessions, and a web-based log to record and rate driving practice sessions (Mirman et al., 2014).

Use: *Checkpoints* is available on the web. *Steering Teens Safe* and *Teen Driving Plan* are still being evaluated and are not available for the public. *Green Light for Life* is not currently available in the United States.

Effectiveness:

Checkpoints: Results from testing in several States show the original *Checkpoints* program produces modest increases in parents' restrictions on teen driving (Simons-Morton & Hartos, 2003; Simons-Morton, Hartos, Leaf, & Preusser, 2005). However, a study in Connecticut found no differences in violations or crashes for families who participated in the *Checkpoints* program when compared with families who did not participate in the program (Simons-Morton, Hartos, Leaf, & Preusser, 2006).

The facilitated *Checkpoints* program has recently been evaluated and has had promising results. Zakrajsek et al. (2009) evaluated the program delivered by trained health educators in driver education classes and found that, relative to a comparison group, parents who participated in the facilitated *Checkpoints* program showed greater awareness of teen driving risks, were more likely to complete a parent-teen driving agreement, and reported setting stricter limits on their teens' driving during the intermediate license phase. Zakrajsek et al. (2013) conducted an evaluation of the facilitated *Checkpoints* program delivered by driver education instructors and also found that parents who participated in the program were more likely to report that they used a parent teens driving agreement and had stricter limits on their teens' driving. Teens also self-reported less risky driving. However, they found no differences in crashes for teens who participated in the program compared to teens who did not participate.

Green Light for Life: To date, *Green Light for Life* has undergone two evaluations. Taubman and Lotan (2011) examined the effectiveness of the GLL program by comparing self-reports of 362 teenagers who participated in the program with 376 teens who did not. They found no difference in the amount of accompanied driving teens obtained during the supervised driving phase or the level of reckless driving reported. However, teenagers who participated in the program reported more positive attitudes about the supervised driving phase and reported less crash involvement. A recent national study evaluated injury crash involvement between teens who participated in the GLL program during 2005 to 2007 compared to teens that did not participate in the program. Based on analysis of injury crash data during the first two years after licensing, teens who participated in GLL had 10% lower injury crash rates (Toledo et al., 2012). Nonetheless, both studies suffered from the possible effects of self-selection bias. A follow-up study is underway to examine behavior and crash data of young drivers at the individual level, in an attempt to address this potential bias.

Steering Teens Safe: To date, the *Steering Teens Safe* program has been evaluated via one randomized controlled trial (Peek-Asa et al., 2014). The study examined the effectiveness of parent communication about driving safety as perceived by the teen driver, and the teens' self-reported risky driving. Teens in the *Steering Teens Safe* program reported a higher quality of parent communication than control teens, and the teens in the program reported a 21% reduction in self-reported risky driving compared with control teens.

Teen Driving Plan: To date, one randomized controlled trial has been conducted to measure the effects of the *Teen Driving Plan*. Mirman et al. (2014) found that families who used the *Teen Driving Plan* reported more driving practice in various environments and situations (i.e., night and bad weather) compared to teens not in the program. In addition, teens that were in the *Teen Driving Plan* group were less likely to be terminated during an on-road driving test compared to teens not in the program (6% and 15%, respectively).

Although evaluations of programs to assist parents have not yet shown reductions in young driver crashes, there is still reason to be optimistic. Programs such as *Checkpoints* have increased parent limit setting, and several studies show that teenagers whose parents impose more strict driving limits report fewer risky driving behaviors, traffic violations and crashes (see Simons-Morton, 2007, for a review). Educational programs alone are unlikely to produce changes in behavior. However, education in combination with other strategies may deliver stronger results.

Costs: Checkpoints is available on the web; however, in order to use the facilitated version, staff time would be needed to implement in the in-person session.

Time to implement: The original *Checkpoints* program and the facilitated program are available immediately. However, to implement the facilitated *Checkpoints* program on a large scale, it would likely take a year for planning, staff training, and dissemination. *Green Light for Life, Steering Teens Safe*, and the *Teen Driving Plan* program are not yet available.

Other issues:

- **Electronic monitoring:** Various technologies have been developed to aid parents in monitoring their teenage drivers. For example, many GPS companies offer "teen tracking" services that will notify parents if their teens go beyond boundaries, or are speeding at any given time. Video-based devices, such as DriveCam, can provide visual monitoring of teen drivers. When these technologies are combined with weekly report cards to parents, they can reduce the incidence of risky driving behaviors among teens (Carney et al., 2010; Farah et al., 2014, Farmer, Kirley, & McCartt, 2010; McGehee et al., 2007; Musicant & Lampel, 2010, Simons-Morton et al., 2013). However, more research is needed to determine the impact of electronic monitoring on crashes and fatalities among young drivers.

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A7. Older Drivers

This section provides expanded discussion of the ☆ and ☆☆ countermeasures. Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

The ☆ and ☆☆ countermeasures covered in this section of the Appendix are listed below.

1. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Formal Courses for Older Drivers	☆☆	$	Low	Short
1.2 General Communications and Education	☆	$	Unknown	Short

2. Licensing

Countermeasure	Effectiveness	Cost	Use	Time
2.4 Medical Advisory Boards	☆	Varies	High	Medium
2.5 License Renewal Policies: In-Person Renewal, Vision Test	☆☆	$$$	Medium	Medium

Effectiveness:

☆☆ – Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources

$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:
High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:
Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Communications and Outreach

1.1 Formal Courses for Older Drivers

Effectiveness: ☆☆	Cost: $	Use: Low	Time: Short

Overall Effectiveness Concerns: *The effectiveness of formal courses for older drivers has been examined in several research studies. While these studies have found some positive outcomes, there is no evidence that this countermeasure reduces crashes relative to comparison groups.*

Formal courses specifically for older drivers are offered by organizations including AAA, AARP, and the National Safety Council, either independently or under accreditation by States (Potts et al., 2004, Strategy D2; Stutts, 2005, Table 12). AARP's Driver Safety Program is the largest of these courses. AARP developed the initial version in 1979 and the current version named "AARP Smart Driver Course," is offered both in the classroom and online (AARP, 2013). The courses typically involve 6 to 10 hours of classroom training in basic safe driving practices and in how to adjust driving to accommodate age-related cognitive and physical changes. As of 2010, there were 36 States and the District of Columbia that mandated automobile insurance discounts for graduates of accredited courses (AARP, 2010).

Courses combining classroom and on-the-road instruction have been offered in a few locations (Potts et al., 2004, Strategy D2).

Use: Courses are taught in all States but reach only a small fraction of older drivers. For example, AARP reports that over 700,000 people each year complete the AARP Driver Safety Program nationwide, which represents approximately 1% of the eligible driving population 50 and older (AARP, 2009).

Effectiveness: Graduates of both the AARP classroom and online courses report that they changed some driving behaviors as a result of the course (AARP, 2009; Skufca, 2008). However, none of the courses has been shown to reduce crashes (Potts et al., 2004, Strategy D2). NHTSA's Older Road User Research Plan includes the high-priority research problem statement, "Do assessment and retraining programs improve driving?" (Raymond, Knoblauch, & Nitzburg, 2001, Table 1). The most thorough evaluation studied approximately 200,000 course graduates and a 360,000-driver comparison group in California from 1988 to 1992. It found that course graduates had fewer citations but no fewer crashes than non-graduates (Janke, 1994; Potts et al., 2004, Strategy D2). AARP also concluded that its course reduces citations but has not been shown to reduce crashes (AARP, 2009).

A study conducted in 2004 evaluated the effects of a well-designed three-hour educational course promoting safe driving strategies for older drivers with some visual defects. Course graduates reported that they regulated their driving more following the course than a control group that did not attend the course. There was no significant difference in crash rates between course graduates and the control group (Owsley, McGwin, Phillips, McNeal, & Stalvey, 2004).

Another 2004 study involving a systematic review of studies evaluating the effectiveness of driver retraining programs (Kua, Korner-Bitensky, Desrosiers, Man-Song-Hing, & Marshall, 2007) reached a similar conclusion as did Owsley et al., (2004). These researchers reported that while there is moderate evidence that educational interventions improve driving awareness and behavior, these interventions do not reduce crashes in older drivers. Regardless, the authors felt that the evidence regarding the effectiveness of retraining aimed at older drivers is encouraging enough warrant further research.

More recent evaluations of courses for older drivers have produced mixed results related to the crash rates of drivers attending these courses. Marottoli (2007) concluded that a training program that combined classroom education with on-road training improved the performance of older drivers on written and on-road tests and may allow these drivers to retain their licenses longer, but did not attempt to assess the program’s impact on subsequent crash rates. Bedard et al. (2008) concluded that an in-class education program coupled with on-road education led to improvements in the participants’ knowledge of safe driving practices and improvements on some aspects of safe driving performance, but that further research is required to determine if these changes will affect crash rates.

Nasvadi and Vavrik (2007) conducted research in British Columbia evaluating the crash risk of drivers after attending a safe driving class and found that, at least in some cases, these classes may produce a negative benefit – that these classes were associated with an increased number of crashes for men 75 and older. However, attendance in these classes had no effect on crashes of younger men and women of all ages. Though acknowledging several limitations of this study, the authors stress that “Recognizing and understanding characteristics and behaviors of older drivers who attend remedial driver education is essential to the design and delivery of successful driver safety programs.”

Korner-Bitensky, Kua, von Zweck, and Van Benthem (2009) conducted a review of articles published from 2004 to 2008 on the effectiveness of older driver retraining programs for improving driving skills and reducing crash rates. Four studies met the inclusion criteria for the review and provided strong evidence that education combined with on-road training improves driving performance. They also found moderate evidence that education alone is not effective in reducing crashes and that physical retraining does improve driving performance. The value of physical training in addition to education is reinforced by the results of research by Romoser and Fisher (2009). They found that active training, such as practice with feedback, is a more effective strategy for increasing older drivers’ likelihood of side-to-side scanning, looking for threats, during turns than is passive training (classroom lecture or video only) or no training.

Costs: Costs for making courses for older drivers available can be minimal since they have been developed and are offered by organizations such as AAA, AARP, and NSC. Courses typically charge a small fee, which may be offset by insurance discounts available to graduates.

Time to implement: Courses are offered regularly by AAA, AARP, NSC, and other organizations.

1.2 General Communications and Education

Effectiveness: ☆	Cost: $	Use: Unknown	Time: Short

Overall Effectiveness Concerns: *There are no known evaluations of the effects of this material on driving or on crashes (Potts et al., 2004, Strategy D2).*

Many organizations offer educational material for older drivers to inform them of driving risks, help them assess their driving knowledge and capabilities, suggest methods to adapt to and compensate for changing capabilities, and guide them in restricting their driving in more risky situations (Potts et al., 2004, Strategy D2).

Self-assessment tools include:

- AAA's *Roadwise Review*, a CD-ROM and instruction booklet;
- AARP's *Older Driver Skill Assessment and Resource Guide*;
- American Medical Association's *Am I a Safe Driver?* one-page checklist; and
- University of Michigan's *Driving Decisions Workbook*. See Stutts (2005) for brief descriptions and web links.

Other programs and material include:

- *Carfit*, a program developed by AAA, AARP, and the American Occupational Therapy Association to help older drivers find a proper fit within their personal vehicles;
- *Drive Well*, a joint program of American Society on Aging and NHTSA;
- *Getting Around*, from Emergency Nurses CARE, on safe driving decisions, pedestrian safety, and safe medication use; and
- Information from NHTSA and many State motor vehicle offices on general issues of older drivers or specific topics such as driving with glaucoma or arthritis.

See Potts et al. (2004, Strategy D2) and Stutts (2005) for examples, brief descriptions, and web links. See also AAAFTS (2009b) for examples of public information and awareness material included in their "Noteworthy Initiatives" database.

Other material is available to assist drivers and family members in understanding how aging affects driving, the effects of medications and health conditions, how to assess an older driver's skills, how to use specialized vehicle equipment to adapt to certain physical limitations, how to guide older drivers into voluntarily restricting their driving, and how to report older drivers to the department of motor vehicles if necessary (Stutts, 2005). Examples include:

- NHTSA's series of fact sheets and more detailed information for older drivers and their families and friends, available from NHTSA's older driver program website: www.nhtsa.gov/Driving+Safety/Older+Drivers
- Clearinghouse for Older Road User Safety: www.roadsafeseniors.org
- AAA's *How to Help an Older Driver*;
- AARP's *At the Crossroads: A Guide to Alzheimer's Disease, Dementia and Driving*;

- The Association for Driver Rehabilitation Specialists' series of fact sheets on issues such as driving after a stroke, driving with rheumatoid arthritis, and driving after a limb amputation;
- New York State Office for the Aging's *When You Are Concerned: A handbook for families, friends and caregivers worried about the safety of an aging driver*.

Use: Data is not available on how frequently these programs or material are used.

Effectiveness: The limited information available suggests that some material may increase driver's knowledge. There are no known evaluations of the effects of this material on driving or on crashes (Potts et al., 2004, Strategy D2). As discussed in Chapter 7, Section 1.1, none of the more structured formal courses has been shown to reduce crashes. NHTSA's Older Road User Research Plan includes the high-priority research problem statement, "Do assessment and retraining programs improve driving?" (Raymond et al., 2001).

Costs: Funds are required for producing and distributing material.

Time to implement: Material and programs are available and ready for use.

Other issues:

- **Seat belt use:** Seat belts are even more effective in preventing injuries and fatalities to older than to younger occupants (Potts et al., 2004, Strategy E1). While belt use among older occupants is comparable to that of younger occupants – 88% for occupants 70 and older and for occupants 25 to 69 in 2013 (Pickrell & Liu, 2015) – the fact remains that nearly 1 in 8 older occupants is unbelted. Communications and outreach on the benefits of seat belt use may be more effective with older occupants than with younger because they may be more attentive to health and safety issues. For example, signs urging seat belt use increased belt use substantially in 6 senior communities compared to controls, and use remained higher after 4 years (Cox, Cox, & Cox, 2005). No other State or local seat belt use efforts directed at older occupants have been identified (Potts et al., 2004, Strategy E1).
- **Considerations for Future Education for Older Drivers:** In a review of the five-level model of driver education, Goals for Driver Education in the Social Perspective (GDE5SOC), Keskinen (2014) indicates that education for older drivers could be improved if it were more focused on a process of mutual understanding where the instructor helps older drivers learn more about their own abilities and challenges while driving rather than teaching knowledge or skills.

2. Licensing

2.4 Medical Advisory Boards

Effectiveness: ☆†	Cost: Varies	Use: High	Time: Medium

† Quality varies considerably

Overall Effectiveness Concerns: *This countermeasure is widely used; however, there are no known studies evaluating the effects of MABs.*

Thirty-Four States and the District of Columbia have medical advisory boards (MABs) to assist the licensing agencies in evaluating people with medical conditions or functional limitations that may affect their ability to drive (AAAFTS, 2009a). MABs generally make policy recommendations on what licensing actions are appropriate for people with specific medical conditions or functional limitations. Most State MABs review individual cases, though this activity varies widely: 7 States reported that their MABs review 1,000 cases or more annually while another 7 review 10 or fewer cases (Lococo, 2003).

In 2003 NHTSA and AAMVA surveyed MAB practices in all States. Lococo (2003) contains the results: detailed documentation of how each State's medical review is organized; how drivers are identified, referred, screened, and assessed; and what licensing actions can be taken.

MABs should play a key role in each State as the link between health care professionals, licensing agencies, law enforcement, and the public. They should take the lead in defining how various medical conditions and functional impairments affect driving; defining medical assessment and oversight standards; improving awareness and training for healthcare providers, law enforcement, and the public; advising health care professionals how drivers can compensate for certain medical conditions or functional impairments; and reviewing individual cases. AAA has developed its list of best practices and recommendations for MABs based on the NHTSA-AAMVA study findings (AAA, 2004). The National Traffic Safety Board has made similar recommendations (NTSB, 2004). In June 2005, NHTSA released a summary of recommended strategies for MABs and national medical guidelines for driving, prepared in collaboration with AAMVA (Lococo & Staplin, 2005).

As noted above, NHTSA and AAMVA produced a guide in September 2009 titled "Driver Fitness Medical Guidelines" that is designed to provide guidance to licensing agencies in making decisions about an individual's fitness for driving (NHTSA, 2009c). These guidelines, as well as NHTSA's *Physician's Guide to Assessing and Counseling Older Drivers* (Wang, Kosinski, Schwartzberg, & Shanklin, 2003; Carr et al., 2010), can be used to provide guidance to MABs as they define how various medical conditions and functional impairments affect driving and what steps can be taken to compensate for any limitations noted due to relevant conditions and limitations.

Use: The AAAFTS (2009a) Driver Licensing Policies and Practices database shows that 34 States have MABs or obtain input from the drivers' physicians or anonymous physicians.

Effectiveness: There are no known studies evaluating the effects of MABs. Maryland's MAB reviewed over 500 individual cases in 2004 and recommended license suspension for about two-thirds of the cases (Soderstrom, 2005).

Costs: MABs are comprised of physicians and other health care professionals together with appropriate administrative staff. Costs will be minimal for an MAB whose activities are limited to policy recommendations. Costs for an MAB that evaluates individual cases will depend on the caseload.

Time to implement: States probably will need at least a year to establish and staff an MAB, depending on what duties the MAB undertakes. States likely can expand the functions of an existing MAB in 6 months.

2.5 License Renewal Policies: In-Person Renewal, Vision Test

Effectiveness: ☆☆	Cost: $$$	Use: Medium	Time: Medium

Overall Effectiveness Concerns: *Some version of this countermeasure has been implemented in over half the States. Its effectiveness has been examined in several research studies. Although there have been some positive research findings, the balance of evidence regarding countermeasure effectiveness remains inconclusive.*

Driver's licenses in most States are valid for 4 to 6 years, longer in a few States. To renew an expiring license, drivers in many States must appear in person, pay the license fee, and have new pictures taken for their licenses. A few States require a vision test for license renewal. Some States allow all drivers to renew by mail or electronically.

More than half the States change license renewal requirements for drivers older than a specified age, typically 65 or 70. These changes may include a shorter interval between renewals, in-person renewal (no renewal by mail or electronically), or a vision test at every renewal. A very few States require written or road tests for some older renewal applicants. AAA (2010), IIHS (2010), and Stutts (2005, Chapter 5) summarize these requirements.

License examiners report that the driver's appearance at the motor vehicle office is the single most important criterion for identifying a person of any age whose driving skills may be impaired (Potts et al., 2004, Strategy C2). This observation is supported by Morrisey and Grabowski (2005), who found that in-person license renewal was associated with reduced traffic fatalities among the oldest drivers. Frequent in-person renewals and vision tests may be more useful for older drivers than for younger drivers because their abilities may change more quickly. AAMVA recommends that all drivers renew licenses in person and pass a vision test at least every 4 years (Staplin & Lococo, 2003; Stutts, 2005). Very few States meet these recommendations for all drivers. In-person renewals would be even more useful, for drivers of all ages, if they included functional ability tests as recommended in the NHTSA-AAMVA *Model Driver Screening and Evaluation Program Guidelines for Motor Vehicle Administrators* (Staplin & Lococo, 2003) (see Chapter 7, Section 2.1).

The value of in-person renewals and vision tests are further supported by a AAA Foundation for Traffic Safety study that analyzed the effects of laws and licensing policies in 46 U.S. States on the fatal crash involvement rates of older drivers during the years 1985 to 2011 (Tefft, 2014). Requiring in-person renewal instead of allowing online or mail-in renewals was associated with a 9% reduction in fatal crash involvement rates for drivers 55 and above. The effects of the in-person renewal requirement were greatest for the oldest age group studied, those 85 and older. There is question, however, whether the large effects of in-person renewal requirements were due to the examiners being able to remove unsafe older drivers from the driving population or to older drivers possibly ceasing to drive prematurely. Other driver license renewal policies investigated – vision test, knowledge test, on-road driving test, and mandatory reporting laws for physicians – were not found to reduce fatal crash involvement rates of older drivers.

Use: At least 31 States and the District of Columbia have one or more different license renewal requirements for older drivers than for younger drivers. These include 21 States with a shorter interval between renewals, 11 that prohibit online and/or renewals by mail, 8 plus the District of Columbia that require vision tests or other vision screening at renewal, and 1 State that requires road tests for applicants 75 and older. On the other hand, Oklahoma and Tennessee reduce or waive licensing fees for older drivers and Tennessee driver's licenses issued to people 65 or older do not expire. In addition, Maryland, Minnesota, Nevada and the District of Columbia have specific provisions that prohibit licensing personnel from treating people differently solely due to age (IIHS, 2014b).

Effectiveness: License examiners report that in-person renewals and vision tests are effective in identifying people whose driving skills may be impaired (Potts et al., 2004, Strategy C2). No known data is available on the number of potentially impaired drivers identified through these practices or on the effects of more frequent renewals and vision tests on crashes. Furthermore, studies regarding the effectiveness of vision screening for license renewal indicate that the value of the vision tests commonly used for licensing decisions as predictors of increased crash risk is inconclusive and that the aspects of vision currently assessed for licensing do not adequately explain unsafe driving (Bohensky, Charlton, Odell, & Keefe, 2008). Nonetheless, one study found that fatalities among drivers 80 years and older in Florida decreased by 17% after the State passed a law requiring these drivers to pass a vision test before renewing their driver licenses (McGwin, Sarrels, Griffin, Owsley, & Rue, 2008).

Thomas, Blomberg, Knodler, and Romoser (2013) examined driver licensing policies and procedures for drivers 65 and older. They selected four States for in-depth study (Kansas, Illinois, Iowa, and New Hampshire) and six comparison States (Indiana, Minnesota, Missouri, Nebraska, Vermont, and Wisconsin). The study States that were chosen had policies with the potential to reduce older driver crashes, including shorter renewal periods, in-person renewal, and vision testing for older drivers. In addition, Illinois and New Hampshire mandated a road test for every renewal. Four or five years of crash data were examined in all 10 States to measure population-based and per-licensed-driver crash rates for drivers of all ages.

Contrary to what might be expected, the older drivers supported and accepted their State's efforts to assure the safety of older drivers. Analysis of crash data for all 10 States revealed either stable or declining crash rates per 1,000 licensed drivers with increasing age for each 5-year age group within each State. Crash rates per licensed driver for the different 5-year age groups showed a similar pattern, with declining rates with increasing age in all States other than Illinois and New Hampshire, the two States that require an on-road test at renewal for all drivers over 75. The overall trend in crash rates suggests that the shorter renewal periods, in-person renewal, and vision testing for older drivers have very little effect on older driver crashes.

Costs: More-frequent license renewals or additional testing at renewal impose direct costs on driver licensing agencies. For example, a State that reduces the renewal time from 6 years to 3 years for drivers 65 and older would approximately double the licensing agency workload associated with these drivers. If 15% of licensed drivers in the State are 65 and older, then the agency's overall workload would increase by about 15% to process the renewals. If more frequent renewals and vision tests identify more drivers who require additional screening and assessment, then additional costs are imposed. See Chapter 7, Section 2.1, for additional discussion.

Time to implement: A vision test requirement for renewal or a change in the renewal interval can be implemented within months. The new requirements will not apply to all drivers for several years, until all currently valid licenses have expired and drivers appear at the driver licensing agency for licensing renewal.

Other issues:

- **Age discrimination:** A few States explicitly indicate that age alone is not a justification for reexamining a driver's qualifications (AAA, 2010; IIHS, 2010; IIHS, 2014b). These States have the same license renewal interval for all drivers and/or have specific provisions that prohibit licensing personnel from treating people differently solely due to age.
- **Road tests and medical reports:** Several Australian States require a medical report, a road test, or both for drivers over a specified age to renew their licenses. Langford, Fitzharris, Koppell, and Newstead (2004) compared Australian States with and without these requirements. They found that Australian States with these requirements had higher older-driver crash rates than States without them. They conclude that there are "no demonstrable road safety benefits" to requiring medical reports or road tests for older drivers.

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A8. Pedestrian Safety

This section provides expanded discussion of the ☆ and ☆☆ countermeasures. Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

The ☆ and ☆☆ countermeasures covered in this section of the Appendix are listed below.

1. Preschool-age Children

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Children's Safety Clubs	☆	Varies	Unknown	Unknown
1.2 Child Supervision	☆	$	Unknown	Short

2. School-age Children

Countermeasure	Effectiveness	Cost	Use	Time
2.3 Child School Bus Training	☆☆	$	High	Short

3. Impaired Pedestrians

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Communications and Outreach Addressing Impaired Pedestrians	☆☆	Varies	Low	Medium
3.2 "Sweeper" Patrols of Impaired Pedestrians	☆	$$	Low	Medium

4. All Pedestrians

Countermeasure	Effectiveness	Cost	Use	Time
4.5 Driver Training	☆	$	Low	Medium
4.6 Pedestrian Gap Acceptance Training	☆	$$	Unknown	Medium
4.7 University Educational Campaign	☆	$	High	Medium

Effectiveness:

☆☆ – Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆ – Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies

1. Preschool-Age Children

1.1 Children's Safety Clubs

Effectiveness: ☆	Cost: Varies	Use: Unknown	Time: Unknown

Overall Effectiveness Concerns: *This countermeasure has been examined in a small number of research studies. The research suggests that this countermeasure does not translate into crash and injury reductions.*

Young children have limited abilities to perceive, understand, and react appropriately to traffic hazards, and they have greater difficulty finding safe places to cross along the roadway (Percer, 2009). A primary purpose of children's safety clubs is to help parents and caregivers become more involved in educating young children about safe walking practices. Related goals are to help promote on-going, age-appropriate training, and safe attitudes towards traffic (Gregersen & Nolen, 1994). An equally important objective of safety clubs is for parents and other caregivers to recognize children's limits and capabilities, and to understand their obligation to provide adequate supervision and control (Gregersen & Nolen, 1994).

Motor vehicle crashes involving preschool children often involve slow-moving vehicles, frequently backing up in driveways and parking lots (Agran, Winn, & Anderson, 1994; Olson, Sklar, Cobb, Sapien, & Zumwalt, 1993). From 2008 to 2011, 883 children 14 and younger were killed in non-traffic-related crashes in which they were not occupants of a vehicle (NHTSA, 2014). On average, 104 of these fatalities involved forward moving vehicles, 95 backing vehicles, 7 driverless vehicles, and 15 involved other types, such as children struck near disabled or parked vehicles (NHTSA, 2014). A majority (84%) of these children were age four and younger. It is important to teach children age-appropriate lessons about traffic and motor vehicles. It is even more important that parents and caregivers take direct responsibility and supervise young children carefully near roadways or in any areas where vehicles may be in use (Rivara, Bergman, & Drake, 1989). See also the following section, Section 1.2, for more information on supervision.

Parents are the primary role models and educators for their children. Research in the United Kingdom has examined the interactions and messages between parents and children with regard to road safety (Green et al., 2008). The researchers found that parents, while feeling competent to the task, were inconsistent role models and lacking in knowledge of best approaches and messages to train their children. Moreover, parents did not take full advantage of opportunities to teach while walking, and attention was focused more on controlling their children's behavior than teaching, particularly under higher risk situations (Green et al., 2008; see also Percer, 2009).

The main development of safety clubs took place in Europe a number of years ago, but they have not been adopted broadly in the United States. In many of the European programs, children may be enrolled in a traffic safety club when they reach their third birthday. Books on traffic safety are then sent to the child every 6 months until they reach 5 years or older (Dragutinovic & Twisk, 2006), but other print or electronic media could be provided, bearing in mind that the intent is to engage both the parent and child. There do not appear to be any national or statewide standards, models, or curricula.

For a British traffic club source, see The Children's Traffic Club, www.childrenstrafficclub.com. The UK Department of Transport released a set of games called *Tales of the Road* to teach children about road safety, http://talesoftheroad.direct.gov.uk.
Similar websites are available from:

- Scotland: www.gosafewithziggy.com/
- Australia: www.det.wa.edu.au/ccm-ldn-theme-assets/__ccm__/themes-prod/sdera/flash/road_safety_games/index.html
- Renault: www.safety-mobility-for-all-the-game.com

Use: The extent of use of child safety clubs in the United States is unknown.

Effectiveness: Safety clubs are one way to teach and promote an understanding of a specific set of appropriate pedestrian behaviors for young children. However, the knowledge and skill benefits have not been found to translate into crash and injury reductions (Dragutinovic & Twisk, 2006; Gregersen & Nolen, 1994; West, Sammons, & West, 1993). The one study that evaluated effects on self- reported crashes found a negative result, but concluded that no impact on crashes could be inferred (Gregersen & Nolen, 1994).

Costs: The costs would depend on the cost of materials and delivery and whether the families are charged anything for participation. In most of the clubs, enrollment is free to the participants; some charge a fee for enrollment (Dragutinovic & Twisk, 2006). If integrated into preschool programs, training for teachers may be needed.

Time to implement: Before a safety club program could be implemented, program material must be located and adapted as necessary. Following that, a modest time period would be needed to arrange for material, identify target recipients, disseminate information, and train teachers as needed.

Other issues:

- A challenge would be to garner high enrollment among families with lower socio-economic status and low-car-ownership. Participation in child safety clubs has been found to be lower among low SES groups in European countries (Dragutinovic & Twisk, 2006).
- It is up to parents and caregivers of young children to use materials appropriately and a lack of control makes it difficult to monitor or assess results.

1.2 Child Supervision

Effectiveness: ☆	Cost: $	Use: Unknown	Time: Short

Overall Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

The primary purpose of this countermeasure is to increase caregiver supervision of children when they are exposed to traffic, or when they are nearby with direct access to traffic. Caregiver involvement is an effective means for shaping children's behaviors (Percer, 2009). Because children do not have the impulse control to make safe walking decisions, these programs can be an asset to anyone responsible for the supervision of children. The State can require such training for teachers, day care workers, and others licensed to care for children. The programs can also be made available to parents, babysitters, or other caretakers through PTAs, faith-based organizations or places of worship, medical providers, or even direct mail or internet access.

NHTSA also supports a website to reach parents, Parents Central, to serve as the gateway to keep children safe on the road (www.safercar.gov/parents/walking.htm). Parent Central includes materials created through a partnership to provide preschool-aged children and their parents with pedestrian safety messages. Worth noting is NHTSA's resource, *Teaching Children to Walk Safely as They Grow and Develop: A Guide for Parents and Caregivers*, with learning objectives and tips for caregivers of children 4 to 6; 7 to 9; and 10, see: www.saferoutesinfo.org/sites/-default/files/TeachingChildrentoWalkSafely.pdf.

Another NHTSA website publication is *Walking Through the Years, Preventing Pedestrian Crashes: Preschool/Elementary School Children.* NHTSA also has several brochures to educate parents and caregivers on child pedestrian safety (www.nhtsa.gov/road-safety/pedestrian-safety) as does Safe Kids Worldwide, including safety tips for parents of young children and links to additional resources (www.safekids.org/safetytips/field_age/little-kids-1%E2%80%934-years/field_risks/pedestrian-safety).

One of the ways to market these programs may be to demonstrate to parents the amount of supervision their child/children needs (and effective training). Rivara et al. (1989) and Dunne, Asher, and Rivara (1992), for example, have shown that parents consistently overestimate the ability of children younger than 9 or 10 to negotiate in traffic. Adults should actively supervise children and not assume that their presence will be adequate to ensure safer behavior.

Use: The availability and use of programs to improve child supervision is unknown. Pedestrian safety in general may be a topic at preschools, but programs are likely to be unique, without consensus objectives, material, or curriculum. Many other outlets such as community centers, churches, and local injury prevention offices may be used to reach caregivers and parents of pre-school age children, but the extent of such outreach, and the penetration of traffic safety messages for caregivers is unknown.

Effectiveness: Programs or material can provide helpful training for caregivers if they point out specific risks as well as guidelines for the kind and degree of oversight that are necessary, but the caregivers need to put the training into practice. Widespread exposure of parents and caregivers to this material and resources should be an objective of such programs with the goal to improve safety and reduce injuries.

Costs: Material for people is already available and quite inexpensive. Training for licensed caregivers would be inexpensive to develop and distribute.

Time to implement: Short, for existing material; medium, to develop and disseminate a training curriculum with material.

Other issues:

Differences in cultural, social, and perceived norms for pedestrian safety should be considered in the development of programs to improve child supervision. For example, in a study by Pfeffer, Fagbemi, and Stennet (2010), 59% of adults held the hands of female children compared with 36% who held the hands of male children when crossing a road. In another study, children 9 and younger in one cultural group believed that more of their peers crossed roadways alone than actually did (Rosenbloom, Sapir-Lavid, & Hadri-Carmi, 2009). Addressing discrepancies in perceived norms and actual norms may help to shift the actual norm toward safer trends.

2. School-Age Children

2.3 Child School Bus Training

Effectiveness: ☆☆	Cost: $	Use: High	Time: Short

Overall Effectiveness Concerns: *There are no evaluation studies showing reductions in crashes or injuries. These outcomes are difficult to demonstrate because minimal, basic training is very widespread and the choice to adopt a stronger curriculum would be confounded with any number of other factors.*

The purpose of school bus training for children is to teach school-age children how to safely approach, board, disembark, and walk away from school buses. According to NHTSA, 102 school-aged pedestrians 18 and younger died in school-transportation-related crashes from 2006-2015 (NCSA, 2017a). These fatalities represent 7.8% of all school-transportation-related fatalities, most of which (72%) involved occupants of non-school-bus vehicles. Of the 102 school-aged pedestrian fatalities, 64% were struck by school buses or vehicles functioning as school buses, and 36% by other vehicles (passenger cars, etc.). In 2015, 11 pedestrians of all ages were struck and killed by school buses.

Basic training for children who ride school buses should be part of the normal school routine, if it is not already. Training should include behavior on the bus as well as getting on or off the bus at bus stops or school, obeying bus drivers and bus monitors, emergency evacuation procedures, and any topics unique to the school. Additionally, education about safety behaviors of parents in school zones and around school buses should be reinforced as part of Back to School night, in school bulletins, or other creative means. The Safe Routes to School website has many resources (www.saferoutesinfo.org/) and the SRTS program guide includes messages for drivers and tips for neighbors living in school walk zones to help improve safety for school-aged pedestrians (guide.saferoutesinfo.org/education/index.cfm). NHTSA also has a refresher training module for school bus drivers (see www.nhtsa.gov/school-buses/school-bus-driver-service-safety-series).

Jurisdictions should use a common curriculum for school bus safety training. Targeted behaviors include boarding and exiting from the bus and crossing the street to and from the bus. The NHTSA Child Pedestrian Safety Curriculum, previously discussed, includes a segment on safety around school buses.

Use: Most school districts have some form of school bus training in place, though the content and quality of those programs varies. Schools should be eager to provide this training, both for child safety and for legal liability.

Effectiveness: Burke, Lapidus, Zavoski, Wallace, and Banco (1996) found that stenciled pavement markings, together with in-school training, led to improved behavior in waiting for and boarding the school bus compared to training alone for students in grades 4-6. Reductions in crashes and injuries are difficult to demonstrate because minimal, basic training is very widespread and the choice to adopt a stronger curriculum would be confounded with any number of other factors.

Costs: The primary cost for the SHSOs would be in adapting material for their States and producing, stocking, and distributing the material. Much of this could be done electronically, through school websites, newsletters, press releases, and other regular communications channels.

Time to implement: Basic material is available from a variety of organizations, including NTHSA, and schools could adopt a curriculum of their choice quickly.

3. Impaired Pedestrians

3.1 Communications and Outreach Addressing Impaired Pedestrians

Effectiveness: ☆☆	Cost: Varies	Use: Low	Time: Medium

Overall Effectiveness Concerns: *There is insufficient evaluation data available to conclude that the countermeasure is effective.*

In 2015, 34% of all fatally injured pedestrians had BACs of .08 g/dL or higher, and 38% of all fatally injured pedestrians had positive BACs (NCSA, 2017b).

Communications and outreach to reduce impaired-pedestrian crashes can be directed at a wide variety of audiences, including law enforcement, drivers, alcohol servers and vendors, civic and neighborhood leaders, faith-based communities, universities, and friends and family of likely impaired pedestrians. Impaired pedestrians are also a target audience, of course. However, they are viewed as a difficult audience for communications and outreach to have a meaningful effect on their behavior because their decision-making is compromised. Reaching others who are in a position to prevent these crashes, or to alter the circumstances that lead up to such crashes, may be among the most effective ways to achieve success. Some of the countermeasures proposed for impaired drivers in Chapter 1, such as responsible beverage service training and alternative transportation, are also appropriate for impaired pedestrians.

Use: Low. NHTSA has successfully implemented one zone-based program in Baltimore, Maryland that included public service announcements, posters, flyers, and interventions aimed at alcohol-impaired pedestrians, but the program is not currently active (Blomberg & Cleven, 2000). Most impaired-roadway user programs focus on impaired drivers.

Effectiveness: Using 5.5 years of before data and 2 years of after data, Blomberg and Cleven (2000) found a 22% decrease in crashes among males 30 to 59 in the targeted zones where the intervention took place. Although encouraging, there have been no demonstrations of crash or injury reductions unless the communications and outreach is part of a comprehensive program that includes engineering measures and some form of law enforcement involvement, as in the case of Blomberg and Cleven.

Costs: The costs for such a program can range from low to high, depending on the extent of the campaign that is designed and implemented.

Time to implement: The actual time to implement depends on the scope and ambition of the program.

3.2 "Sweeper" Patrols of Impaired Pedestrians

Effectiveness: ☆	Cost: Varies	Use: Low	Time: Medium

***Overall Effectiveness Concerns:** This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

The purpose of "sweeping" alcohol-impaired pedestrians from the streets until they no longer have high BACs is intended to reduce the exposure of these at-risk pedestrians to traffic, and can also address other social issues such as public intoxication and crime. Pedestrians with high BACs are at high risk of injury due to motor vehicle crashes. A program of removing alcohol-impaired pedestrians from the streets can be effective in reducing their exposure and thus the risk.

There are some important issues that need to be resolved when setting up sweeper programs, such as how to identify at-risk pedestrians (e.g., calls from bars or direct observers, observation by police or health professionals), who will pick up the targets, where will they be kept until they are sober, what friends or family need to be notified at the time of the pickup (if any), how the pedestrians are returned home after the intervention, and how the costs of the program are borne.

Huntley (1984) focused on police "sweeper" squads and "support on call" programs involving taxis and trained escorts to get intoxicated people home or to a detoxification center. Services of these types in the Boston area were surveyed. Both types of services appeared practical and effective, though the number of people who could be reached by these services was relatively small. There was a problem related to the number of available detoxification beds in the community. The sweeper squads wanted to deliver intoxicated pedestrians to the mental health community, not to police facilities, and they stopped the sweep when the beds were filled. There were also problems with the number of taxi drivers who wanted to deal with intoxicated people and the availability of volunteer escorts.

In 2005, the National Health Service of London created a program of alternative response vehicles (often called "booze buses") in response to an increasing number of alcohol related ambulance calls (Hayes, 2010). These buses, staffed with paramedics, collect intoxicated pedestrians and bring them to alcohol treatment centers or hospitals.

Use: Well-publicized sweep operations, which involve picking up intoxicated people from the street and letting them "sleep it off," have been conducted in Puerto Rico and in Gallup, New Mexico. Puerto Rico's program, which included a statute, communications and outreach, and law enforcement training, led to a 7% drop in alcohol-related pedestrian crashes (Stewart, 1994). There appear to be no well-publicized programs operating now.

Effectiveness: Such programs typically reach only a fraction of those people who need the services. The sweeps typically deal with people who are too drunk to walk or even know that they are being "swept." These same people are at risk while they are becoming intoxicated, and, in all likelihood, will be at risk again in the near future as they become sober and thus more mobile. As described by Huntley (1984), these people need intensive treatment for alcoholism; and sweeper programs may be useful in identifying potential treatment candidates.

Costs: The program incurs ongoing costs directly related to the effectiveness, i.e., the number of people swept up. Depending on how it is set up, the program may incur costs related to the sweeper patrol (or law enforcement overtime), the use of facilities, and any subsequent treatment requirements.

Time to implement: Once it is decided to offer the program, the logistics for starting it up could be handled within weeks or months, depending on the extent and coordination of services.

Other issues:

- The legal rights of those potentially being swept need to be preserved.
- Often if law enforcement or other formal agencies are involved, their regular procedures would require some formal charge or other processing to take place. Alternatively, a sweeper program could be without subsequent consequences to those being swept, with no formal records kept. This might eliminate certain organizations or agencies from participating.

4. All Pedestrians

4.5 Driver Training

Effectiveness: ☆	Cost: $	Use: Low	Time: Medium

Overall Effectiveness Concerns: *Driver training alone has not been shown to reduce overall crash rates. There is no evidence indicating that this countermeasure is effective. However, driving skill begins with knowledge education and then practicing defensive driving in relation to all other types of traffic, including pedestrians.*

The purpose of pedestrian safety-related driver training is to increase the sensitivity of drivers to the presence and characteristics of pedestrians and their role as drivers to enhance the safety of pedestrians. Current training for new drivers typically includes relatively little information on other road users. Information on pedestrians can be significantly strengthened. Specifications for driver education curricula, typically a State requirement, can be adjusted to include more specific information on the status of the pedestrian in the traffic environment, right of way requirements for drivers and pedestrians, other driver and pedestrian responsibilities, categories of pedestrian crash types, and key ways drivers can avoid being involved in such crashes. Standards for curriculum and training developed by the American Driver and Traffic Safety Education Association (ADTSEA) include some of these pedestrian-related learning objectives (Driver Education Working Group, 2009).

One way driver training can incorporate pedestrian and bicyclist concerns for new and existing drivers is through "Share the Road" education concepts and programs, though many focus exclusively on bicycles. One of many such resources is the State of New York's highly readable *Sharing the Road Safely* (www.safeny.ny.gov/media/share-road.htm). It should be noted that "Share the Road" programs have not been accepted everywhere, and some States have discontinued these programs after implementing them.

Use: As noted, all driver education curricula include some information on other road users, but the kind of expanded information recommended here is sparse.

Effectiveness: Driver education alone has not been shown to reduce overall crash rates. The objective for adding more pedestrian information would be to increase knowledge and desire to share the road safely with pedestrians, of how to avoid the most common types of motor vehicle/pedestrian type crashes, and to improve drivers' anticipation of and interactions with pedestrians – as well as improve their behavior as pedestrians.

Cost: Low. The cost would be for the development of the new segments of the standard curriculum and for getting it into the material used by driver education instructors and schools.

Time to implement: Material would need to be developed and integrated into the standard driver education curriculum, and adjustments made elsewhere in the curriculum to reflect likely additional time required for the new pedestrian material.

The same timeframe would be appropriate for making changes to official State driving manuals, license exams, and related material and procedures.

4.6 Pedestrian Gap Acceptance Training

Effectiveness: ☆	Cost: $$	Use: Unknown	Time: Medium

Overall Effectiveness Concerns: *This countermeasure has been examined in few research studies. While there is some evidence that certain approaches may lead to limited positive outcomes, there is insufficient evaluation data available to conclude that the countermeasure is effective.*

The purpose of pedestrian gap acceptance training is to help pedestrians learn to make better road crossing decisions, which may reduce the incidence of crossing-related injuries and fatalities. Previous studies have indicated that human error, such as poor judgment in gauging the speed and/or distance of oncoming traffic, underlies a significant portion of roadway collisions (Hunt, Harper, & Lie, 2011).

Identifying safe gaps is a task that children pedestrians and bicyclist must be taught. Although children as young as 5 can understand the concepts of speed and distance—and young children can be taught to mimic gap judgments of adults—they can still have difficulty interpreting vehicle speed and direction at 6 and 7 (Percer, 2009). Additionally, child bicyclists as old as 10 to 14 show developmental differences in learning to adjust their trajectories to match safe gaps relative to older drivers (Chihak et al., 2014; Plumert & Kearney, 2014). These trends suggest that children require training on different types of gap judgment skills than adults.

Use: Unknown. Preliminary studies have taken place in New Zealand and France but no adult simulator trainings on gap acceptance have been found in the United States.

Effectiveness: Hunt, Harper, and Lie (2011) used laboratory-based instruction (e.g., a video simulating the roadway environment) to test three different approaches for giving feedback to pedestrians in how to better incorporate vehicle speed information to their gap estimates and crossing decisions. While the study group was small—58 people 18 to 80—preliminary results indicate that video-based training with a feedback mechanism can be successful in improving the accuracy of pedestrians' estimates of driver speeds. However, improved speed estimation did not consistently translate into improved gap-acceptance judgments, and participant age played a role in training effectiveness. Older pedestrians, in particular, had significantly more conservative gap judgments after the training, which were independent of improvements in vehicle speed estimations.

Another study by Dommes and Cavallo (2012) evaluated the effectiveness of an education-based intervention aimed at training older pedestrians (60+ years) to improve crossing safety by taking into account vehicle speeds. Results showed that after simulated crossing training, the treatment group participants crossed more quickly, had larger safety margins, and had fewer close encounters than the control group, although differences were no longer significant 6 months after training. Also, in contrast to the Hunt et al. study, participants did not appear to improve in taking into account vehicle speed when making crossing decisions. The authors concluded that age- related perceptual and cognitive difficulties may exist in gauging speed and gap acceptance that cannot be remedied by educational training alone.

Costs: Medium. Costs would involve development of the training materials (or adaptation from existing study materials) and determining an applicable and appropriate venue to reach the adult and senior pedestrian population.

Time to implement: Medium. Training materials could be developed and integrated into existing educational channels for adult and senior pedestrians.

Other issues:

- As mentioned earlier, environmental treatments such as allowing sufficient time for the pedestrian crossing in signal timing, median refuges, and careful attention to sidewalk accessibility issues are also important to older pedestrians who may have mobility declines.

4.7 University Educational Campaign

Effectiveness: ☆	Cost: $	Use: High	Time: Medium

Overall Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

Frequently, university settings are areas of high pedestrian concentrations. This, combined with a younger age population who frequently take more risks as both pedestrians and drivers, may result in increased pedestrian crashes on roads around and through a campus setting (Zegeer, Sandt, & Scully, 2008). At the same time, a university campus may offer an opportune setting to reach a well-defined target audience of drivers and pedestrians about the risks of unsafe behaviors. Fall of a new academic year may be a good time to reach new students, faculty, and staff who may be less familiar with walking and driving in the campus environment. Activities may need to be repeated several times a year for maximal effect, during higher risk times such as in the fall as day length shortens, and again in spring as weather warms and jogging and other outdoor activities may increase. Potential educational messages may include right-of-way rules and the importance of yielding right-of-way (pedestrians, bicyclists, and drivers), being visible and predictable at both day and night times and during inclement weather (pedestrians and bicyclists), making eye contact at conflict points (pedestrians and drivers), avoiding distractions (pedestrians and drivers), and speed control (drivers and potentially bicyclists) (Zegeer, Sandt, & Scully, 2008). Partnerships may include campus public safety offices, student health and wellness programs, city/county public safety agencies, injury prevention agencies, parking and transportation services, transit agencies, and student groups. There may be academic or research units on campus that could also help with developing a campus campaign.

Use: A number of universities are known to conduct some form of outreach or have pedestrian safety campaigns. The University of North Carolina combines educational outreach with targeted crosswalk enforcement to remind both motorists and pedestrians of safe yielding behaviors, but the program effects have not been evaluated. John Hopkins University Arts and Sciences campus developed a pedestrian training campaign based on focus groups, university crash reports, and an environmental audit. Based on their research, they increased enforcement at busy intersections, included pedestrian training as part of new student orientation, and increased signage to educate pedestrians. However, the effectiveness of this program has not been evaluated (Pollack et al., 2014).

Effectiveness: No studies of crash effects are known. The University of South Florida at Tampa conducted a one-week campaign in the fall that began with campus administrators, local agencies, and elected officials leading a “parade” walk around campus. Over four days, there were lectures on walking and biking safely (WalkWise and Bike Smart), and posters and booklets with walking and biking rules were distributed across campus. The campaign ended with a bicycle celebration event. Zhang, Gawade, Lin, and McPherson (2013) reported some improvement in observed safety behaviors, most notably at locations closest to a student center where many of the activities took place. They also noted, however, that all groups (drivers, pedestrians, and bicyclists) self-reported better behavior than was observed in the field, and that there were differences in perceptions of the interactions among the groups. For example, drivers thought they yielded more frequently to pedestrians than pedestrians thought they did, and vice versa.

Effectiveness is likely to be increased when education is combined with appropriate infrastructure to facilitate safer interactions.

Costs: Costs vary depending on the activities implemented, but could include costs for events and materials. The well-identified campus environment and potential campus partners are characteristics that provide an opportunity to lower and/or share costs when compared to other similar types of educational campaigns in a broader community.

Time to Implement: The timeline may be short once problem identification and program development has occurred. Time should be allowed to gather campus community input and to develop and test materials that resonate with the campus community.

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A9. Bicycle Safety

This section provides expanded discussion of the ☆ and ☆☆ countermeasures. Countermeasures that receive ☆ or ☆☆ have NOT been determined to be effective, either because there has been limited or no high quality evidence (☆) or because effectiveness is still undetermined based on the evidence that is available (☆☆).

States should use caution in selecting ☆ or ☆☆ countermeasures, since conclusive evidence is not available to demonstrate the effectiveness of these countermeasures. If they decide to use a new or emerging countermeasure that has not yet been studied sufficiently to demonstrate that the countermeasure is effective, they are encouraged to have the countermeasure evaluated in connection with its use.

The ☆ and ☆☆ countermeasures covered in this section of the Appendix are listed below.

1. Children

Countermeasure	Effectiveness	Cost	Use	Time
1.3 Bicycle Safety Education for Children	☆☆	$	Unknown	Short
1.4 Cycling Skills Clinics, Bike Fairs, Bike Rodeos	☆	$	Unknown	Short

2. Adults

Countermeasure	Effectiveness	Cost	Use	Time
2.2 Bicycle Safety Education for Adult Cyclists	☆	$$	Low	Medium

3. All Bicyclists

Countermeasure	Effectiveness	Cost	Use	Time
3.2 Promote Bicycle Helmet Use with Education	☆☆	$$$	Medium	Medium
3.3 Enforcement Strategies	☆	$$	Unknown	Varies
3.4 Motorist Passing Bicyclist Laws	☆	$	Medium	Short

4. Drivers and Bicyclists

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Driver Training	☆	$	Low	Medium
4.2 *Share the Road* Awareness Programs	☆☆	$$	Unknown	Medium

Effectiveness:

☆☆- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

☆- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than 1 year
Medium: more than 3 months but less than 1 year
Short: 3 months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Children

1.3 Bicycle Safety Education for Children

Effectiveness: ☆☆	Cost: $	Use: Unknown	Time: Short

Overall Effectiveness Concerns: *Previous studies examining the effectiveness of this countermeasure found that bicycle safety education increases children's knowledge of laws and safe behaviors (Hooshmand, Hotz, Neilson, & Chandler, 2014; Lachapelle, Noland, & Von Hagen, 2013; Thomas et al., 2005), but whether this translates into adoption of the safe behaviors is less certain. The balance of evidence regarding countermeasure effectiveness remains inconclusive.*

The purpose of bicycle education is to teach children basic bicycle handling skills, traffic laws, how to ride on streets with traffic present, proper helmet use, bicycle safety checks, and bicycle maintenance. As part of a regular school curriculum, education can reach every student, but providing training outside of school settings such as through parks and recreation departments, community centers or faith-based organizations may be more feasible in some circumstances. Community-based programs could also provide greater flexibility in tailoring to meet the needs of specific target groups.

Young children are just learning about traffic. They have little experience with which to anticipate and interpret potential traffic hazards, and limited abilities to reason and react. Their brains are still developing and they lack the maturity and judgment needed to negotiate traffic safely and to limit risk-taking behaviors. They are also less skilled at riding than older children or adults. Many children under ten have difficulty accurately judging the speed and movements of vehicles, and may require adult supervision. Supervision is also recommended until children are able to ride in a straight line, swerve to avoid hazards in the roadway, comfortably start and stop their bicycles, and maintain balance at slow speeds.

Readers should note that safe bicycling principles can be counterintuitive, and safety skills taught to pedestrians (such as walking facing traffic) do not necessarily hold true for bicyclists. However, some actions are common to both, such as looking left right left for traffic, and going only when clear. Making these connections is particularly helpful when correlating walking and bicycling as precursors or stepping stones to safe driving (with older pre-driving youth). Further, bicycle safety skills for children may differ from safety skills needed by adults riding in different environments and at different speeds. For example, bicycle education programs may teach young children to ride their bikes slowly on the sidewalk or adjacent paths, and as far away from the roadway as possible. However, adult cyclists may need to be trained where to position themselves in the travel lane, riding in the same direction with traffic, and further from the curb, depending on the facility type. For more on adult bicyclist education, see Section 2.2. One common theme in bicycle education for both children and adults is the need to scan for traffic and potential hazards, ride predictably, and use correct hand signals to indicate changes in speed or direction.

Whether school or community-based, bicycle education should include, at a minimum, a demonstration and handout on how to properly fit a bicycle helmet and an emphasis on everyone, regardless of age, wearing a helmet every ride. As noted above, the curriculum should also include information on how parents and children should decide what locations are safe places to ride, and how children can be predictable and visible to drivers. In addition, bicycle safety training should be reinforced (potentially by caregivers), with opportunities to practice new skills in appropriate settings (Ellis, 2014). Twisk et al. (2013) found that it may be very difficult to improve behaviors in real-traffic situations using educational programs that occur in a controlled school setting, even using models for the traffic situations, and even if recognition of risks (knowledge) appears to be improved.

Bicycle safety training and education may be incorporated into life-long, comprehensive traffic safety education, with components assembled from NHTSA or comparable programs. Many bicycle safety education materials target children in grades K-8, though some are aimed at younger children. Bikeology, an on-bicycle skills curriculum specifically designed for professional physical education teachers and recreation specialists, is suited for teaching middle to high school students of varying abilities and with special needs (AAHPERD, 2014). This curriculum is available at shapeamerica.org/publications/resources/teachingtools/-qualitype/bicycle_curriculum.

NHTSA has produced publications on how to properly fit a bicycle helmet, rules of the road, presentations to generate peer to peer discussion on safe walking and bicycling, and games to educate children and parents on bicycle safety. The materials are available in English and Spanish on NHTSA's Bicyclepage. Bicycle Safer Journey is an updated series of web-based training videos and discussion guides targeted for bicyclists 5 to 9, 10 to 14, and 15 to 18. The materials are available on the Pedestrian and Bicycle Information Center website (www.pedbikeinfo.org/bicyclesaferjourney/).

Use: The use of school-based programs, which is at the discretion of local school districts, is unknown, but some localities are introducing bicycling as a physical activity class taught by experienced teachers. In-school education and training; however, is a frequent part of local SRTS programs. In addition to programs offered by teachers and school personnel, local bicycling coalitions sometimes offer age-appropriate bicycle training within a school setting. Examples are the Bicycle Transportation Alliance in Portland, and the Hawaii Bicycling League (Thomas, Masten, & Stutts, 2005). The prevalence of community-based programs is also unknown, but there are some programs active in some States such as California, New York, New Jersey, and Virginia.

Effectiveness: Both short lecture-based programs and more extensive programs with on-bicycle training can increase children's knowledge of laws and safe behaviors (Ellis, 2014; Hooshmand, Hotz, Neilson, & Chandler, 2014; Lachapelle, Noland, & Von Hagen, 2013; Thomas et al., 2005) or observed behaviors in an educational context (Ducheyne et al., 2013, 2014), but whether these translate into adoption of the safe behaviors is less certain. A 2005 study for NHTSA described four school-based, on-bicycle training programs that each achieved sustained knowledge gains, and higher average knowledge compared to students who had never had a training course (Thomas et al., 2005). Self-reports from students and parents also suggested that safe riding behaviors and enjoyment of riding improved, more so in the courses taught on road than those taught in a closed course (on the school grounds).

A review of evaluations of 13 educational programs (without legislation enactment) among children and youth found that educational programs were effective at increasing observed helmet use. Most of the programs also offered discounted or free helmet distribution. Meta-analyses found the odds of observed helmet wearing to be more than 2 times higher than at baseline or among the non-intervention group, but results were quite varied across the different studies (Royal, Kendrick, & Coleman, 2007). The authors were unable to tease apart differences in programs that might contribute to different outcomes other than whether they were community-based or school-based, and whether or not they offered free or reduced-priced helmets. Community educational programs that provided free helmets were reported to be more effective than programs set in schools or that provided only an opportunity to purchase a discounted helmet, although the latter types also increased use. School-based programs also tended to obtain best results among the younger participants (Royal et al., 2007). Three of the studies found helmet use benefits persisting at 9 to 12 month follow-up, although evidence is still lacking regarding longer-term (1 year or more). Based on the evidence of effectiveness of helmets at preventing head-injuries when worn, injury-reduction benefits would be expected from programs that increase proper use of helmets. Crash reduction benefits of educational programs have not been conclusively demonstrated. Evidence is also lacking as to whether programs might have any unintended effects such as reducing amounts of riding or conferring overconfidence in one's riding skills.

Costs: Coalitions may be paid by their associated State to provide training, or otherwise use SRTS funds if money is still available, or if SRTS funding at the State is being maintained. Activities formerly eligible under Federal SRTS funding are now eligible under the TAP program outlined in MAP-21, but funding priorities are established by each State. State contacts may be located on the PBIC website (pedbikeinfo.org/data/state.cfm) or search individual States' DOT websites for information about TAP and SRTS funding. Teachers can provide education using NHTSA's free materials, but training, administration, and supervision of a comprehensive program could increase costs somewhat.

Time to implement: Short, for existing material; medium, to develop and disseminate a training curriculum with material.

1.4 Cycling Skills Clinics, Bike Fairs, Bike Rodeos

Effectiveness: ☆	Cost: $	Use: Unknown	Time: Short

Overall Effectiveness Concerns: *While cycling skills clinics or rodeos can result in an increase in knowledge and skills, a review of the research literature does not reveal any studies that document crash and injury reduction, at least not in isolation. There is insufficient evaluation data available to conclude that this countermeasure is effective.*

The purpose of cycling skills clinics, bike fairs, or bike rodeos is to teach children bicycle handling skills such as starting, stopping, weaving to avoid objects, and the meaning of traffic signs and signals and some traffic laws. The intent of these types of activities is to introduce or reinforce bicycle safety concepts learned in a classroom with actual on-bike practice and application. It should be part of a more comprehensive program of traffic safety education and training, parent education, and other efforts.

A cycling skills clinic, bike fair, or rodeo is an event that provides children an opportunity to learn and practice bicycling skills. A clinic typically has several stations for specific skills and also includes bicycle and helmet inspections. Parental involvement can also be a valuable component of bicycle fairs, providing reinforcement of desired safe riding behaviors and modeling appropriate bicycling behaviors. Events should also include discussions and examples of proper bicycle helmet fitting. NHTSA collected many examples of these across the country and created a guide of best practices. NHTSA's Cycling Skills Clinic Guide aids first time or seasoned organizers in how to set-up a clinic, stations to chose based on their audience, station set-up, and teaching tools for volunteers, see: www.nhtsa.gov/staticfiles/-nti/bicycles/pdf/811260.pdf.

There are a number of bicycle safety courses and models for fairs, rodeos, and clinics. NHTSA, using older bike rodeo as models, developed a cycling skills clinic with the League of American Bicyclists (2011) to provide a how-to guide including stations based on a basic, intermediate, or advanced skills. The League of American Bicyclists and the American Bicyling Education Association have numerous certified instructors across the country to teach various levels of courses that include a combination of classroom and on-bicycle courses to people of all ages and skills. These courses teach more about defensive riding around traffic and about traffic laws.

Use: Bicycle safety fairs and rodeos are local events. They are often run by law enforcement, school personnel, or other civic and volunteer organizations. There may be permanent "neighborhood" layouts where the rodeos are conducted, and the events may be scheduled as part of the elementary and middle school curriculum. Although the extent of use is unknown, they are increasingly implemented as part of Safe Routes to School projects and as part of pedestrian and bicycle safety efforts.

Effectiveness: While cycling skills clinics or rodeos can result in increases in knowledge and skills, a review of the research literature does not reveal any studies that document crash and injury reduction, at least not in isolation. One program of comprehensive education for preschool children and their parents, that included a skills and safety rodeo, led to a doubling of helmet use

(Britt, Silver, & Rivara, 1998; Rivara & Metrik, 1998). Some studies have found that single event bike rodeos did not lead to increases in knowledge or improvements in behaviors or attitudes (Macarthur, Parkin, Sidky, & Wallace, 1998); thus, bike rodeos need to be part of a larger, more comprehensive program. Again, see Rivara and Metrik (1998) for a more in-depth discussion.

Costs: A one-time clinic or rodeo can be operated with volunteers at minimal cost. A permanent rodeo facility could cost thousands of dollars. Associated costs may include bicycle and helmet rentals, but many communities have bicycle coalitions that have purchased these resources and bring them in trailers to scheduled events, or have children or community members bring their own.

Time to implement: A one-time clinic or rodeo can be organized in a few months. Implementing a permanent program with a facility may take up to a year or longer.

2. Adults

2.2 Bicycle Safety Education for Adult Cyclists

Effectiveness: ☆	Cost: $$	Use: Low	Time: Medium

Overall Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that this countermeasure is effective.*

The goal of bicycle safety education for adult bicycle commuters is to improve knowledge of laws, risks, and cycling best practices, and to lead to safer cycling behaviors, including riding predictably and use of safety materials such as reflective clothing and helmets. The Cycling Skills Clinic discussed in 1.4 of this chapter can be adopted for use by adult audiences as can a safety class prior to and part of planning for a community bike ride (like a ride to support a particular disease or cause). Opportunities to educate adults new to or returning to bicycling can reinforce traffic safety principals and to generate more interest in additional on-bicycle classes to enhance comfort, safety, and defensive riding maneuvers in and around traffic.
A handful of communities have developed bicycle education programs, with large variation in program elements. Common elements include safety ads (e.g. radio, TV, outdoor), dissemination of safety materials, bike “ambassadors” and social supports, individual skills training or workshops, and coordination with enforcement officers to reinforce safe behaviors. The League of American Cyclists provides online training videos. Case study summaries are available of programs in Tucson, AZ, Portland, OR, Augusta, ME, Chicago, IL, and many other cities (PBIC, 2010). A recent University of Texas at Austin program was designed to provide tailored education and encouragement to new or timid bicyclists in the African American community and reported improvements in perceptions of comfort and safety among those participating (McCray, Durden, & Schaubert, 2013).

NHTSA has developed a campaign, *Be a Roll Model*, aimed at encouraging all road users, including bicyclists, to model safe travel behaviors for their children and others. The campaign includes educational materials, tip sheets, and a pledge program for local agencies to adopt and disseminate (one.nhtsa.gov/Driving-Safety/Bicycles/Be-a-Roll-Model).

Adult cyclists are trained that bicyclists fair best when riding and acting as a vehicle in the roadway, following the same rules as motorists such as riding in the same direction with traffic and following the traffic signs and signals. For example, adults learning to ride safely are taught where to position themselves in the travel lane based on their intent to go straight or turn, the use of judgement to enhance their comfort and safety while riding in traffic, and when they must stay in a bicycle lane if one is present.

Use: Low. Adult-oriented safety education programs in the United States are not well documented and are rarely formally evaluated. Multiple bicycle groups offer bicycle education to adults (and youth) including both classroom and on-bicycle training to help cyclists of varying levels enhance their knowledge of traffic laws and rules of the road and skills to ride safely and more comfortably in traffic. The oldest and most well known is the League of American Bicyclists, see http://bikeleague.org/content/take-class for more information and to find league-trained cycling instructors (LCI’s as they are called) by geographic area. LCIs typically provide group training.

Effectiveness: Unlikely to be effective in reducing crashes without comprehensive and sustained efforts to improve the cycling environment. A high-quality evaluation conducted in Brazil by Bacchieri, Barros, dos Santos, Goncalves, & Gigante (2010) found that “an intervention based on an educational component and the promotion of the active use of safety equipment is not capable of reducing accidents among cycling workers” (in this case, male cycling commuters). The study concluded that “isolated educational programs, attempting to only change individual behavior, are not effective in reducing accidents” and that “the number of accidents will not considerably decrease without actions that also include improved road infrastructure and the effective application of legislation (with comprehensive and systematic law enforcement)” (Bacchieri et al., 2010).

Costs: Medium. Costs may vary depending on the intensity of the educational program. Costs for radio/TV ads, print materials, safety equipment, workshop and training events, and personnel time could be incurred.

Time to implement: A comprehensive education program could require several months of start-up time to plan and develop program materials.

3. All Bicyclists

3.2 Promote Bicycle Helmet Use With Education

Effectiveness: ☆☆	Cost: $$$	Use: Medium	Time: Medium

Overall Effectiveness Concerns: *This countermeasure has been examined in several research studies. There is some evidence that certain approaches may lead to increased helmet use and more favorable attitudes towards helmet use, especially among children. However, more research is needed to conclude that the countermeasure is effective when broadly targeted towards all cyclists.*

The purpose of bicycle helmet promotions is to increase use of helmets and thereby decrease the number of severe and fatal brain injuries to bicyclists involved in crashes. Bicycle helmet promotions are frequent, but are usually aimed at child bicyclists only, often through youth health organizations and schools. Promotions can target various barriers to helmet use, including absence of a helmet, child and families' lack of understanding of the importance of helmet use, cost of helmets, and negative attitudes or beliefs about helmet use. Programs that provide helmets can include sponsoring organizations and often involve law enforcement and schools to deliver helmets, fit the helmets, and teach proper fitting and use. Promotions can be conducted through single events or extended campaigns to promote helmet distribution and use. Helmet promotions should not be limited to just children, but should include adults requires as well because crashes are not limited to just children to those who are deemed less skilled at bike riding. Expanding helmet promotions to adults requires an expansion in focus, and perhaps different sponsors. However, adding adult-oriented riding tips may increase the appeal of the program. Other adult-oriented strategies should also be included, such as peer-based interventions on a college campus (Buckley, Sheehan, & Chapman, 2009).

Regardless of the target audience, bicycle helmet promotions must include instruction on how to properly fit the helmet and the importance of wearing helmets on every trip. See Sections 1.1 and 2.1 for more information. The Bicycle Helmet Safety Institute has extensive information on helmets, purchasing a helmet, helmet fit, when to buy a new helmet, helmet recalls, and the difference between helmet brands, see www.helmets.org/. Programs might also need to target differences in tendency to adopt helmet use for different riding purposes (recreational versus commuting), or riders who identify as only one type of rider (Kakefuda, Stallone, & Gibbs, 2009). All bicyclists could benefit from utilizing resources that demonstrate how helmets work to reduce injury. Moreover, further efforts are needed to encourage parents and authority figures (e.g., law enforcement officers, school officials and staff, and health-care professionals) to reinforce and model desired behaviors including the use of a properly fitted bicycle helmet every ride (Maitland, 2013). Trained and skilled cyclists may also be more likely to adopt helmet use (Kakefuda et al., 2009), so adult bicycle training programs that incorporate the importance of helmet use may help increase wearing by adult riders. A U.S. survey of attitudes toward bicycling and walking indicates that about 34% of respondents who had ridden a bicycle in the past year used a helmet for all or nearly all of their rides (Schroeder & Wilbur, 2013).

Use: Most States have conducted bicycle helmet promotions for children within the last few years, although only a few have ongoing or regular programs. Some States have conducted bicycle helmet promotions for a general audience.

Effectiveness: Bicycle helmets are proven to reduce injuries and fatalities (see Chapter 9, Sections 1.1 and 2.1). Helmet promotions are successful in getting more helmets into the hands of bicyclists. Rouzier and Alto (1995) describe a comprehensive program of presentations, media coverage, messages from doctors to patients, as well as low-cost helmet availability, which significantly increased helmet purchases and use for all ages. A peer-led, social marketing program on a medium-sized college campus also raised observed helmet use, at least for the short term (Ludwig, Buchholz, & Clarke, 2005). A school-based injury-reduction program targeting 13- and 14-year-olds incorporating opportunities for instruction, demonstration, rehearsal, feedback, social reinforcement and practice was associated with a 20% increase in observed rate of helmet use among this challenging target age group at 6 months follow-up (Buckley et al., 2009). In France, voluntary helmet use increased from 7.3% in 2000 to 22% in 2010. During that time period, national public awareness and informational campaigns were initiated and carried out promoting helmet use among youth, adults with children, and the general population (Richard, Thélot, & Beck, 2013).

Recently, a Cochrane systematic review and meta-analysis of twenty-two studies evaluating non-legislative helmet promotion programs aimed at children under 18 found the odds of observed helmet wearing were significantly greater among those receiving the interventions (Owen, Kendrick, Mulvaney, Coleman, & Royal, 2011). The study found the more effective programs were community-based (rather than aimed at people), provided free rather than subsidized helmets, and were set in schools. A Canadian program, *Operation Headway*, involving enforcement of bike helmet legislation, education, rewards for wearing and economic penalties for non-wearing, and provision of helmets to low-income groups was evaluated by Lockhart, Fenerty, and Walling (2010). The researchers found the program increased wearing rates (based on observations pre- and post-intervention), increased knowledge and commitment to wearing a helmet, saw greater public awareness of the law through media tracking, and improved relationships between police and the public (based on anecdotal evidence). Another helmet-use promotion program, involving distributing helmets and information, was evaluated in France (Constant, Messiah, Felonneau, & Lagarde, 2012). This study found that the helmet promotion program was of value in increasing helmet use, but not sufficient to achieve high rates of helmet use among adult cyclists. A related theme of these studies is that population-wide, multifaceted, integrated, and repeated prevention programs are needed, which should include distribution of free helmets and safety information and strategies to increase peer and parental pressure.

Programs that increase proper use of helmets would be expected to reduce injuries in the event of a bicycle crash (see Section 1.3).

Costs: The cost for underwriting large numbers of helmets can be quite high, including supporting communications and outreach material. Adequate helmets can be purchased for as little as $8 each, within reach of most adult bicyclists. Purchase of large quantities of helmets by businesses, hospitals, or through partnerships with merchants for example can also lower the cost per helmet and make free or subsidized distribution of helmets to at-risk segments of the population more feasible.

Time to implement: A good campaign, including market research, material development, and message placement, will require at least 6 months to plan and implement.

3.3 Enforcement Strategies

Effectiveness: ☆	Cost: $$	Use: Unknown	Time: Varies

Overall Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

The purpose of targeted enforcement is to increase compliance with appropriate traffic laws by both bicyclists and motorists. Enforcement of traffic laws for all operators, including speed, distracted, and impaired enforcement, may help to enhance behavioral compliance and reduce the severity and frequency of collisions as well as promote bicycle safety. (See Chapter 3 for more information on strategies to reduce speeding and aggressive driving.) Targeted enforcement directed at bicyclists is rare but does occur with their failure to obey traffic signs and signals. Some college towns, such as Madison, WI, have enforcement periods at the beginning of each school year.

State Highway Safety Offices can help ensure correct riding and driving around bicyclists through communications and outreach campaigns, and through training law enforcement officers about laws that impact the safety of bicyclists, and applicable enforcement. Some types of violations may be especially pertinent to bicyclist safety. For example, motorists may violate bicyclist' right-of-way following an overtaking maneuver by immediately turning right across the bicyclist's path when making a right or left hand turn, or by passing a bicyclist too closely (see Section 3.4 below). Similarly, bicyclists riding the wrong-way put themselves at greater risk of head-on collisions or angle collisions with motorists pulling out at side streets or driveways who are looking to the left for oncoming traffic. By enforcing and educating bicyclists and drivers about relevant laws, the motoring and bicycling public may become better-informed about the risk of these types of violations and importance of obeying all traffic laws. Law enforcement can also reinforce active lighting and helmet use laws in effect by stopping and educating offending bicyclists as well as writing citations if appropriate. (Also see Chapter 9, Section 1.1, and BIKESAFE Law Enforcement countermeasure for more information: www.pedbikesafe.org/BIKESAFE/countermeasures_detail.cfm?CM_NUM=40.)

Law enforcement officers typically receive little to no specialized training in bicycle (or pedestrian) safety, but such training can yield safety improvements. For instance, the Watch for Me NC program in North Carolina provided comprehensive officer training combined with public safety messages about pedestrian and bicycle safety (Sandt et al., 2015). After receiving the training, officer test scores increased from 77% to 90% correct, and they reported improvements in self-reported attitudes, knowledge, and perceived ability to enhance safety through their enforcement efforts. Importantly, driver yielding increased by an average of 15-16% after a year or more from the onset of the program. Officers in Utah who received training in bicycle safety enforcement, including classroom and field training through a NHTSA cooperative agreement in 2012, stated they were more likely to watch and enforce high risk motorists' behavior after having received training.

NHTSA offers free self-paced interactive training for law enforcement to enhance the safety of bicyclists (and pedestrians). Training can be found from several sources including:

- NHTSA's Law Enforcement's Roll Call Video: Enforcing Law for Bicyclists: www.nhtsa.gov/multimedia/bicycles/bicycle_safety_LE.wmv
- NHTSA's Enhancing Bicycle Safety: Law Enforcement's Role (CD-ROM training): one.nhtsa.gov/Driving-Safety/Bicycles/Enhancing-Bicycle-Safety:-Law-Enforcement%27s-Role
- Pedestrian and Bicycle Information Center: www.pedbikeinfo.org/programs/enforcement.cfm
- Safe Routes to School's *Enforcement: Role for Law Enforcement in SRTS*: guide.saferoutesinfo.org/enforcement/

These products can satisfy the needs of departments regardless of how they choose to emphasize bicycle safety. Additional consideration should be given to:

- Training for prosecutors and judges. This helps build the case for enforcement of traffic laws and planned enforcement operations with appropriate follow-up for citations throughout the judicial system.
- Alternative programs. An example includes educational diversion programs for adjudication of citations involving bicyclists. Diversion programs may be easier to implement in settings such as universities and college campuses. For example, UC Berkeley teamed with the East Bay Bicycle Coalition to provide free bicycle safety classes as an option to reduce the fine for a bicycle ticket from the UC police department. For more, visit: www.ebbc.org/safety. Trauma Nurses Talk Tough collaborated with local Portland organizations (including the Portland Department of Transportation) to create the Share the Road Safety Class program (Lifesavers, 2016). The class teaches right-of-way safety to bicyclists, pedestrians, and motorists who have received citations for incorrect lane use, lack of safety equipment, or failure to yield. Pre and post-class testing found a 20% increase in knowledge of laws and safety issues, and 97% of students who evaluated the course rated it as worthwhile. Other examples of programs can be found at the University of Wisconsin (Madison) and through Marin County (California) Bicycle Coalition.

A Massachusetts law included measures for enforcement of motorist violations affecting cyclist safety and enabled local jurisdictions to cite bicyclists for violating traffic laws under the same procedure for ticketing motorists. This legislation has led to increased enforcement for bicyclist laws in some jurisdictions. There was some initial confusion in implementing the law, but police in Boston are now citing bicyclists for traffic violations as well as looking out for motor vehicle violations that they may have overlooked before. Some jurisdictions see the measures as primarily an aid to outreach and education of cyclists to increase their safety.

Use: Unknown. Targeted enforcement of bicycle-related violations is likely a rarely used intervention.

Effectiveness: Gilchrist, Schieber, Leadbetter, and Davidson (2000) describe an enforcement program in Georgia that impounded the bicycles of unhelmeted children and produced long-term increases in helmet wearing. This specific example seems unlikely to be broadly popular. Increasing community awareness and law enforcement efforts through the training courses and approaches noted above could, however, yield benefits that go beyond bicycle safety, to include improved community relations and more positive interactions between law enforcement and members of the community. A Japanese study by Okinaka and Shimazaki (2011) evaluated the effects of vocal and written prompts delivered by security guards on a university campus to reinforce safe behaviors (such as dismounting and walking bicycles on a sidewalk). The intervention involved posting campus security guards at sidewalk locations. The guards wore sashes that read, “Let’s not drive on campus” and provided vocal prompts, “Please get off and push [bicycles] to [bike racks] for safety on campus,” and then thanked compliant riders for their cooperation. Results indicated the intervention was effective at increasing safe behaviors exhibited by bicycle riders in this context. Riders walked their bicycles on the sidewalk 22% of the time at baseline, compared to 88% of the time during the intervention phases.

Costs: Training currently exists for law enforcement officers. Roll-call videos can be implemented at essentially no cost to the departments. NHTSA’s nationally focused CD-ROM trainings (bicycle and pedestrian) can be taken by officers on their work or personal computer. They were designed to enable officers to earn eligibility for in-service training hours. (NHTSA expects to revamp these trainings to include new laws and a web-based format in the next few years). Longer in-person courses take officers away from their regular duties or require overtime commitment and may incur a financial cost, which may make online courses a more cost effective option. Some States or localities have developed their own training to reflect State and local laws, some are roll-call videos, other in-person. In-person courses may offer an added value if they include observations of bicycle-motorist interactions, on-bicycle experience, and/or training of a bicycle safety enforcement operation. SHSOs may be able to provide funding for departments to participate in longer training courses, especially for those States eligible through 405 (h) State Highway. Training for prosecutors and judges would likely need to be developed, as would a supporting communications and outreach program for the public, motorists and bicyclists.

Time to implement: For existing law enforcement training, with ongoing presentation schedules, implementation time can be quite short. For the full effort described above, a longer time frame would be needed.

3.4 Motorist Passing Bicyclist Laws

Effectiveness: ☆	Cost: $	Use: Medium	Time: Short

Overall Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

The purpose of bicyclist passing laws are to require motor vehicle drivers to leave at least three feet of clearance space between the vehicle and the cyclist when overtaking the cyclist, to minimize the likelihood of a sideswipe, and to reduce the chance of a close encounter that could potentially destabilize or divert the course of a cyclist and cause a crash.

Use: As of December 2016, 27 States and the District of Columbia are known to have enacted bicyclist passing laws requiring drivers to leave a space of 3 feet or more when passing cyclists (National Conference of State Legislatures, 2017). Pennsylvania requires at least 4 feet for passing, and South Dakota requires at least 6 feet for roads with a speed limit greater than 35 miles per hour. Nine other States have laws requiring motorists to pass at a safe distance and speed, but are usually not more specific.

Effectiveness: Love et al. (2012) evaluated the effectiveness of a passing law enacted in Baltimore, Maryland. The study saw low compliance with the passing law and little to no enforcement of the law by area police. Other factors that influenced passing distance included lane width, bicycle infrastructure, cyclist identity, and street type. The authors concluded that in addition to the passage of a law, interventions such as driver education, signage, enforcement, and bicycle infrastructure changes (such as bike lanes and Complete Streets designs) are needed to influence driving behavior and to increase motorist compliance with the three-foot law. Public education should include some level of description, or say something about equipment to measure or visualize a safe distance, such as imaging the distance of an opened car door. Bicycle passing laws can be difficult to enforce because it is a challenge to measure the exact distance between bikes and vehicles. Police in Chattanooga, TN and Austin, TX use a device called C3FT, which is a handlebar mounted ultrasonic device, to measure when a vehicle passes a police bicycle with less than three feet of distance (Goodyear, 2015; BikeAustin, 2016). These devices can offer valuable, accurate information to help make passing laws enforceable.
Costs: Minimal costs could be incurred for informing and educating the public and providing training for enforcement personnel.

Time to implement: A bicyclist passing law can be implemented as soon as the law is enacted.

4. Drivers and Bicyclists

4.1 Driver Training

Effectiveness: ☆	Cost: $	Use: Low	Time: Medium

Overall Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

The purpose of addressing bicycle safety as part of driver education is to increase the sensitivity of drivers to the presence and characteristics of bicyclists and how to safely share the road with them. Although driver education and most State driver manuals address sharing the road with bicyclists, many devote little attention or emphasis to the topic. NCHRP released model driver handbook materials that may be adapted by States to enhance their driver handbook information on sharing the road with bicyclists (Thomas, Stutts, & Gillenwater, n.d.). These materials could also be used in driver education courses. Other existing print and electronic publications from organizations such as AAA could and are being used to increase the emphasis on safe driving around bicyclists. NHTSA has developed a series of videos to reach audiences that are either not literate in their native language or do not speak the English language to educate drivers about sharing the road with cyclists, including a motion graphic called *Driving Safely Around Pedestrians and Bicyclists* (www.trafficsafetymarketing.gov/file/17963/download?-token=LTY0OcoO). Several States distribute Share the Road materials. For example, the Utah Department of Health developed a 12-minute video to be shown in driver education classes to reinforce how drivers can safely share the road with bicyclists.

One standard approach would be to implement a *Share the Road* module *www.trafficsafetymarketing.gov/file/17963/download?token=LTY0OcoOe* (see Section 4.2), covering interactions with bicyclists in driver education curriculums. For complete coverage, the same messages would need to be included in State-provided material for new drivers and covered by new questions added to the license knowledge exam. Standards for driver education curriculum and training developed by the American Driver and Traffic Safety Education Association mentions sharing the road with cyclists and pedestrians as a learning objective (Driver Education Working Group, 2009).

For links to more resources and discussion of considerations in educating motorists about bicycle safety, see the Pedestrian and Bicycle Information Center, under Educating Motorists (www.pedbikeinfo.org/programs/enforcement_motorists.cfm).

Use: As noted, all driver licensing handbooks have some coverage of driving safely with bicycles on the road, but the information may not be very complete and there may be little assessment or testing of the material. Information is unavailable on the extent of training materials being used. Multiple States, including New Mexico, Louisiana, and Washington, have expanded sections on bicycle safety in their driver's education handbooks and curriculum. (For New Mexico's handbook see page 25 of www.nmcycling.org/advocacy/NM_Driver_-Manual_Jun11.pdf).

Effectiveness: Driver education has not been shown to reduce overall crash rates. The objective for adding more bicycle information would be to increase knowledge and desire to share the road safely with bicyclists, of the most common crash types and hazards and to improve new drivers' anticipation of and interactions with bicyclists – as well as improve their behavior as bicyclists. Lifelong traffic safety education that includes bicycle training might also provide motorists with a greater understanding of bicyclist characteristics and needs and how to safely share the road.

Costs: Free material such as that listed above are available from NCHRP as well as the Transportation Research Board, American Association of Motor Vehicle Administrators, and the League of American Bicyclists. The cost would be for the adaptation or development of the new segments of the standard curriculum and for getting it into the material used by driver education instructors and schools. Changes to State driver manuals and other publications could be done within the normal material update budget.

Time to implement: Material would need to be adapted and integrated into the standard driver education curriculum, and adjustments made elsewhere in the curriculum to reflect likely additional time required for the new bicycle material.

The same timeframe would be expected for making changes to official State driving manuals, license exams, and related material and procedures.

4.2 *Share the Road* Awareness Programs

Effectiveness: ☆☆	Cost: $$	Use: Unknown	Time: Medium

Overall Effectiveness Concerns: *This countermeasure has not been systematically examined. There is insufficient evaluation data available to conclude that the countermeasure is effective.*

The purpose of Share the Road programs is to increase drivers' awareness of bicyclists, as well as improve both bicyclist and driver compliance with relevant traffic laws. *The National Strategies for Advancing Bicycle Safety* was developed from a July 2000 conference of bicycle advocates, injury prevention specialists, and government representatives (NHTSA, 2001). The result was five goals, each with a series of strategies and action steps. The first goal, Motorists Will Share the Road, called for the creation of a "coordinated 'Share the Road' public education campaign that can be adapted at the State and local levels."

For an example of communication and outreach material, see www.pedbikeinfo.org/ee/ed_-motorist.htm?/ee/ed_motorist.htm. AAA created a series of Share the Road promotional videos in partnership with the Share the Road Cycling Coalition and the Canadian Automobile Association. These videos can be accessed at exchange.aaa.com/safety/bicycle-safety.

Use: Unknown.

Effectiveness: Share the Road awareness educational materials can be effective in increasing knowledge and appropriate attitudes, but as with other awareness programs, there is limited evidence of behavior change, and no evidence of reductions in crashes.

Some limited evidence suggests that Share the Road signs can have a positive effect on drivers' lane position and speed when passing bicyclists. Kay et al. (2014) conducted a series of field studies that examined drivers' passing behavior on a rural two-lane highway before and after the installation of "Share the Road" signs. Although the presence of the sign did not significantly reduce crowding, fewer drivers traveled in the rightmost lane position after the signs were installed. Drivers also reduced the vehicle speed by an average of 2.5 mph when passing bicyclists in the presence of the sign. Similarly, in a limited study, shared-use arrow ("Sharrow") pavement markings were shown to influence bicyclist lane position toward the "Sharrow" marking in the shared-use lane (Pol et al., 2015). While these studies do not provide conclusive evidence of safety improvements, they suggest that these infrastructure interventions may have the potential for positive effects on both driver and cyclist behavior.

Some cities and States are specifically changing their Share the Road signs to indicate that bicyclists may occupy the full lane. This is because Share the Road is perceived differently by different users and not always in its intended way to encourage motorists to look out for and drive safely around bicyclists.

Costs: Medium, including the costs to develop new publications or tailor current ones. The material can be delivered as training for specific target audiences, such as new drivers or all high school students, or drivers as they renew their licenses, or general communications and outreach intended for mass media delivery.

Time to implement: A good campaign, including market research, message development and testing, and implementation, will require at least 6 months to plan and implement.

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