Countermeasures That Work:

A Highway Safety Countermeasure Guide For State Highway Safety Offices Eighth Edition, 2015

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16. Abstract
The guide is a basic reference to assist State Highway Safety Offices 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;
- Pedestrians; and
- Bicycles.

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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Preface to the Eighth Edition, 2015

This edition of *Countermeasures That Work* was prepared by the University of North Carolina Highway Safety Research Center. Researchers who contributed to this edition include Arthur Goodwin, Libby Thomas, Bevan Kirley, William Hall, Natalie O'Brien, and Kate Hill. 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, 2014, have been reviewed and included as appropriate. Data has been updated to include information from 2013 FARS (Fatality Analysis Reporting System).

User Suggestions and Future Editions

NHTSA will update this guide biennially and may expand it with additional problem areas and countermeasures as appropriate. In particular, NHTSA is considering adding sections on drugs other than alcohol and pupil transportation to the next edition. 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 http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_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. 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
- 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

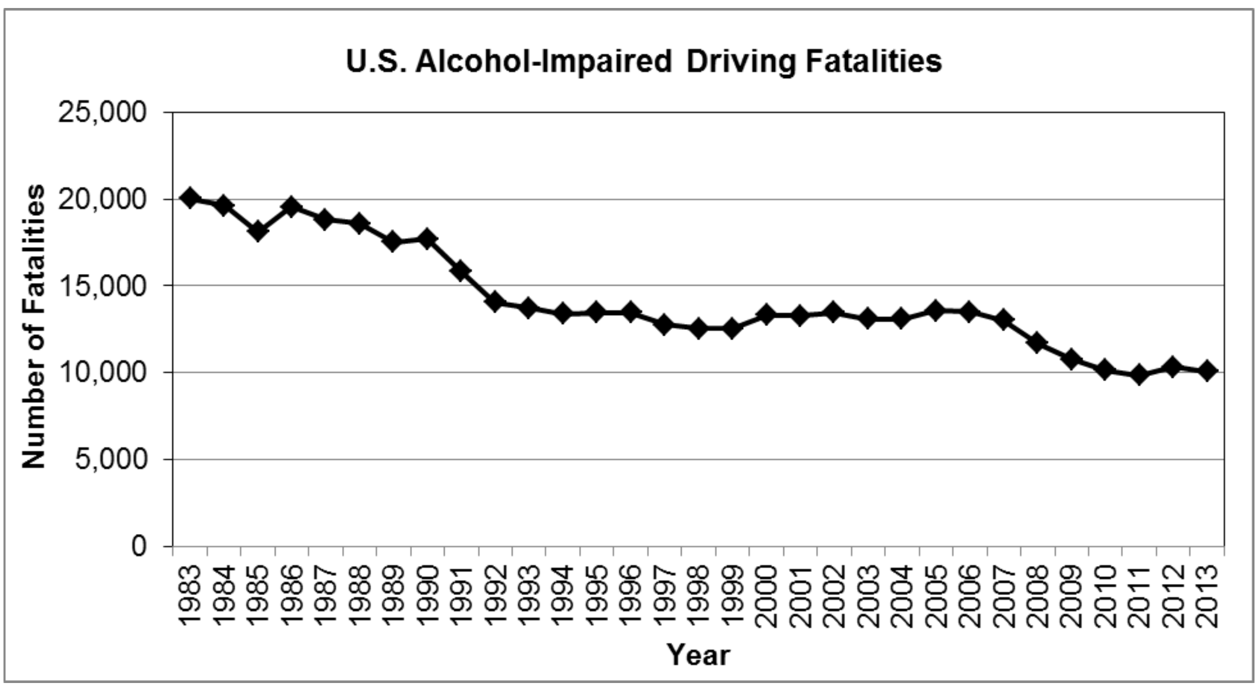
1. Alcohol- and Drug-Impaired Driving

Overview

In 2013, 10,076 people were killed in crashes involving alcohol-impaired drivers (defined as drivers or motorcycle riders with blood alcohol concentrations (BACs) of $\geq$.08 g/dL), a decrease of 2.5% from the 10,336 fatalities in 2012 (NHTSA, 2014a). Fatalities in crashes involving alcohol-impaired drivers continue to represent almost one-third (31%) of the total motor vehicle fatalities in the United States (NHTSA, 2014a). See NHTSA's most recent *Traffic Safety Facts* (NHTSA, 2014a) for the latest national and State data.

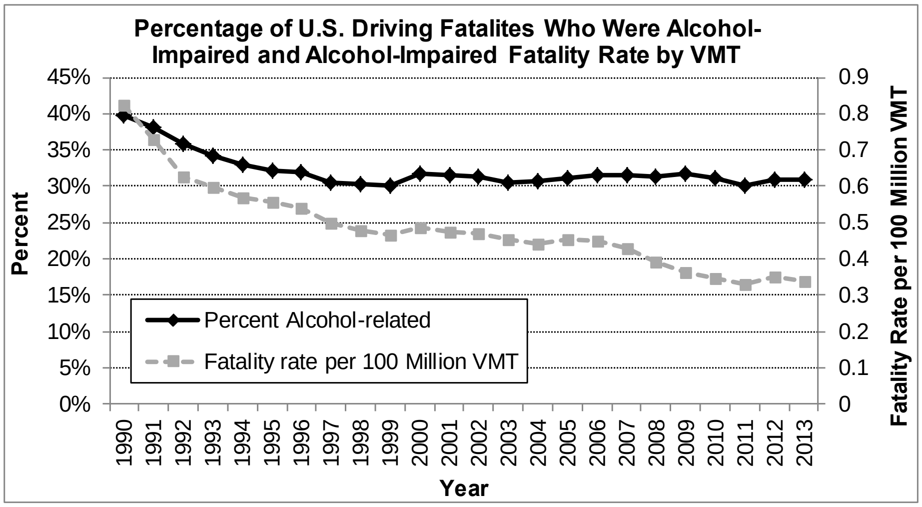
Trends. Alcohol-impaired driving dropped steadily from 1982 to the mid-1990s. A study showed that much of this decrease could be attributed to alcohol-related legislation (e.g., .08 BAC, administrative license revocation, and minimum drinking age laws) and to demographic trends (e.g., the aging of the 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, a growth of grassroots organizations such as Mothers Against Drunk Driving and Remove Intoxicated Drivers, increased Federal programs and funding, State task forces, 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 between 1992 and 2007, but then began declining again in 2008. This decrease likely reflects, in part, the recent economic recession.



Source: NHTSA (2014a, 2014b)

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 (NHTSA, 2014b).



Source: NHTSA (2014a, 2014b)

One age group has shown an especially sizeable decrease in alcohol-related traffic fatalities. Between 1996 and 2005, the percentage of fatally injured 16- to 18-year-old drivers with positive BACs (.01 g/dL or higher) decreased by up to 16% (Ferguson, Teoh, & McCartt, 2007). 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 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 2007 National Roadside Survey estimated that 12.4% of drivers on weekend nights have positive BACs, while 2.2% have BACs of .08 or higher (Compton & Berning, 2009; Lacey et al., 2009a). This represents a significant reduction from 1996, when 16.9% of drivers had positive BACs and 4.3% had BACs of .08 or higher.

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 2 hours of drinking alcohol in the past year. Males, college graduates, and unmarried individuals were more likely than their respective counterparts to report driving after drinking too much. Similarly, a 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 problems with alcohol. For example, among drivers involved in fatal crashes during 2013 with positive BACs (.01 or higher), 56% had BACs at or above .15 (NHTSA, 2014a). 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).

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 all of 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 drivers in fatal crashes with BACs of .08 or higher in 2013 ranged from 17% in the lowest State to 44% in the highest (NHTSA, 2014a).

Drug-impaired driving characteristics. There is considerably less research on drug-impaired driving than alcohol-impaired driving. However, two roadside surveys suggest some drivers have detectable levels of one or more drugs in their systems. In a study for NHTSA, Lacey et al. (2009b) collected voluntary and anonymous oral fluid samples from 7,719 drivers across the United States in 2007, and blood samples from 3,276 drivers. Among nighttime drivers who provided oral fluid and/or blood samples:

- 11.3% tested positive for an illegal drug;
- 3.9% tested positive for a medication (i.e., a prescription or over-the-counter drug); and
- 1.1% tested positive for both an illegal drug and a medication.

Marijuana was the most commonly detected illegal drug, followed by cocaine. Among those drivers who tested positive for an illegal drug, 28% also tested positive for alcohol (Lacey et al., 2009b).

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 between 1992 and 2002 (Schwilke, Sampaio dos Santos, & Logan, 2006). In part, this likely reflects larger trends in the drug's popularity.

Research on whether drug use contributes to crashes is limited. A NHTSA study found 18% of all fatally injured drivers in 2009 tested positive for drugs (NHTSA, 2010). However, not all fatally injured drivers were tested. Additionally, States varied widely in the types of drugs they tested for, and many times the test results were not known. When considering only those fatally injured drivers who were tested with known results, 33% tested positive for drugs (NHTSA, 2010). Narcotics and cannabinoids (e.g., marijuana) accounted for almost half of the positive test results. In addition, 48% of fatally injured drivers who tested positive for drugs also tested positive for alcohol (ONDCP, 2010). Although drugs are often detected among drivers involved in crashes, this does not necessarily imply drug impairment played a causal role in the crash. At present, the evidence is mixed on whether cannabis and benzodiazepines increase crash risk, while fewer studies have examined the risks associated with stimulants, opioids, and other drugs (Stewart, 2006).

In 2010, the Office of National Drug Control Policy announced an initiative to decrease the prevalence of drug-impaired driving 10% by 2015 (ONDCP, 2010). The initiative encourages States to adopt *per se* drug impairment laws, provide increased training to law enforcement on identifying drug-impaired drivers, and further data collection.

Strategies to Reduce Impaired Driving

Four basic strategies are used to reduce alcohol-impaired crashes and drinking and driving:

- Deterrence: enact, publicize, enforce, and adjudicate laws prohibiting alcohol-impaired driving so that people choose not to drive impaired;
- Prevention: reduce drinking and keep drinkers 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 treatment: reduce alcohol dependency or addiction among drivers.

In this chapter, 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). There are also many environmental countermeasures, such as improved vehicle structures and centerline rumble strips, 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:
  - Impaired Driving - www.nhtsa.gov/Impaired
  - Impaired Driving (Alcohol-Related) Reports - www.nhtsa.gov/Driving+Safety/Research+&+Evaluation/Impaired+driving+(alcohol-related)+reports
  - Impaired Driving (Drug-Related) Reports - www.nhtsa.gov/Driving+Safety/Research+&+Evaluation/Impaired+driving+(drug-related)+reports
  - 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 Safety Council: www.nsc.org/safety_road/DriverSafety/Pages/ImpairedDriving.aspx
- 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), NCHRP’s A Guide for Reducing Alcohol-Related Collisions (NCHRP, 2005), and the eE-Circular produced by TRB’s Alcohol, Other Drugs, and Transportation Committee (TRB, 2013).

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
- DUID: Driving Under the Influence of Drugs
- 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.
- 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 Tests, 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

Countermeasures That Work

Countermeasures to reduce alcohol-impaired driving are listed below and discussed individually in the remainder of this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The symbols and terms used are described below. 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.

1. Deterrence: Laws

Countermeasure	Effectiveness	Cost	Use	Time
1.1 ALR/ALS	★★★★★	$$$	High	Medium
1.2 Open containers	★★★	$	High	Short
1.3 High-BAC sanctions	★★★	$	Medium	Short
1.4 BAC test refusal penalties	★★★	$	Unknown	Short
1.5 Alcohol-impaired driving law review	★★★	$$	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 and plea agreements††	★★★★	$	Medium	Short
3.3 Court monitoring††	★★★	$	Low	Short
3.4 Sanctions	★★	Varies	Varies	Varies

† Proven for reducing recidivism
†† Proven for increasing convictions

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

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Alcohol problem assessment, 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 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 one year
Medium: more than three months but less than one year
Short: three 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 is called *general deterrence* when it influences the general driving public. An example 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.

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 follow-up 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 control. 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 guide, such as BAC test refusal penalties (Chapter 1, Section 1.4), alcohol-impaired driving law review (1.5), and DWI courts (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 15 years have passed, the basic findings of Ulmer et al. (1999) 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 National Committee on Uniform Traffic Laws and Ordinances (NCUTLO, 2007).

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 (NCHRP, 2005, Strategy C1) and NHTSA’s *Traffic Safety Facts* on ALR (NHTSA, 2008a).

Use: As of July 2015, 41 States and the District of Columbia had some form of ALR or ALS law (IIHS, 2015). Thirty-five States had a minimum license suspension 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 quite old. 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 NCHRP (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 (Chapter 1, Section 4.2) and close monitoring (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 BAC 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 Containers

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. NHTSA has prepared a question and answer sheet that describes common pitfalls for compliance with the minimum Federal requirements (www.nhtsa.gov/staticfiles/administration/programs-grants/Q&A-Sections_154+164.pdf). For additional information, see www.fhwa.dot.gov/map21/guidance/guidepentransprov.cfm.

Use: As of October 2014, 37 States and the District of Columbia had open-container laws that complied with the Federal requirements (FHWA, 2014).

Effectiveness: The only study of open-container law effectiveness (Stuster, Burns, & Fiorentino, 2002) examined 4 States that enacted laws in 1999. It found the proportion of alcohol-involved fatal crashes appeared to decline in three of the 4 States during the first 6 months after the laws were implemented, but the declines were not statistically significant. 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). 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. Half of all impaired drivers in crashes or arrests have BACs of .15 or higher (Century Council, 2008).

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: Two-thirds (68%) of impaired drivers involved in fatal crashes in 2013 had BACs of .15 or greater (NHTSA, 2014a). Enhanced sanctions for high-BAC drivers vary by State, and may include mandatory assessment and treatment for alcohol 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 December 2012, 49 States and the District of Columbia have increased penalties for drivers with high BACs (NCSL, 2014a). Mississippi is the only State without such a law.

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 2013, there were 200 children 14 or younger who were killed in alcohol-impaired-driving crashes. Of those, 121 were occupants of vehicles with drivers who had BACs of

.08 or higher (NHTSA, 2014a). Child endangerment laws create a separate offense or enhance DWI penalties for impaired drivers who carry children. Presently, 46 States and DC 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, 2007).

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. As of 2008, all States except Nevada imposed administrative sanctions for test refusal (NHTSA, 2008d). See NHTSA's *Digest of Impaired Driving and Selected Beverage Control Laws* for more detail on each State's laws (NHTSA, 2015).

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 2013, BAC test refusal was a criminal offense in 18 States (NHTSA, 2015). 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 4 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).

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 (BAC tests, SFSTs), and new sentencing and monitoring alternatives (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).

NCUTLO has prepared a model DWI law, which has been incorporated into the Uniform Vehicle Code (NCUTLO, 2007). It addresses 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 an Impaired-Driving Statewide Task Force to review key legislation and improve current DWI systems (Fell & Langston, 2009), and another to assist officials and the general public in establishing a task force at a local or regional level (Fell, Fisher, & McKnight, 2011).

At a State's request, NHTSA will facilitate an Impaired Driving Assessment (IDA) 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 are 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 (SMRs; 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 can take 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, 2015), but few States conduct them regularly. According to 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).

Effectiveness: 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 (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 can 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, 2015). 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 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. 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. NHTSA strongly supports that officers conducting such activites be trained in the SFST battery.

- **Standardized Field Sobriety Tests:** Officers have used SFSTs for more than 20 years to identify impaired drivers. The SFST is a test battery that includes 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. States may request an SFST assessment which looks at a State's application of the basic law enforcement tool for detecting impaired drivers.

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 to look for drivers who may be impaired. 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 three 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 (NCHRP, 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 Preliminary Breath Test Devices (PBTs)

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

[†]Proven for increasing arrests

A preliminary breath test device is a small hand-held alcohol sensor used to estimate or measure a driver's BrAC. Law enforcement officers use PBTs in the field to help establish evidence for a DWI arrest. The driver blows into a mouthpiece and the PBT displays either a numerical BAC level, such as .12, or a BAC range, such as a red light for BACs at or above .08.

Several PBT models are available commercially. They are quite accurate and generally reliable. For a "Conforming Products List" of alcohol testing and screening instruments, including PBTs, see www.gpo.gov/fdsys/pkg/FR-2012-06-14/pdf/2012-14581.pdf.

Use: PBTs are used in 33 States to provide evidence of alcohol use to support DWI arrests (Century Council, 2008). This evidence of alcohol use is admissible in court in approximately half the States, but in most States PBT evidence cannot be used to establish a driver's BAC. California allows officers to use PBT evidence to enforce zero-tolerance laws for drivers under 21; officers at the roadside can issue a citation and seize the driver's license (Ferguson, Fields, & Voas, 2000).

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

Costs: PBTs cost from $200 to $600 apiece. Many law enforcement departments have only a limited number of PBTs 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 PBT.

Time to implement: PBTs can be used as soon as they are purchased and officers are trained in their use and maintenance. PBT 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:** A PBT will not 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 PAS scores were 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 are 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 at checkpoints can detect 50% more drivers at BACs of .10 and above 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 will not 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 since impaired drivers often speed or fail to wear seat belts. (Such operations can be particularly effective when conducted at night.)

Use: There are 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), NCHRP (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 three 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 (NCHRP, 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). In 2007, MADD Canada launched a program 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 who are interested in establishing a citizen's DWI reporting program in their community (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 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 almost 2,500 Drug Courts around the Nation (Huddleston, Marlowe, & Casebolt, 2008; NADCP, 2009; NCHRP, 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 2014, the National Center for DWI Courts reported 216 designated DWI Courts in 31 States (NCDC, 2014). In addition, there were 409 hybrid DWI/Drug Courts, which are Drug Courts that also take DWI offenders. States with the most designated DWI Courts include Michigan (21), Georgia (20), Missouri (20), Texas (17), and Pennsylvania (14).

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 two 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 one estimate, for every dollar invested in Drug Courts, taxpayers save up to $3.36 (NADCP, 2009).

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 issues:

- **Traffic Safety Resource Prosecutors and Judicial Outreach Liaisons:** 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 State. Judicial Outreach Liaisons (JOLs) are current (or former) judges who are 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; NCHRP, 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, 33 States provided for diversion programs in State law or statewide practice, and 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 2013, 14 States had anti-plea-bargaining statutes limiting plea agreements in certain cases (NHTSA, 2015).

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 they reduced various outcome measures by an average of 11%. 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 three months. Individual prosecutor offices and courts also can 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 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 MADD, Remove Intoxicated Drivers (RID), or a similar organization. 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

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, 2006d) 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, 29 States and the District of Columbia 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: estimated to be $20,267 in Ohio per inmate per year, for example (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, 2002b).

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 individuals 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).

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 use problems. They likely will continue to drink and drive unless their alcohol problems are addressed. A DWI arrest provides an opportunity to identify offenders with alcohol 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, NHTSA and 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 (APPA, 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 (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 is 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 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 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. 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 BAC 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 BAC 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, NCHRP (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 professions, 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). 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 25 States and 4 California counties, interlocks are mandatory for all convicted offenders, including first offenders (IIHS, 2015). Four States (Indiana, Montana, North Dakota, and South Dakota) and the District of Columbia currently have no mandatory interlock requirements (IIHS, 2015).

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 304,600 in 2013 (based on information supplied by interlock distributors; Roth, 2014). 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 currently installs interlocks in the vehicles of half of all convicted DWI offenders – the highest level of penetration of any State (Marques, Voas, Roth, & Tippetts, 2010).

Effectiveness: A review of 15 studies of interlock effectiveness found that offenders who had interlocks installed in their vehicles had recidivism rates that were 75% lower than drivers who did not have interlocks installed (Elder et al., 2011). 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. Although only three 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). 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. However, the preponderance of evidence 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 one 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 NCHRP (2003, Strategy C2).
- **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 are becoming familiar with the equipment, and in some cases may be testing 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 with stronger monitoring practices (Florida and Texas) (Vanlaar et al., 2013).

- **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 can be problematic (NHTSA, 2014d). 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).

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 NCHRP (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: 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 (NCHRP, 2003, Strategy B1; NHTSA, 2008e).
- License plate impoundment: Used in 17 States (McKnight, Watson, Voas, & Fell, 2008). 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 (NCHRP, 2003, Strategy B2; NHTSA, 2008e; NTSB, 2000). Fourteen States allow for impounding a vehicle's registration (McKnight et al., 2008McKnight, Watson, Voas, & Fell, 2008).
- 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 (NCHRP, 2003, Strategy C1; NTSB, 2000).

- Vehicle impoundment: 27 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 (NCHRP, 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: Thirty-five States have provisions allowing vehicle forfeiture for impaired driving and/or driving with a suspended license (Voas et al., 2008); 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 (NCHRP, 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. 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 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 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 three additional rural States: Montana, North Dakota, and Wyoming.

For overviews of DWI offender monitoring and further references, see Century Council (2008) and NCHRP (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 are 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, 48 States have used the SCRAM device with at least some offenders, while 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. Two studies of South Dakota’s 24/7 Sobriety Program have found reductions in recidivism of up to 74% among program participants compared to controls (Kilmer, Nicosia, Heaton, & Midgette, 2013; Loudenburg, Drube, & Leonardson, 2010). 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 one year after program completion, compared to a normal recidivism rate of 35% for offenders (Century Council, 2008).

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. 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 2001, 5 States also lowered the BAC limit for people convicted of DWI, to emphasize that they should not be driving after drinking even moderate amounts (Jones & Rodriguez-Iglesias, 2004).

Use: No recent study has quantified the number of States that have established lower BAC limits.

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 suggest 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 3-day license suspension and possible vehicle impoundment for drivers with BAC levels between .05 and .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. These are discussed in the Youth section that follows.

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. 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 Interventions

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 use 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 problems and one-third use some form of brief intervention (NCHRP, 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 (NCHRP, 2005, Strategy A4).

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 9 studies that evaluated alcohol screening and brief intervention effects on injury. These studies generally found that alcohol screening and brief interventions reduced both drinking and alcohol-related traffic crashes and injuries.

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 every other way imaginable. 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. 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 demonstrates 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% decrease in young adults who reported driving after drinking relative to a comparison community (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

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, 17 States 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 4 to 8 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, 41 States have laws that allow individuals 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).
- **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 program have been tried in Australia, Canada, and New Zealand, although effectiveness data is lacking.

5.4 Alternative Transportation

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

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 NCHRP (2003, Strategy E1).

Use: During the 1980s, 325 programs were 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 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 (NCHRP, 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

Designated drivers are individuals 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.

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

Teenagers drink and drive less often than adults, but they are more likely to crash when they do drink and drive (Williams, 2003). Teenagers 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.

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 while impaired by alcohol is not. With a BAC limit of .08, drivers know they should not drive after drinking “too much,” but are faced with mixed messages at low levels of alcohol, because lower BAC’s are not illegal per se. The message for those under 21 is unambiguous: they should not be drinking at all, and 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 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 below 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 specific laws implementing MLDA 21 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 in all 50 States and the District of Columbia. Surprisingly, in a 2008 survey of the general public conducted by NHTSA, only 71% of respondents believed there was a minimum legal drinking age in the United States. Of those who said there was a minimum legal drinking age, 86% correctly identified the legal drinking age as 21 (Moulton et al., 2010).

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 legal minimum drinking age 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 28,230 lives since 1975, and an estimated 550 lives in 2010 alone (NHTSA, 2012).

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:** Between 2007 and 2010, 6 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 minimum legal drinking 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. 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; NCHRP, 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 6 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 4 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 3 or 4 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 to seize the driver's license if it has (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. 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 (NCHRP, 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.
- Be 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).
- Be 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.
- Be 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 good 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.

Effectiveness: Several studies document that well-publicized and vigorous compliance checks reduce alcohol sales to youth; for example, a review of 8 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 or alcohol beverage control staff. These costs can be supported, in part, though alcohol license fees or fines collected from non-compliant vendors.

Time to implement: Compliance checks can be implemented within three 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 (NCHRP, 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 (NCHRP, 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).
- 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 2013, 30 States and the District of Columbia had "use and lose" laws and another 10 States had "use and lose" authority that may be applied in varying circumstances (Alcohol Policy Information System, 2014a).

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 2013, 30 States and the District of Columbia had mandatory keg registration laws (Alcohol Epidemiology Program, 2000). In the only 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.

Media campaigns: Ohio has conducted a statewide media campaign, *Parents Who Host Lose the Most*, since 2000. 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. The toll-free tipline operates 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 tipline 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 the 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 (2014b).

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: www.nhtsa.gov/people/injury/alcohol/Community%20Guides%20HTML/Guides_index.html.

6.5 Youth Programs

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

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 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).

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 a positive BAC, 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 6 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 4 group sessions and 2 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

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 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.
- 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.

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). 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.

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 7,000 officers (National Sobriety Testing Resource Center, 2014). During 2013, there were 26,100 drug evaluations conducted by DREs (National Sobriety Testing Resource Center, 2014). This is equivalent to less than 4 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.

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 individuals 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 three 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 in order 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

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 et al., 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 (2007c) for recommendations to improve the prosecution of drug-impaired driving cases.

Use: As of May 2015, 19 States had *per se* laws that forbid the presence of any prohibited drug while a driver is in control of a vehicle (GHSA, 2015c). 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, 2014a). In addition, 2 States (North Carolina and South Dakota) have *per se* laws that apply only to those younger than 21, and 5 States (California, Colorado, Idaho, Kansas, and West Virginia) have made it illegal for a drug addict or habitual drug user to drive a vehicle (Lacey, Brainard, & Snitow, 2010). More information about the drug-impaired driving laws in each State can be found in Lacey et al. (2010), NCSL (2014a), 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 (2012) 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

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 DUI, 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 most costly.

Time to implement: Targeted communications could require a year or more to plan, produce, and distribute.

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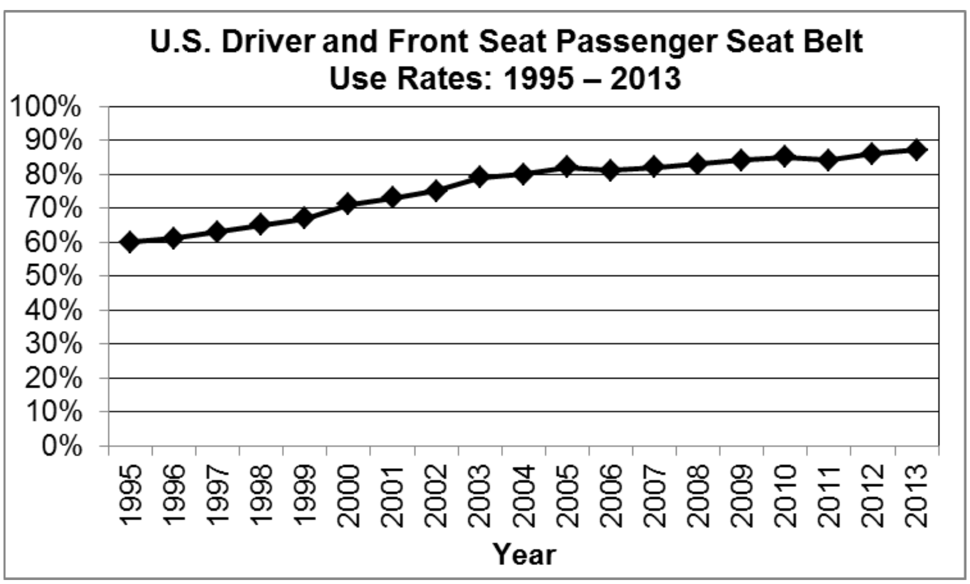
2. Seat Belts and Child Restraints

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, 2000). For light-truck occupants, seat belts reduce the risk of fatal injury by 60% and moderate-to-critical injury by 65% (Kahane, 2000).

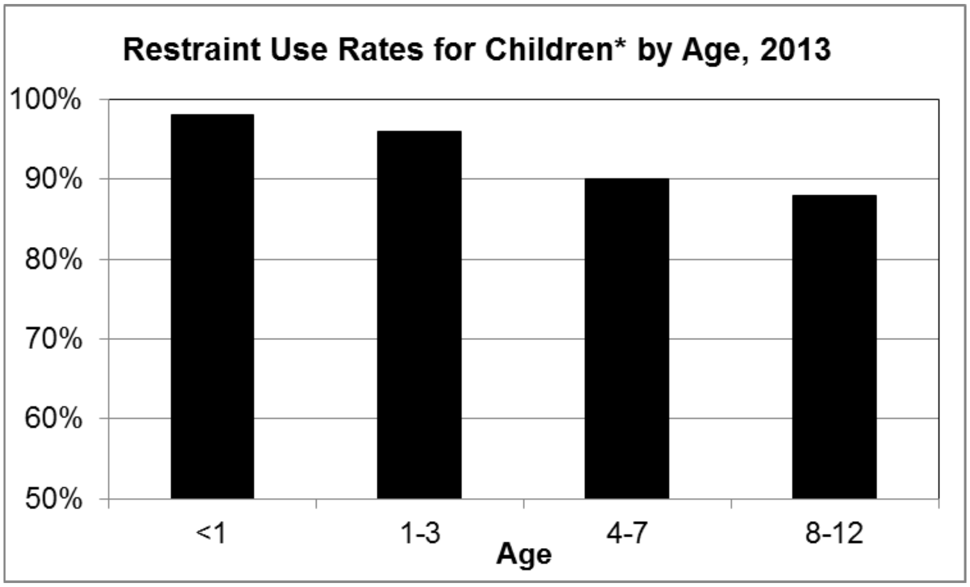
NHTSA estimates that correctly used child restraints are even more effective than seat belts in reducing fatalities. Child restraints reduce fatalities by 71% for infants younger than 1 year old and by 54% for children 1 to 4 years old in passenger cars. In light trucks, the fatality reductions are 58% for infants and 59% for children 1 to 4 years old (NCSA, 1996). 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).

Trends. The challenge is to convince all passenger vehicle occupants to buckle up. Current data show that observed seat belt use nationwide was 87% in 2014 for adult drivers and right-front seat passengers (Pickrell & Choi, 2015). Seat belt use was over 90% in 19 States with 4 States achieving belt use rates higher than 95% (Alabama, 97.3%; California, 97.4%; Georgia, 95.5%; and Oregon, 98.2%). However, seat belt use was less than 75% in 5 States (Massachusetts, 74.8%; Mississippi, 74.4%; Montana, 74.0%; New Hampshire, 73.0%, and South Dakota, 68.7%) and one U.S. Territory (American Samoa, 74.9%) (Chen, 2014). Nationally, seat belt use has increased dramatically since seat belt use laws went into effect in the early 1980s. With the exception of 2011, the National seat belt use rate has been steadily increasing since at least 1995.



Source: Pickrell and Liu (2014)

In general, overall restraint use for children is higher than what is demonstrated in the adult population, particularly among the youngest children. In 2013, the observed restraint use for children less than 13 years old was 91% (ranging from 98% for children younger than 1 to 89% for children 8 to 12) (Pickrell & Choi, 2014).



*Restraint use rates do not indicate correct use.
Source: Pickrell and Choi (2014)

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. In March 2011, NHTSA and the American Academy of Pediatrics strengthened their child restraint guidelines. The current recommendations include keeping children rear-facing until the rear-facing capabilities of the car seat are out grown (with the American Academy of Pediatrics specifying rear-facing until a minimum of 2 years old), then forward-facing with a harness until the harness is out grown 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 2013 National Survey of the Use of Booster Seats (Pickrell & Choi, 2014) details the recommendations and observed restraint use for children under 1, 1 to 3, 4 to 7, and 8 to 12. Since 2011, there have been some improvements in the proportion of children riding optimally restrained. The proportion of children 1 to 3 riding in rear-facing child restraints increased from 7% in 2010 to 10% in 2013, and only 9% of children 1 to 3 were prematurely riding in booster seats, a decrease from 12% in 2011. Restraint use does vary by race and ethnicity. Across all ages, non-Hispanic White children had the highest restraint use (age birth to 12 months, 100%; 1 to 3, 99%, 4 to 7, 96%; 8 to 12, 95%) and non-Hispanic Black children had the lowest (age birth to 12 months, 96% [tied with Hispanic children]; 1 to 3, 85%, 4 to 7, 78%; 8 to 12, 69%).

Despite high observed belt use rates, many unrestrained people die in crashes each year. In 2013, 21,132 passenger vehicle occupants were killed in crashes (NCSA, 2015). Of these, 49% were known to be unrestrained. In 2013, 437 children under 13 were killed as passengers in motor vehicle crashes, 38% of which 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.

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 July 2014, 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, 2014a; IIHS, 2014).

Between 1978 and 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 (2014) and GHSA (2014b) 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 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, often 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 2000-2006, in part due to the *Click It or*

Ticket seatbelt enforcement programs (Tison & Williams, 2010). Since then, most States have continued to increase or maintain their seat belt use rates (Chen, 2014).

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 that fasten to anchors built into the vehicle. LATCH consists of two components in the vehicle – the lower anchors and the top tether anchors – with complimentary connectors on the child restraint. However, even with LATCH, misuse remains a problem. A 2011 observational study found that fewer than 50% of forward-facing child restraints were installed using the top tether, an important component of the LATCH system (Jermakian & Wells, 2011).

The National Child Restraint Use Special Study found 5 common child restraint use errors including using the wrong harness slot, positioning the harness retainer clip incorrectly, failing to correctly tighten the harness strap, installing the seat too loosely, and improperly positioning the lap belt on a child using a booster seat (NHTSA, 2012).

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 Safe Kids national certification process, 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. Individuals 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). As of December 2013, there were 35,953 certified CPS technicians and instructors (Safe Kids Worldwide, 2013).

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. Guidebooks are available on how local programs can set up and operate a mobile CPS clinic or permanent inspection station (NHTSA, 2003a). Seat belt and child restraint use may also be affected by vehicle design features such as the comfort and convenience of belt systems, and by lights, buzzers or gear shift interlocks to remind occupants to buckle up (NHTSA, 2003b; Van Houten, Malenfant, Reagan, Sifrit, & Compton, 2009). These vehicular countermeasures are not included in this guide because SHSOs have little or no authority or responsibility for them.

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/Driving+Safety/Occupant+Protection
  - Parents Central - www.safercar.gov/parents/index.htm
  - Research and Evaluation - www.nhtsa.gov/Driving+Safety/Research+&+Evaluation
  - Behavioral Safety Research Reports - ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Centers for Disease Control and Prevention, Injury Prevention & Control: Motor Vehicle Safety: www.cdc.gov/Motorvehiclesafety/index.html
- 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:
  - Seat Belts - www.nsc.org/safety_road/DriverSafety/Pages/SeatBelts.aspx
  - Child Safety Seats & Boosters - www.nsc.org/safety_road/DriverSafety/Pages/ChildPassengerSafety.aspx
- 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

Child Passenger Safety

- 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
- Center for Injury Research and Prevention, The Children's Hospital of Philadelphia: www.research.chop.edu/programs/injury/
- Safe Ride News Publications: www.saferidenews.com
- SafetyBeltSafe U.S.A.: www.carseat.org
  University of Michigan Transportation Research Institute: www.cpsbestpractice.org

Key terms

- Primary enforcement: laws that permit child passenger safety law and seat belt use law violators to be stopped and cited by a law enforcement officer independently of any other traffic violation.
- Secondary enforcement: laws that permit child passenger safety law and seat belt use law violators to be cited only after they have been stopped for some other traffic violation.

Countermeasures That Work

Countermeasures to increase seat belt use are listed below and discussed individually in this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, cost, use, and time required for implementation. The terms used are described below. 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 on each item.

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	★★★★★	$$$	Medium†	Medium
2.2 Combined seat belt and alcohol enforcement, nighttime	★★★★	$$$	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

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

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 one year
Medium: more than three months but less than one year
Short: three 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 August 2014, 33 States and the District of Columbia had primary belt use laws, 16 States had secondary enforcement laws, and New Hampshire had no belt use law applicable to adults (GHSA, 2014a; IIHS, 2014). 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 2014, belt use averaged 90% in the 33 States and District of Columbia with primary belt laws and 79% in States with weaker enforcement laws (Pickrell & Choi, 2015). Nichols, Tippetts, et al. (2010) examined the relationship between the type of seat belt law enforcement and seat belt use between 1997 and 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) (NHTSA, 2014b).

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 Haseltime (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 23 States (GHSA, 2014a; IIHS, 2014). 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, 2004; NHTSA, 2003b). 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. 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).

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 available evidence suggests that local primary belt laws increase belt use (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 August 2014, a violation resulted in a typical fine of $25 or more in all but 15 States (IIHS, 2014). 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 August 2014, 12 primary law States and 3 secondary law States had maximum fines of $30 or more for at least some occupants (IIHS, 2014). As of March 2009, 3 jurisdictions, the District of Columbia, Georgia, and New Mexico, assessed driver license points for all seat belt law violations (Decina, Hall, & Lococo, 2010).

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 fine 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. Similarly, increasing the fine from $25 to $100 was associated with an increase of 6% to 7%.

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 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. These periods sometimes are called STEP waves (Selective Traffic Enforcement Programs) or blitzes. The 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 (Hinch, Solomon, & Tison, 2014). Some States also conduct seat belt mobilizations in November. NHTSA has supported these campaigns. More than 10,000 law enforcement agencies took part in the May 2012 campaign (Hinch et al., 2014). 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. Similarly, Hinch et al. (2014) found that law enforcement in primary belt use law States issued more seat belt citations in the 2012 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 through 2003.

The 2012 *Click It or Ticket* campaign used extensive paid advertising ($8 million nationally and $12 million in individual States). National belt use following the campaign increased to 86% from 84% in 2011 (Hinch et al., 2014).

Since 2002 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. National belt use has increased significantly since then (from 75% in 2002 to 87% in 2014).

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 2012 *Click It or Ticket* campaign used extensive paid advertising ($8 million nationally and $12 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.

2.2 Combined Seat Belt and Alcohol Enforcement, Nighttime

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).

According to 2013 FARS data, almost two-thirds (62%) of passenger vehicle occupants killed in crashes between 9 p.m. and 6 a.m. were unrestrained (FARS data). In contrast, 40% of fatally injured passenger vehicle occupants in daytime crashes were unrestrained (FARS data). Furthermore, according to FARS data for the 10-year period from 2004 to 2013, 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. Using night-vision technology, where permitted, or other light enhancing technologies can assist with nighttime enforcement. 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 the multifocused high visibility enforcement strategy is 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), and 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).

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).

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: Combined or 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, 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 98%; Washington: 93 to 98%) (Chen, 2014).

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 immediately. 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 Communications and Outreach 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 through 2003.

Costs: Paid advertising can be expensive. In the average State, paid advertising costs were nearly $350,000 for the 2007 campaign (Solomon, Preusser, et al., 2009).

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. 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 campaigns. Additionally, because information shared via social media may travel quickly, it is essential that States ensure the message they want to convey is accurate.

3.2 Communications and Outreach Strategies for Low-Belt-Use Groups

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

† For programs supporting enforcement

Nationally, seat belt use is at 87% (Pickrell & Choi, 2015), with 41 States and the District of Columbia having seat belt use at 80% or higher (Chen, 2014). This indicates the large majority of drivers and passengers are wearing their seat belts; 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, 84% and 88% respectively in 2012. This trend has been evident since at least 2003 (Pickrell, 2014). Similarly, belt use rates for occupants 16 to 24 years old tends to be lower than the use rates of other age groups. In 2012, belt use was 80% for occupants 16 to 24, 87% for occupants 8 to 15, 87% for occupants 25 to 69, and 88% for those occupants 70 and older (Pickrell, 2014). Since 2005, belt use rates for black occupants have been lower than use rates for members of other races. In 2012, belt use for black occupants was 77% compared to 86% among white occupants, and 92% among members of other races (Pickrell, 2014). Additionally, NHTSA's 2014 National Occupant Protection Use Survey indicated belt use was lower for front seat passengers (85%) compared to drivers (87%), pick-up truck occupants (77%) compared to occupants of passenger cars (88%) and vans/SUVs (89%), and was lower in rural areas (83%) compared to urban (86%) and suburban (89%) areas (Pickrell & Choi, 2015). NHTSA's 2007 national telephone survey found the same patterns with males, young drivers, rural drivers, and pickup truck drivers-all reporting lower seat belt use (Boyle & Lampkin, 2008, p. iv).

Most non-seat belt users report wearing seat belts at least some of the time. In NHTSA's 2007 national telephone survey, 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 2011 *Click It or Ticket* campaign targeted 18- to 34-year old males and found they were more likely than the general population to have heard about special enforcement efforts (21% versus 17%) and were more likely to have heard messages to buckle up (75% versus 71%), but were somewhat less likely to think a ticket was likely if they did not wear their seatbelt while driving (64% versus 66%) (Nichols & Solomon, 2013).

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 6 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 6 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 during 2004–2007 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 4 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 between 1978 and 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 where in the vehicle the restraints can be positioned. 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, 2014b; IIHS, 2014). 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, 2014). 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, 2006; NHTSA, 2003b; NHTSA, 2006). 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 covers children until they are big enough for the lap and shoulder belts to fit properly.

Use: As of August 2014, 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, 2014). However, a wide variation in age, height, and weight requirements exists between the laws of the various States (GHSA, 2014b; IIHS, 2014).

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 between 4 and 8 were using booster seats (Ebel, Koepsell, Bennett, & Rivara, 2003). Following a new law requiring booster seats for children weighing between 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).

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).

A number of 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

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

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 a lack of commitment by 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 seat belt 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**: NHTSA (1990) suggests that in order to maximize child restraint enforcement efforts, certain activities should be part of the overall program. These are: 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; child restraint distribution programs; and public service announcements and other media coverage. 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.

6. Communications and Outreach

6.1 Communications and Outreach Strategies for Older Children

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

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 15. In January 2015, NHTSA will announce a new campaign for older children 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 Communications and Outreach 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 2013 National Survey of the Use of Booster Seats (NSUBS) show that 7% of children under age 1 were moved to a forward-facing child restraint. Similarly, 17% 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 (Pickrell & Choi, 2014).

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, 2013 NSUBS data show that children are moving into the seat belt much earlier than is recommended. In 2013, 24% of children 4 to 7 were restrained using the seat belt alone and 46% were using a booster seat. Only 10% of children 8 to 12 were using booster seats (Pickrell & Choi, 2014).

Since then, there has been positive movement on child restraint use, particularly with extended rear-facing and extended harnessing. In 2013, 10% of children 1 to 3 were rear-facing, a significant increase from 7% in 2011. Similarly, fewer children 1 to 3 were prematurely moved to booster seats (9% in 2013 compared to 12% in 2011). While not statistically significant, in 2013 more children 4 to 7 were riding in car seats or booster seats compared with 2011 (66% versus 65%) (Pickrell & Choi, 2014).

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 aimed at booster seat use is unclear. 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. 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 (Aitken et al., 2013).

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. Guidebooks on how local programs can set up and operate a mobile CPS clinic or permanent inspection station are available from NHTSA (NHTSA, 2003a).

Use: Child restraint inspection stations have become common components of State and local child passenger safety programs. There are over 5,500 inspection stations registered with NHTSA (NHTSA, 2014b).

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 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).

A recent 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.

Seat Belts and Child Restraints References

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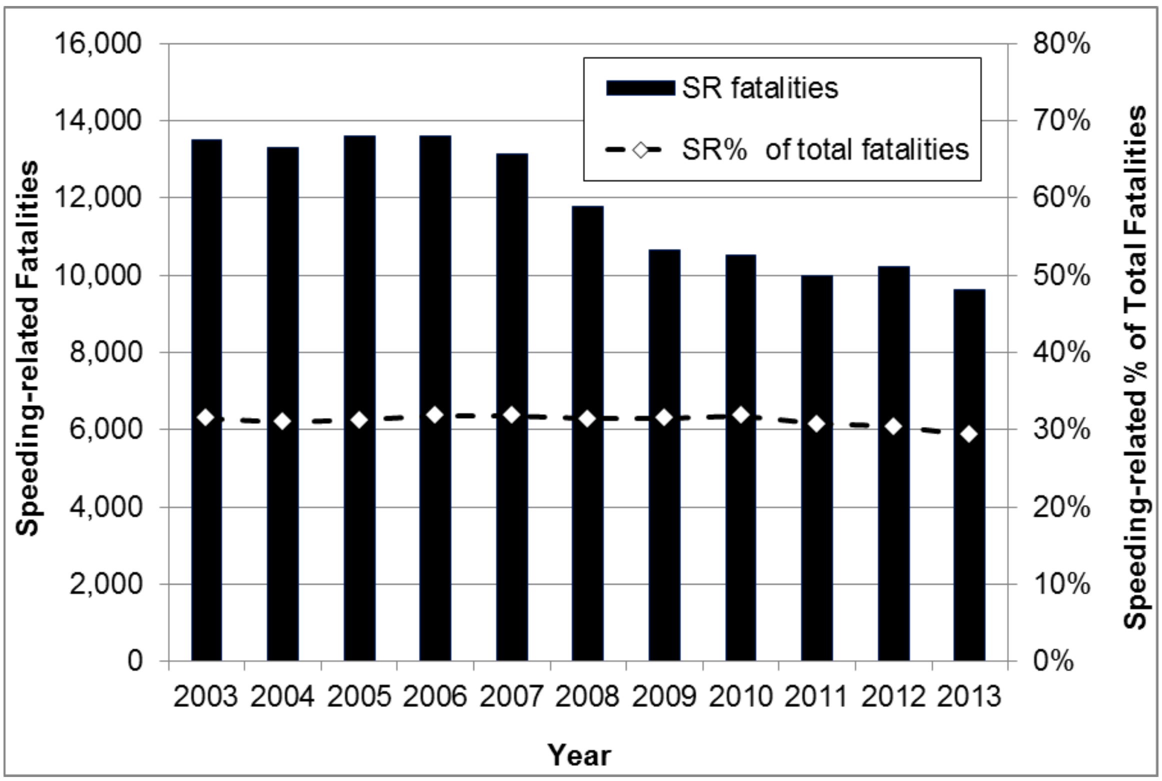
3. Speeding and Speed Management

Overview

Characteristics and problem size: Speeding. Speeding-related fatalities have generally trended downward since 2007, as shown in the figure below. In 2013, there were 9,613 speed-related fatalities, a decrease of 7% from the 10,329 fatalities in 2012 (NHTSA, 2015). Despite generally decreasing numbers over the past seven years, speeding is a contributing factor in 29% of fatal U.S. crashes (NCSA, 2015), a percentage that has remained relatively unchanged for decades.



Source: NCSA (2015), NHTSA (2015)

Younger drivers, particularly young, male drivers, continued to be the most likely to be identified as speeding in fatal crashes in 2013. Thirty-five percent (35%) of male drivers in both 15- to 20-year-old and 21- to 24-year-old age groups involved in fatal crashes were speeding; however, this percentage was slightly lower than the 39 percent for both groups in 2010. Other risk factors associated with speeding in 2012 included driver alcohol use, lack of seat belt wearing, driver not being properly licensed, nighttime hours, and wet and icy road surfaces at the time of the crash. In addition, motorcycle drivers were overrepresented in fatal crashes involving speeding (34% were speeding) compared to passenger vehicle drivers (21%) and light truck drivers (18%) (NCSA, 2015).

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.

Speeding is legally defined by States and municipalities in terms of a "basic speed rule" and statutory maximum speed limits. Although the wording of the basic speed rule varies, it usually requires drivers to drive at a reasonable and prudent rate for roadway conditions. This is open to the officer's judgment, but is frequently related to weather, surface conditions, congestion, 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 on the basis of 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.

Speeding can be dangerous on all types of roads. In 2013, 47% of vehicles involved in speed-related fatal crashes occurred on roads posted at 50 mph or less, and 27% occurred on roads posted at 40 mph or less (NHTSA, 2015, Table 33). In 2013, 16.2% of speeding-related fatalities occurred on Interstate highways and other expressways, with 25% occurring on local streets, 20% on non-interstate collectors, and 38% on non-interstate principal and minor arterials combined (NCSA, 2015).

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, 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.

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, 2001a). 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 (NCHRP, 2003a). 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. Speed limits should be set carefully, taking into account 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 available at http://safety.fhwa.dot.gov/speedmgt/ref_mats /fhwasal2004/. Additionally, the *NCHRP Guide for Addressing Aggressive-Driving Collisions* (NCHRP, 2003a) 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.

Speed enforcement can be conducted through regular traffic patrols; sustainable levels of widespread, randomly-allocated enforcement (Newstead, Cameron, & Leggett, 2001); intense, highly publicized enforcement periods; and automated speed or red-light enforcement. The sections in this chapter discuss relevant laws and sanctions, special enforcement techniques, and publicity.

Although often thought of as primarily an enforcement problem, increasingly researchers and practitioners are recognizing the critical importance of road design and traffic engineering measures to support established speed limits, manage speed, and reduce fatalities and injuries. Traffic calming measures, including area-wide traffic calming and low speed zones on collector streets and near schools, parks, and other areas, can reduce speeds and crashes (Speed Management, 2008; TRB, 1998; also see *Engineering Countermeasures for Reducing Speeds: A Desktop Reference of Potential Effectiveness*, 2009. FHWA Office of Safety website: http://safety.fhwa.dot.gov/speedmgt/ref_mats/eng_count/). 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 (NCHRP, 2007; 2008; 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 (NCHRP, 2003a, 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 or ride-sharing, 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.

Setting appropriate speed limits and managing traffic speeds requires cooperative efforts between State Departments of Transportation (DOTs) and SHSOs, law enforcement agencies and others. SHSOs are also encouraged to act cooperatively with State DOTs to identify their speeding and aggressive driving traffic safety problems and to adopt comprehensive plans and programs to address them. NCHRP (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 NCHRP (2003a) for specific examples of cooperative strategies on aggressive driving, and NCHRP (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 Department of Transportation, together with GHSA and several national organizations sponsored a National Forum on Speeding in June 2005. The forum's invited presentations documented speed-related issues and highlighted speed management practices in Australia, Canada, and the Netherlands. The presentations are available at www.nhtsa.dot.gov/people/injury/enforce/Speed_Forum_Presentations/. The forum report presented an action agenda (NHTSA, 2005). The Department of Transportation's 2005 Speed Management Strategic Initiative formalized the Federal speed management plan and contains a comprehensive set of engineering, enforcement, and education strategies to reduce speeding-related fatalities and injuries (FWHA, FMCSA, & NHTSA, 2005). A key component of the *Speed Management Strategic Initiative* has been to emphasize the interdisciplinary nature of effective speed management, whereby engineering, enforcement, and the judiciary are all critical components.

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 (U.S. DOT, 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
    - Aggressive Driving - www.nhtsa.gov/Aggressive
    - Enforcement and Justice Services - www.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 Information Services (TRIS) database – bibliographic database of transportation-related research: tris.trb.org

Countermeasures That Work

Countermeasures to reduce aggressive driving and speeding are listed below and discussed individually in this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The terms used are described below. 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.

1. Laws

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Speed limits	★★★★★†	$	High	Short
1.2 Aggressive driving 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 agreements	★	Varies	Unknown	Varies

4. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Public Information 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 one year
Medium: more than three months but less than one year
Short: three 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 the City of Edmonton (Alberta province, 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). Between 2003 and 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 2007, six metropolitan areas in the United States were employing enforceable, variable speed limits on freeways (posted on changeable message signs) (RITA, 2007). Variable speed limits have also been tested in Michigan work zones (FHWA, 2004). 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 (NCHRP, 2013).

1.2 Aggressive Driving and Other Laws

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

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 (NCHRP, 2003a, 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 (NCHRP, 2003b).

2. Enforcement

2.1 Automated Enforcement

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

[†] Can be covered by income from citations

Automated enforcement is used in some jurisdictions to reduce red-light running and speeding above limits. At intersections with traffic lights, automated cameras take photographs of vehicles entering the intersection on a red light. Citations are sent to the vehicle's registered owner. FHWA's Red- Light Camera Systems Operational Guidelines (FHWA, 2005) provides information on red-light camera program costs, effectiveness, implementation, and other issues. Speed cameras, also called photo radar or automated speed enforcement, operate similarly, recording a vehicle's speed using radar or other instrumentation and taking a photograph of the vehicle when it exceeds a threshold limit. NCHRP (2012), and NHTSA and FHWA (2008) have 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 cameras are used extensively in other industrialized countries and were first employed in the United Sates in 1993 (NCSRLR, 2002). As of June 2015, red-light cameras were being used in about 460 communities in 24 States, the District of Columbia, and the U.S. Virgin Islands. Speed cameras were being used in approximately 134 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, 2015b; IIHS, 2015a). Speed cameras also are used extensively in other countries (WHO, 2004).

Effectiveness: Red-light camera effectiveness has been studied fairly extensively. Summary reviews conclude that they increase rear-end crashes, reduce side-impact crashes (the target group), and reduce overall crash severity (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). Because there tend to be increases in lower-severity rear end crashes that somewhat offset reductions in the target group of higher- severity angle crashes, cameras were found to be more beneficial at intersections with a higher ratio of angle crashes to rear-end crashes. 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). Other factors that may improve safety benefits included the posting of warning signs in advance of the intersection. Washington and Shin (2005) also caution that less expensive engineering solutions should be sought before implementing camera programs.

Speed cameras can also reduce crashes substantially. 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.

In 2009/2010, the freeway speed camera program in Arizona was discontinued as the result of a political decision based on a variety of factors. A mobile speed camera operator was shot and killed on a deployment, creating 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.

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). 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.

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). In 2001, red-light film-based camera systems cost about $50,000 to

$60,000 and digital systems were around $100,000 to purchase and $25,000 to install. Monthly operating costs were about $5,000 (Maccubbin et al., 2001). 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).

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 4 to 6 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 (2004) 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 (NCHRP, 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 NCHRP (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 are 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.

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 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. NCHRP (2003a, Strategy A1) provides 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).

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

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 NCHRP (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

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 (NCHRP, 2003a, 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. (2008a) 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., 2008a).

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 (NCHRP, 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 (NCHRP, 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

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 are 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 are 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).

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 (NCHRP, 2003a; 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 NCHRP (2003a, 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 (NCHRP, 2003a, 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: they are societal issues rather than just driving and transportation system issues. 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 has held two distracted driving summits in Washington DC, developed a "Blueprint for Ending Distracted Driving" (NHTSA, 2012), and created a website to address this issue (www.distraction.gov). 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. Attention and research on drowsiness has concentrated on commercial truck drivers, but the problem is far more widespread.

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 (NHCRP, 2005, Section III).

In 2013, AAA Foundation surveyed 3,103 U.S. residents and found that nine in ten (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 (AAAFTS, 2013). Similarly, a survey in 2011 of 1,208 Canadian drivers found that 74% reported distracted drivers are a "very" or "extremely" serious problem, up from about 40% in 2005 (Marcoux, Valnaar, & Robertson, 2012).

Although people are concerned about distracted driving, they frequently admit to engaging in such behaviors behind the wheel. NHTSA conducted a telephone survey of a nationally representative sample of more than 6,000 drivers in 2012, asking about a variety of attitudes and behaviors related to distracted driving (Schroeder, Meyers, & Kostyniuk, 2013). Among the behaviors that drivers reported doing at least sometimes:

- 80% talked to other passengers;
- 68% adjusted the car radio;
- 47% ate or drank;
- 40% made or accepted phone calls;
- 36% interacted with children in the back seat;
- 35% used a navigational system;
- 25% changed CDs, DVDs, or tapes;
- 20% used a smartphone for driving directions;

- 14% read e-mail or text messages;
- 10% sent text messages or email;
- 9% did personal grooming.

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In the AAA Foundation survey, two-thirds (67%) of respondents admitted to talking on the phone while driving during the past 30 days (AAAFTS, 2013). A third (35%) admitted to reading text messages while driving, and a fourth (26%) had sent text messages. The AAA Foundation summed their findings by observing that 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 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 3,154 fatalities in distraction-affected crashes in 2013 (NCSA, 2015). This represents an 7% decrease from the 3,380 fatalities in 2012. Ten percent (2,910) of all fatal crashes are distraction-affected crashes (NCSA, 2015). 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 cellular phone or texting and distraction by an outside person/event (NHTSA, 2015).

The risks posed by specific distracted driving behaviors are not well understood. The "100 car" study monitored 100 drivers for a year using specialized instrumentation, and examined the risk associated with engaging in various secondary tasks compared to regular driving. In the table below, a change in risk greater than 1 represents an increase in risk due to the secondary task, while a change in risk less than 1 represents a decrease in risk. For example, drivers are 3.38 times more likely to be in a crash or near crash while reading and driving compared to regular driving (Klauer et al., 2006).

Estimated Change in Crash Risk When Engaging in Secondary Tasks, Adult Drivers in the 100-Car Study

Type of Secondary Task	Change in Risk
Reaching for a moving object	**8.82**
Insect in vehicle	6.37
Looking at external object	**3.70**
Reading	**3.38**
Applying makeup	**3.13**
Dialing a hand held device	**2.79**
Inserting/retrieving CD	2.25
Eating	1.57
Reaching for a non-moving object	1.38
Talking/listening to hand-held device	1.29
Drinking from an open container	1.03
Passenger in the adjacent seat	**0.39**
Child in rear seat	0.33

Note: **Bold** indicates a significant change in crash risk.
Source: Klauer et al. (2006), p.30.

Klauer et al. (2014) used in-vehicle cameras and sensors to study distracted behaviors among 42 newly licensed (novice) drivers. 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. Texting, looking at a roadside object, eating, and reaching for an object (other than a cell phone) were also associated with increased risk. In general, the risks posed by various types of distraction appear more problematic for young drivers than adult drivers.

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
Talking	n.s.
Texting	3.9
Reaching for phone	7.1
Reaching for object (other than cell phone)	8.0
Looking at outside object	3.9
Adjusting radio/HVAC	n.s.
Adjusting other controls	n.s.
Eating	3.0

Note: n.s. indicates no significant change in crash risk.
Source: Klauer et al. (2014).

Regardless of driver age, many of the highest-risk activities require the driver to look away from the roadway. This finding is supported by another naturalistic study which compared the effects of distraction associated with hand-held, portable hands-free, and integrated hands-free phones (Fitch et al., 2013). Simply talking on a cell phone was not associated with an increased risk of a crash or near crash, regardless of what type of phone was being used. However, visual-manual subtasks, such as dialing or answering a phone, increased the amount of time drivers took their eyes off the roadway and increased the risk of a crash or near-crash.

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 text messaging, GPS navigation systems, 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. Several U.S. and international telephone surveys provide consistent estimates of the prevalence and key characteristics of drowsy driving. 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. Similarly, a Centers for Disease Control and Prevention survey of almost 150,000 U.S. residents found that 4.2% reported having fallen asleep while driving at least once in the past 30 days (CDC, 2013). 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. All three 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; CDC, 2013; Royal, 2003). Moreover, driving while drowsy does not just occur late at night. About one-third of those drivers who admit to nodding off say the most recent incident occurred in the afternoon (noon to 6 p.m.), which might be attributable to circadian rhythms. 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. NHTSA estimated that 2.5% of fatal crashes and 2% of injury crashes between 2005 and 2009 involved drowsy driving (NHTSA, 2011). A study by the AAA Foundation using data from 1999 through 2008 found that driver drowsiness may have contributed to 7% of all crashes and 16.5% of fatal crashes (Tefft, 2012). Again, differences between these studies reflect the difficulty in determining whether driver drowsiness may have been a contributing factor to the crash.

Strategies to Reduce Distracted and Drowsy Driving

The obvious way to reduce distracted or drowsy driving crashes is to convince or require drivers to get enough sleep and to pay attention to their driving. These are very difficult goals. 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. 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. Moreover, studies indicate that drivers themselves are poor judges of the performance decrements that result from distracting activities (Horrey, Lesch, & Garabet, 2008).

Behavioral strategies for distracted or 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, 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 and the Occupational Safety and Health Administration are available through distraction.gov. 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 has 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. 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 hold promise for reducing crashes among drivers who are drowsy or inattentive (IIHS, 2012). 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). 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 (Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices, 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 driver 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 has developed a prototype Drowsy Driver Warning System that appears promising in reducing drowsiness among drivers of heavy vehicles (Blanco et al., 2009). 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 - www.nhtsa.gov/Driving+Safety/Research+&+Evaluation
  - Behavioral Safety Research Reports - http://ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Governors Highway Safety Association: www.ghsa.org
- National Safety Council:

www.nsc.org/safety_road/Distracted_Driving/Pages/distracted_driving.aspx
- National Conference of State Legislatures:
 www.ncsl.org/issues- research/transport/spotlight-distracted-driving.aspx
- National Sleep Foundation: www.sleepfoundation.org
- Insurance Institute for Highway Safety: www.iihs.org
- AAA Foundation for Traffic Safety: www.aaafoundation.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 (Vegega, Jones, & Monk, 2013).
- NHTSA's Driver Distraction: A Review of the Current State-of-Knowledge (Ranney, 2008).
- Overview of the National Highway Traffic Safety Administration's Driver Distraction Program (NHTSA, 2010a).
- 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).

For overviews on drowsy driving, see NCHRP (2005), TIRF (2009), and Grigo & Baldock (2011).

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.

Countermeasures That Work

Countermeasures to reduce distracted and drowsy driving are listed below and discussed individually in this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The symbols and terms used are described below. 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.

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 proven 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 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:

★★★★★ - 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 one year
Medium: more than three months but less than one year
Short: three 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 proven 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 newer 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 teens are more likely than adults to drive while drowsy (AAA Foundation, 2010; CDC, 2013; Royal, 2003).

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 more dangerous than during the day 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 Chapter 4, 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 (NCHRP, 2007). The Insurance Institute for Highway Safety (IIHS, 2014a) and the Governors Highway Safety Association (GHSA, 2014a) summarize State GDL laws. These summaries are updated monthly. See Chapter 6, Sections 1.1 to 1.7, for a complete discussion of GDL for beginning young drivers.

Use: As of July 2014, 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 45 States and the District of Columbia limit the number of passengers allowed with a driver with a provisional license (GHSA, 2014a; IIHS, 2014a). Thirty-eight 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 (GHSA, 2014a; IIHS, 2014a).

Effectiveness: Several studies document that nighttime and passenger GDL restrictions reduce teenage driver crashes and injuries (Hedlund & Compton, 2005; NCHRP, 2007; Williams, 2007a). The only evaluation of a GDL cell phone restriction suggests these laws may have little effect on teenage drivers' cell phone use (Foss, Goodwin, McCartt, & Hellinga, 2009; Goodwin, O'Brien, & Foss, 2012).

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

Cell phones have become an essential feature of modern life. In a NHTSA survey of more than 6,000 U.S. residents, 60% admitted to answering phone calls while driving and 51% reported making phone calls (Schroeder et al., 2013). Half (50%) of cell phone users reported no differences in their driving when using a cell phone. NHTSA's 2012 national observation survey found 5% of drivers on the road at any given moment were using hand-held cell phones, unchanged since 2009 (NHTSA, 2014). The percent of drivers who were manipulating a hand-held device (e.g., texting or dialing) increased from 0.6% in 2009 to 1.5% in 2012. NHTSA currently estimates that 9% of drivers are using some type of phone (hand-held or hands-free) in a typical daylight moment (NHTSA, 2014). 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). Studies using in-vehicle cameras and sensors to study distracted behaviors suggest talking on a cell phone increases risk by a small, non-significant amount (Klauer et al., 2006, 2014).

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 2013, legislators in 40 States considered approximately 170 bills related to distracted driving (NCSL, 2014). 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 96% support bans on texting while driving (AAFTS, 2013; Guarino, 2013; Schroeder et al., 2013).

Use: As of July 2014, 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, 2014b; IIHS, 2014b). 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 July 2014, 44 States and the District of Columbia prohibit text messaging for all drivers (GHSA, 2014b; IIHS, 2014b). NHTSA has prepared a sample bill to assist States in crafting new legislation to prohibit texting while driving (NHTSA, 2010b).

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.

Two studies have examined the effectiveness of laws prohibiting texting while driving. One study evaluated the effect of a texting ban in Michigan (Ehsani, Bingham, Ionides, & Childers, 2014); the other 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.

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 (TTI) 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.

1.3 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 spotter techniques 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 can assist 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 create the impression that violators will be caught.

NHTSA has conducted a high visibility enforcement demonstration project aimed at reducing cell phone use among drivers. The message of the program is: "Phone in one hand. Ticket in the other." Pilot programs were tested in Hartford, Connecticut, and Syracuse, New York, in April 2010 through 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 recently implemented a HVE campaign in Delaware and in nine California counties in the Sacramento area. Three waves of enforcement were conducted between November 2012 and June 2013. Paid and earned media were similar to that in Hartford and Syracuse. See Schick, Vegega, and Chaudhary (2014) for more information.

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 the results are encouraging, the effect of these HVE campaigns on crashes is unknown. 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

States implicitly prohibit driving while seriously distracted or drowsy through their reckless driving laws (NCHRP, 2005, Strategy C2). These existing laws in each State allow individuals 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, 2012). 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 NCHRP, 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: A new drowsy or distracted driving law can be implemented quickly, 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

Drowsy driving typically occurs because drivers don't get enough sleep. This apparently obvious statement is well-documented. 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). 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 (NCHRP, 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). 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 NCHRP, 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, 2007b).

An additional barrier is that drowsy driving is a byproduct of busy lifestyles that do not include enough sleep. The only truly effective method to prevent drowsy driving crashes 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. Based on NCHRP research, no drowsy driving communications and outreach program for the general public has been evaluated (NCHRP, 2005, Strategies C1 and D2).

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: Utah is the only State known to have conducted a drowsy driving campaign for the general public (see NCHRP, 2005, Strategy C1). However, several States including California, Florida, Pennsylvania, and Texas 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 percent 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

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 with 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, 2010). Some States have also developed their own education materials and programs aimed at teen drivers. See GHSA (2010) 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 NCHRP, 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, 2007b). 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 41 States and the District of Columbia have implemented public information/education campaigns to address distracted driving (GHSA, 2010). 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 (NCHRP, 2005, Strategies C1 and D2).

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 16 States as well as NHTSA now use social networking sites to educate motorists about distracted driving (GHSA, 2010). 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

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 30-40 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 (NCHRP, 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 NCSDR 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 established corporate outreach programs related to distracted driving (GHSA, 2010). 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 http://shop.nsc.org/eProducts-Cell-Phone-Policy-Download-P252.aspx. Additionally, a sample employer policy is available at www.distraction.gov/content/get-involved/employers.html.

Use: At least 16 States and the District of Columbia work with employers in their State to develop distracted driving policies (GHSA, 2010). 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 (NCHRP, 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 three months.

3.2 Education Regarding Medical Conditions and Medications

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

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 than 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 (NCHRP, 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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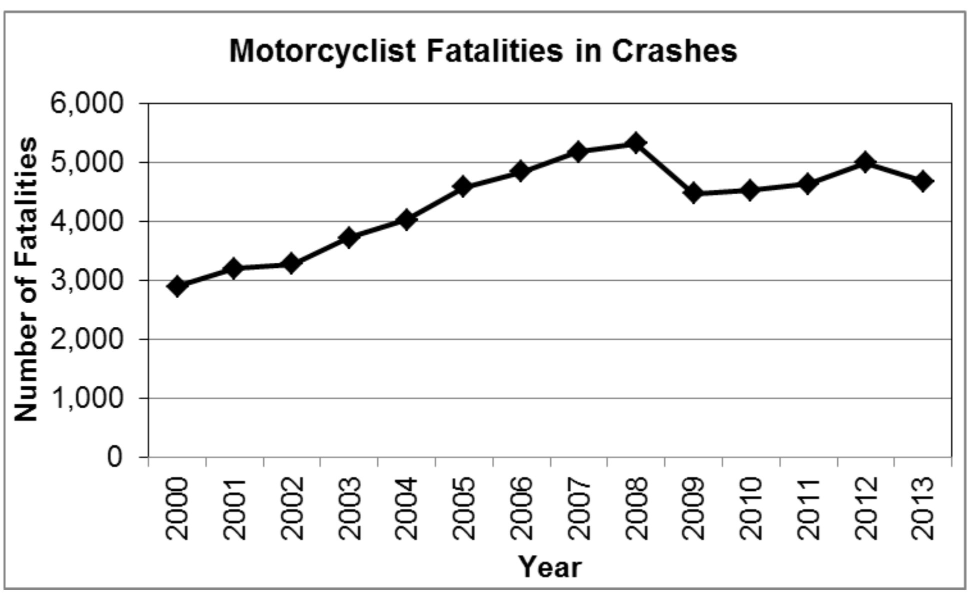
5. Motorcycle Safety

Overview

A motorcycle is inherently more difficult to operate than a passenger vehicle because it requires more physical skill. The relationship of speed and balance is also a critical consideration when riding a motorcycle, as the stability of a motorcycle is relative to speed. A motorcycle becomes more stable as speed increases, although it becomes less maneuverable. At very low speeds, the motorcycle rider must balance the motorcycle.

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 26 times more likely than passenger car occupants to die in traffic crashes. Motorcyclists are killed at a rate of 22.92 per 100 million vehicle miles traveled (VMT) as compared to 0.86 fatalities per 100 million VMT for passenger cars (NCSA, 2015).

Trends. Motorcycling has become increasingly popular over the last 10 years even as total vehicle miles traveled has declined. Not surprisingly, there has been a corresponding increase in crashes and fatalities involving motorcyclists. From 2000 to 2008, the crash data shows that number of motorcyclists killed in crashes increased by 83% and the number of motorcyclists injured increased by 92%. In 2008, motorcyclist fatalities increased for the 11th consecutive year to a level not seen since 1980 (NHTSA, 2009). Motorcyclist fatalities decreased in 2009, but then began rising again. In 2013, there were 4,668 fatalities, a decrease of 6% from 2012 (NCSA, 2015). Motorcyclists accounted for 14% of total motor vehicle related fatalities during 2013 (NCSA, 2015).



Source data: NCSA (2015)

In the 10-year period from 2004 to 2013, over half of motorcyclists injured in crashes were injured in single-vehicle crashes (FARS data). Approximately two-thirds (65%) of motorcyclist injuries during this time period occurred during daylight hours, more than two-thirds occurred during the months from April to September, and almost two-thirds (63%) occurred on weekdays. On average, about 85% of those injured were male and about 15% female. And about 9% of those injured were passengers. These trends have remained relatively consistent over this 10-year period, although there are year-to-year fluctuations.

One trend that is changing is an increase in fatalities and injuries among older motorcyclists. In 2013, 73% of the motorcyclists killed in crashes were 30 or older and 55% were 40 or older. The change in only 10 years is striking: in 2004, 68% were 30 or older and 46% were 40 or older (NHTSA, 2015). 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 28% to 30% of motorcyclists injured nationally during 2012 and 2013, 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-four percent of all motorcyclists involved in fatal crashes in 2013 were speeding, compared to 21% of passenger car drivers (NHTSA, 2015). 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 (NHTSA, 2015). In 2013, 28% of the motorcyclists killed in crashes had BACs of .08 g/dL or higher (NHTSA, 2015). Forty-one percent of fatally injured motorcyclists were not wearing helmets (NHTSA, 2015), although the percentage varies considerably from State to State. Additionally, 25% of the motorcyclists involved in crashes in 2012 did not have valid motorcycle operator licenses (NHTSA, 2015).

Other trends in motorcycle safety relate to the types of motorcycles being produced and purchased. While registrations of all types of motorcycles have increased from 2000 to 2005, registrations for supersport type 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, but these rates do not control for other possible risk factors (IIHS, 2007; Teoh & Campbell, 2010). The more recent IIHS analysis by Teoh and Campbell of 6 years of data also found that 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 and scooters. State laws defining and regulating these vehicles vary significantly by State, 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 a maximum speed, generally 25 to 30 mph), most of the countermeasures aimed at motorcycles would also apply to low-powered cycles.

Strategies to Improve Motorcycle Safety

There are various existing strategies to improve motorcycle safety that have been extensively reviewed in published research. 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. All motorcycle riders should wear motorcycle helmets that meet Federal Motor Vehicle Safety Standard (FMVSS) 218 and clothing that provides both protection and visibility. 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), 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 9 State motorcycle safety program technical assessments conducted by NHTSA (Baer & Skemer, 2009).

The most important demonstrable objectives for improving motorcycle safety are to increase helmet use, reduce alcohol-impaired motorcycle riding, increase proper licensing, and promote lifelong learning through the completion of rider training courses. These objectives are all difficult to accomplish. Universal helmet laws are extremely effective in assuring that virtually all motorcycle riders use helmets, but they also are politically difficult to enact and retain. Strategies using only communications and outreach to promote helmet use, reduce impaired motorcycling, and increase licensing appear to have been 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 by educating other 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 (NCHRP, 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. 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
- Guide to Community Preventive Services Community Guide: Use of Motorcycle Helmets – www.thecommunityguide.org/mvoi/motorcyclehelmets/index.html

NHTSA's web pages:

- Motorcycles - www.nhtsa.gov/Safety/Motorcycles
- Research and Evaluation - www.nhtsa.gov/Research/Behavioral+Research
- Behavioral Safety Research Reports - http://ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm

Countermeasures That Work

Countermeasures to improve motorcycle safety are listed below and discussed individually in this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The symbols and terms used are described below. 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.

1. Motorcycle Helmets

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Universal coverage State motorcycle helmet use laws	★★★★★	$	Medium	Short
1.2 Helmet use promotion programs	★	Varies	Unknown	Varies
1.3 Helmet law enforcement; noncompliant helmets	★	$	Unknown	Medium

2. Alcohol Impairment

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Alcohol impairment: detection, enforcement, and sanctions	★★★	Varies	Unknown	Varies
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 Other driver 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: 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 one year

Medium: more than three months but less than one year

Short: three 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; NCHRP, 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 2013, DOT-compliant helmet use increased to 64%, and use of noncompliant helmets decreased from 7% in 2013 to 5% in 2014 (Pickrell & Choi, 2015). Additionally, helmet non-use decreased slightly from 33% in 2013 to 31% in 2014 (Pickrell & Choi, 2015).

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 (2014) summarizes the helmet law history in each State.

Use: As of June 2015, 19 States, the District of Columbia, Puerto Rico, and the U.S. Virgin and Northern Mariana Islands had helmet laws covering all riders. Three States (Illinois, Iowa, and New Hampshire) did not have motorcycle helmet laws (GHSA, 2015; IIHS, 2015). Guam and most other States had laws covering only riders under a specified age, typically 18 or 21 (GHSA, 2015; IIHS, 2015). 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, 2015).

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.

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.

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 Chapter 5, Section 1.3.

1.2 Motorcycle Helmet Use Promotion Programs

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

A few 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 (NCHRP 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 (NCHRP, 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. NCHRP (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 (NCHRP, 2008). However, helmet use remains substantially lower in States without universal helmet laws than in States with such laws (Pickrell, & Liu, 2014).

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

Law enforcement officers in universal helmet law States easily can observe and cite motorcycle riders who are not wearing helmets. This 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, 2013b). Use of noncompliant helmets by all riders decreased from 7% in 2013 to 5% in 2014 according to a nationally representative observational survey of helmet use (Pickrell & Choi, 2015). Use of compliant helmets increased to 64%.

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 percent 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 (NHCRP, 2008, Strategy E1). In May 2011, NHTSA issued a Final Rule (effective 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 June 2015; GHSA, 2015; IIHS, 2015). 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 only 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

2.1 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 2013, 27% of motorcycle riders involved in fatal crashes had BACs of .08 or higher, which is higher than passenger car drivers (23%) and light-truck drivers (21%) (NHTSA, 2015). Even higher proportions of fatally injured 35- to 49-year-old riders had BACs of .08 or higher (33% for riders 35 to 39, 40% for riders 40 to 44, 40% for riders 45 to 49; NHTSA, 2015). 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 (NHTSA, 2015). Furthermore, in 2013 40% of riders killed in single-vehicle crashes had BACs of .08 or above, and on weekend nights this figure climbed to 63% (FARS data). The 2007 National Roadside Survey similarly found that 5.6% of motorcycle riders on weekend nights had BACs of .08 or above, as compared to 2.3% of passenger vehicle drivers (Lacey et al., 2009a).

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 Standardized Field Sobriety Tests 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.

Use: Thirty-two of 43 responding States reported having programs to focus on spotting impaired motorcyclists or on enforcing laws related to operating motorcycles while impaired (Baer et al., 2010). NHTSA (2006a) provides examples and links of State programs that distribute the NHTSA cue cards and brochures widely to law enforcement (Illinois), present this information in 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 (NCHRP, 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 proven to be effective for 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 impairement 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

Many States have conducted communications and outreach campaigns directed at drinking and riding. See NHTSA (2006a) and NCHRP (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 NCHRP (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., 2008McKnight, 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; NCHRP, 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 in order to be effective.

3. Motorcycle Rider Licensing and Training

3.1 Motorcycle Rider Licensing

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

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 the minimum skills needed to operate motorcycles safely (NHTSA, 2000a).

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 NCHRP (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, 2000a). NCHRP (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 2013, 25% of motorcycle riders involved in fatal crashes did not have valid motorcycle licenses, compared to 12% of passenger vehicle drivers who were not properly licensed (NHTSA, 2015). Licensing systems in some States provide no incentive to become fully licensed because learner's permits may be renewed indefinitely (NCHRP, 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 NCHRP (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, 2010). 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, 2000a) and ranks it as a medium priority item in the Prioritized Recommendations of the National Agenda for Motorcycle Safety (NHTSA, 2013b). 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

As of 2013, all 50 States offered rider education (MSF, 2013). 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 risks 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 that should be included in all 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, 2000a). 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). NCHRP (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 all 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 likely 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.

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 is required), qualified instructors, and motorcycles 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 addressing 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

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, 2000a). 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 (NCHRP, 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).

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; NCHRP, 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 (NCHRP, 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 (NCHRP, 2008, Strategy D1).

Communications and outreach campaigns promoting protective and conspicuous clothing have been conducted by States and by motorcyclist organizations. The NCHRP (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 could 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 potential 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 (NCHRP, 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: Other Driver Awareness of Motorcyclists

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

In general, studies show that when motorcycles crash with other vehicles, the other vehicle driver usually violates the motorcyclist's right-of-way (Clarke et al., 2007; Elliott et al., 2007; NCHRP, 2008, Strategy F3; NHTSA, 2000a). 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 (NCHRP, 2008, Strategy F3; NHTSA, 2000a). 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 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. See NHTSA (2006a, Section 5) and NCHRP (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 NCHRP (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 (NCHRP, 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 (NCHRP, 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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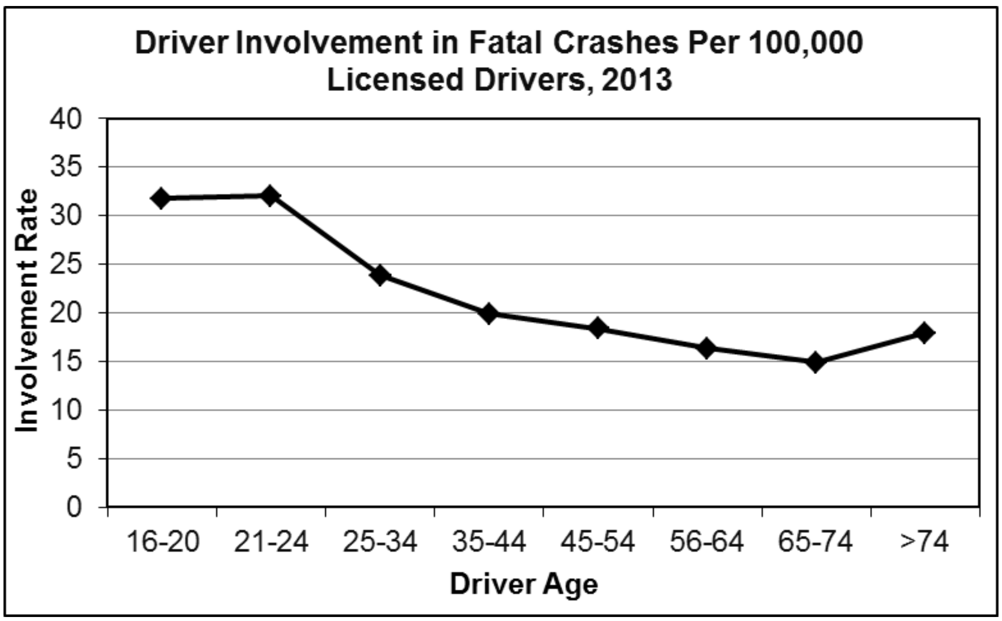
6. Young Drivers

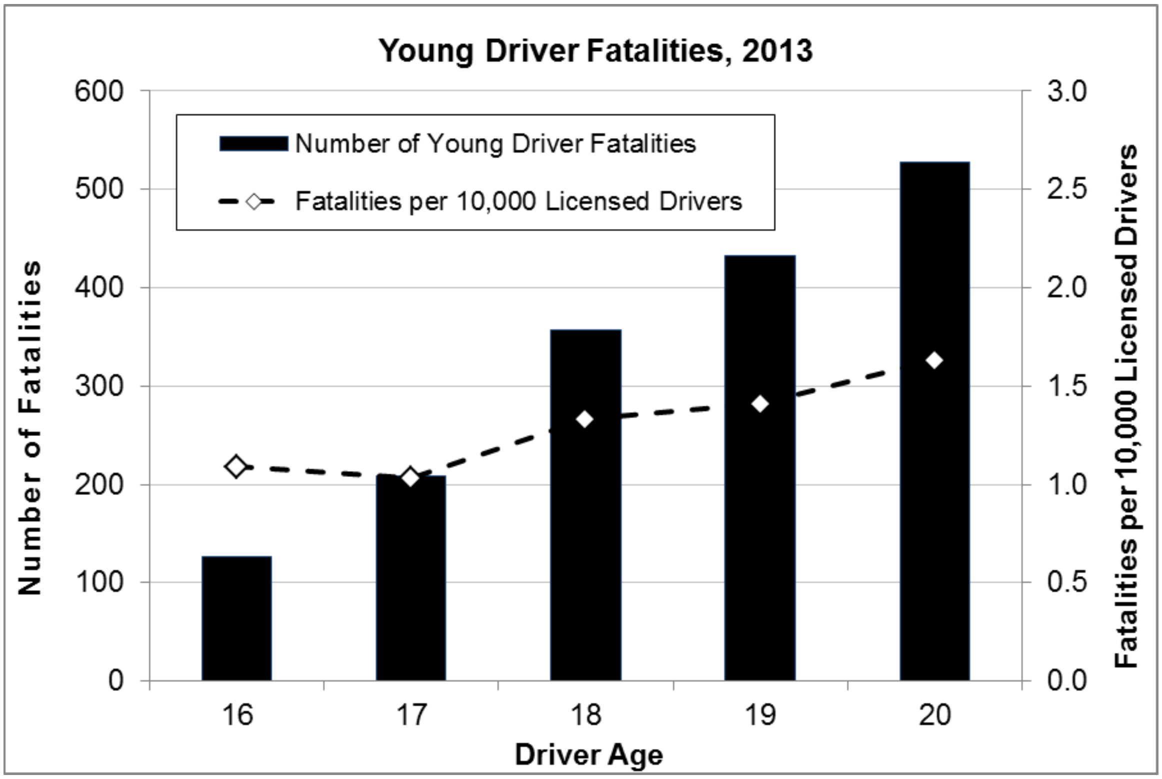
Overview

Motor vehicle crashes are the leading cause of death for teenagers in the United States. In 2013, 1,691 drivers 15 to 20 years old were killed and another estimated 177,000 were injured in motor vehicle crashes (FARS data). In comparison with adult drivers, young drivers are substantially over-involved in crashes. In 2013, drivers 15 to 20 made up 5.8% of licensed drivers in the United States, yet they made up 9% of total drivers in fatal crashes, and 13% of drivers in all crashes (FARS data). 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 (2015), 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: Analysis of data from the U.S. Department of Transportation's Fatality Analysis Reporting System (FARS data)

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. Between 1996 and 2012, there was a 74% decrease in the fatal crash rate for 16-year-old drivers per population, and a 64% decrease for 17-year-old drivers. By comparison, fatal crash rates declined by 34% among adult drivers 30 to 59 (McCartt & Teoh, 2014). There was a similarly large decrease in police reported crashes during the same time period. Police-reported crashes per population fell 65% for 16-year-olds and 50% for 17-year-olds (McCartt & Teoh, 2014). The reasons for the dramatic reductions in fatal and police-reported crashes among 16- and 17-year-olds 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, & 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 Chapter 4, 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 Chapter 4, 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 in particular:

- 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, 2.1, 2.2, and 3.1 (GDL requirements, communications and outreach, and employer programs).
- Chapter 5, 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/Teen-Drivers
  - Driver Safety Research Reports: New Drivers - www.nhtsa.gov/Driving+Safety/Research+&+Evaluation/Driver+Safety+Research+Reports:+New+Drivers+and+Older+Drivers
  - Behavioral Safety Research Reports - http://ntlsearch.bts.gov/repository/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/safety_road/TeenDriving/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* (ip.bmjjournals.com/content/vol12/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 (NCHRP, 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.

Countermeasures That Work

Countermeasures to improve young-driver safety are listed below and discussed individually in this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The symbols and terms used are described below. 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.

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	★★	$$	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 one year
Medium: more than three months but less than one year
Short: three 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* (NCHRP, 2007, strategies A1 through A5). See also NHTSA's *Traffic Safety Facts* on GDL (NHTSA, 2008) and Report to Congress (Compton & Ellison-Potter, 2008).

Use: All States and the District of Columbia had some GDL components in place as of August 2014. In addition, all States and D.C. 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; Fell, Jones, Romano, & Voas, 2011; Lyon, Pan, & Li, 2012; McCartt, Teoh, Fields, Braitman, & Hellinga, 2010; Masten, Foss, & Marshall, 2011; Masten et al., 2013; 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 D.C. 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, 20013; 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.

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, driver drowsiness is more common, and alcohol is more likely to be used. Many intermediate license drivers have limited experience driving at night. For all of 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, 49 States and the District of Columbia 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, 46 States and the District of Columbia 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

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, 2014b; IIHS, 2014b). Fourteen States and D.C. prohibit hand-held cell phone use for all drivers. In addition, 44 States and D.C. 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

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 2014c; IIHS, 2014c). 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

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

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 classroom instruction and 6 hours 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).

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 three 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

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

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; NCHRP, 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 2005-2008 approximately 130,000 families have 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 (TDP): 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 2005-2007 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.

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. 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).

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7. Older Drivers

Overview

In 2013, more than 17% of licensed drivers in the United States were 65 or older. By 2030 this proportion is expected to rise to at least 20%. 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 2013, the proportion of licensed drivers 65 and older rose from 11.2% to 17.3 % while the proportion of these older drivers in fatal crashes rose more rapidly, from 7.0% to 17.0%.

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%
2013	44.6	14.1%	36.8	17.3%	5,671	17.0%
2030	72.8*	19.3%*	60.4*	> 20%*	?	?

*Estimated
Source: FARS data; FHWA Highway Statistics (1995, 2015); NHTSA (2015); U.S. Census Bureau (2014)

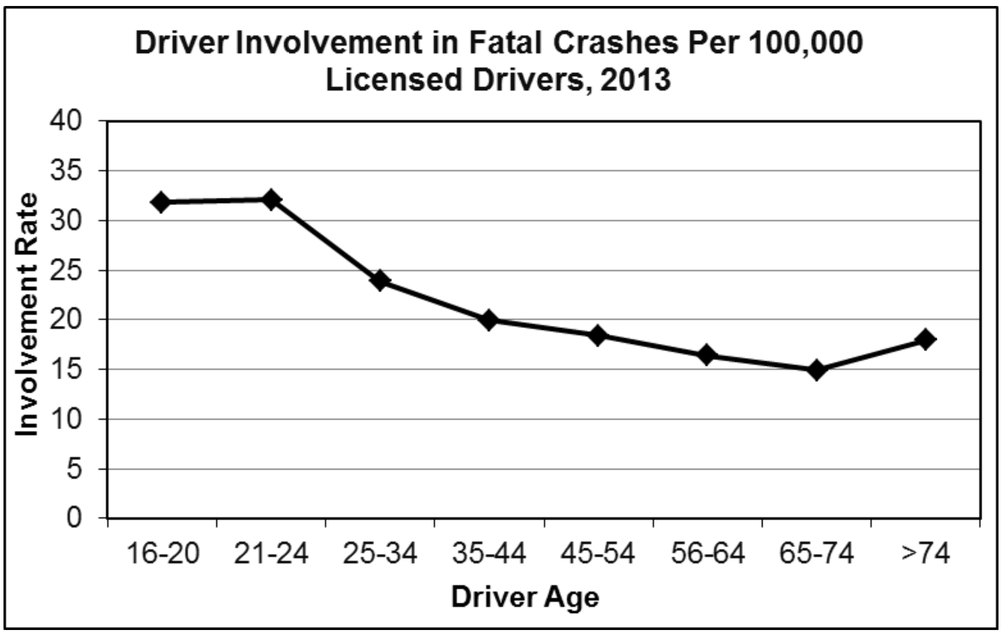
The United States population 65 and older increased at a much faster rate (15.1%) than the total population (9.7%) between the years 2000 and 2010 (U.S. Census Bureau, 2014). By 2030, the Census Bureau estimates that the resident population over 65 will double the 2010 population, to over 72 million, and will comprise 19.3% of the total 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 82% in 2013. If the licensure rate remains the same, by 2030 there will be nearly twice as many older drivers in the United States as there are today. As of 2013, 90.5% of people 65 to 69 are licensed, as are 87.7 of people 70 to 74, 83.6% of people 75 to 79, 76.3% of people 80 to 84, and 57.6% of people 85 and older (FHWA, 2015). 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 at least 65 years old.

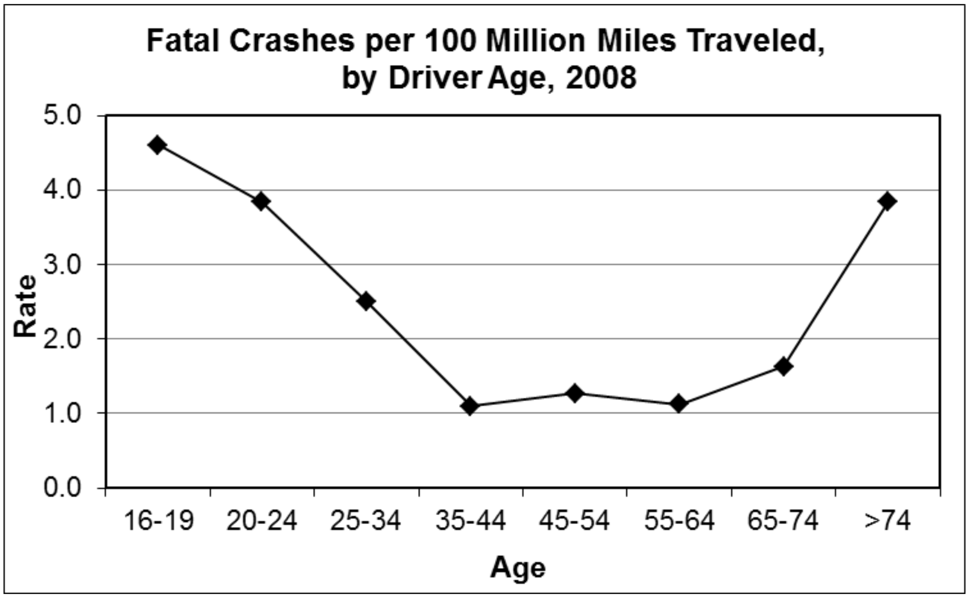
Older driver characteristics. Certain changes are inevitable as drivers age (Potts et al., 2004; National Cooperative Highway Research Program [NCHRP], 2004, Section III)

- 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 (2014b), 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.
- However, the fatal crash rate for drivers ages 65 and older *per mile traveled* is *higher* than for all but the drivers ages 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).
  - More recent 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).
  - Recent 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).

- Even more recently, 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 the most recent national crash data 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 speed-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" is 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). A number of strategies that could be addressed on the State or local level to address this goal were established in this plan. These include 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 an "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 another "Older Driver Program Five-Year Strategic Plan" in 2010 focused on how NHTSA will address the safety needs of older drivers through the years 2012-2017 (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 “Traffic Safety for Older People – 5-Year Plan” to address traffic safety concerns of older drivers, passengers, and pedestrians. The plan describes 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).

It is important to note that there are a number of vehicular, environmental, and societal strategies that are critical to provide 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 will 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 elements listed can be addressed directly by SHSOs. As noted by NHTSA, “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 document 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 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* (NCHRP, 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:
  - Senior Drivers - www.nhtsa.gov/Senior-Drivers
  - Driver Safety Research Reports: Older Drivers – www.nhtsa.gov/Driving+Safety/Driver+Safety+Research+Reports:+Older+Drivers
- 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
- 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 Center on Senior Transportation**:** www.seniortransportation.net/
- National Safety Council: www.nsc.org/safety_road/DriverSafety/Pages/MatureDrivers.aspx

Countermeasures That Work

Countermeasures to improve older driver safety are listed below and discussed individually in this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The terms and symbols used are described below. 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.

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	★★★★	$$	High	Medium
2.2 Referring older drivers to DMVs	★★★★	$$	Low	Medium
2.3 License restrictions	★★★★	$	Unknown	Short
2.4 Medical advisory boards	★★	Varies	High	Medium
2.5 License renewal policies	★★	$$$	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 one year
Medium: more than three months but less than one year
Short: three 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

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 (NCHRP, 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, 36 States and the District of Columbia 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 (NCHRP, 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 (NCHRP, 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; NCHRP, 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 between 2004 and 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

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 (NCHRP, 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:

- *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 NCHRP (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
- 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 are 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 (NCHRP, 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 (NCHRP, 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 (NCHRP, 2004, Strategy E1).

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 (NCHRP, 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).

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 individuals 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 individuals age" (Molnar & Eby, 2008, p.3).

Use: All States screen and test drivers referred to them, though their procedures and criteria vary considerably (NCHRP, 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 NCHRP, 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 (NCHRP, 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 *Physician's Guide to Assessing and Counseling Older Drivers* (Wang et al., 2003; Carr et al., 2010), prepared in cooperation with the AMA, provides detailed information for physicians and medical professionals. 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 NCHRP (2004, Strategy C3) for overall discussion.

Chapter 3 of the second edition of the *Physician's Guide to Assessing and Counseling Older Drivers* (Carr et al., 2010) discusses the assessment of functional abilities and provides physicians with the instructions and basic forms needed for them to conduct a brief in-office "Assessment of Driving-Related Skills" (ADReS). The ADReS 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 ADReS (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 ADReS 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 *Physician'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. NCHRP (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, 2005) 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 fewer 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. NCHRP (2004, Strategy C3) provides examples and web links. As one example, Pennsylvania increased physician referrals substantially by sending letters to all physicians (NCHRP, 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 individuals (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).

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 that over 1,600 drivers reported as being cognitively impaired between 2003 and 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 (NCHRP, 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

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 et al., 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

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 (NCHRP, 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 – 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 ages 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 (NCHRP, 2004, Strategy C2). No known data are 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 ages 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 provide 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.

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.

NHTSA's Older Driver Law Enforcement Course is available through the International Association of Directors of Law Enforcement Standards and Training. The 4-hour course provides background on older driver issues and discusses traffic stops, referring older drivers to licensing agencies, and community outreach.

Use: NHTSA (2003) describes older driver programs in 28 States.

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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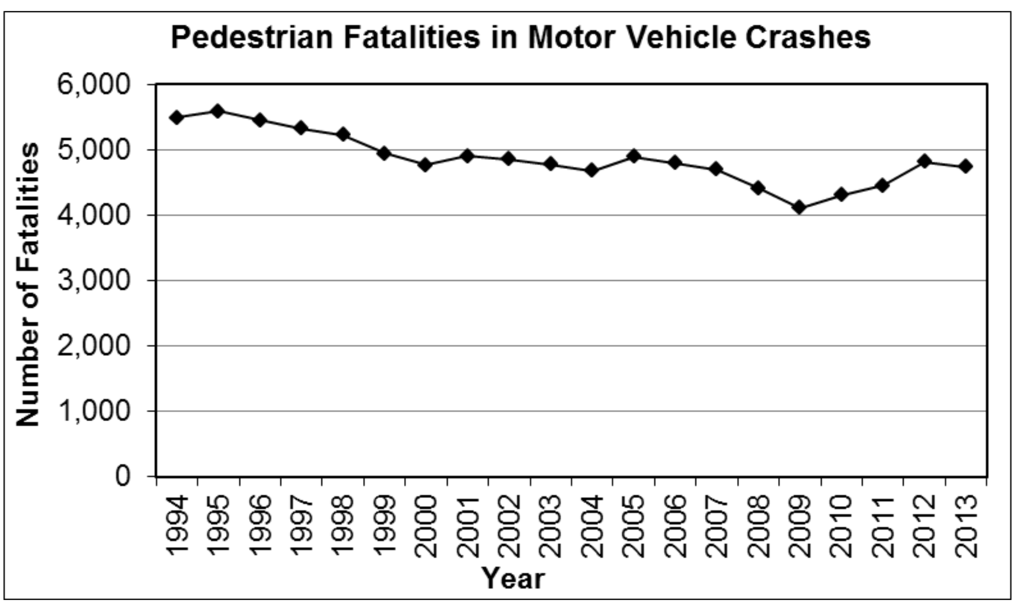
8. Pedestrians

Overview

In 2013, 4,735 pedestrians died and approximately 66,000 were injured in traffic crashes in the United States (NHTSA, 2015b). Pedestrians accounted for 14% 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 2013:

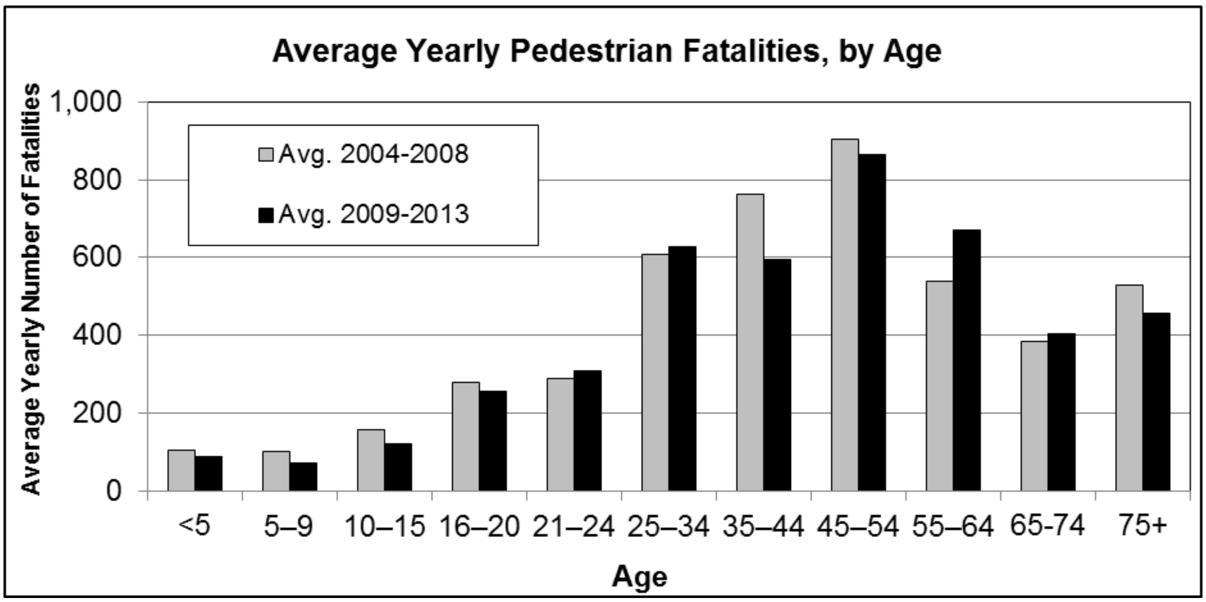
- Children 14 and younger accounted for 5% of the pedestrian fatalities and an estimated 15% of all pedestrians injured in traffic crashes;
- 19% of those killed were adults 65 and older, including 284 pedestrians 80 years and older;
- 69% of those killed were males;
- 34% of pedestrians fatally injured had BACs of .08 g/dL or greater;
- 73% of pedestrian fatalities occurred in urban areas;
- 69% of pedestrian fatalities occurred at non-intersection locations; and
- 72% of pedestrians were killed in collisions that occurred when it was dark.

Crash Trends. Pedestrian fatalities have dropped gradually over the past 20 years, from an average of about 5,500 per year from 1994-1998, to an average of about 4,500 annually for the most recent five years (2009-2013, see figure below). The 4,735 pedestrians killed in 2013 was 2% lower than the number killed in 2012 (4,818). 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 1.5 per 100,000 population, with a rate of 2.1 for males and 0.9 for females (NHTSA, 2015b). However, population-based rates do not fully account for trends in amounts of walking.



Source: NHTSA (2014a, 2014b)

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 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 2013 in NHTSA's Traffic Safety Facts reports, NHTSA, 2014a). Differences in amounts or types of walking may also play a role, as may other safety factors and chance variation.



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 2009 – 2013 to those from 2003 – 2007, pedestrian fatalities decreased among children 15 and younger, and among young adults 16 to 20 years (see figure). For those 35 to 44, a notable decrease in pedestrian fatalities was observed from around 760 per year to 600 per year. Decreases for this age group were also observed among bicyclist fatalities. Unlike among bicyclists, however, there was also a slight decline in fatalities among pedestrians 45 to 54. The only age group to observe a large increase in total number of fatalities was among those 55 to 64, which as noted earlier may reflect an increase in population and walking among this age group. Fatalities went down among those 75 and older; however, pedestrians 75 and older had the highest fatality *rate* per population of any age group in 2013 (2.4 per 100,000 persons compared to 1.5 for all ages; NHTSA 2014b). Older pedestrians 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 oncoming vehicle speeds, dealing with turning vehicles at intersections, and possible confusion about pedestrian signal phases (Karsch, Hedlund, Tison, & Leaf, 2012).

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, there is little information as yet about pedestrian safety programs targeted to the specific needs of low-income, minority, or immigrant populations, so the effectiveness of countermeasures in reaching these special populations is unknown. NHTSA introduced an English as a Second Language program tailored to teach basic walking and bicycling safety concepts to adult immigrants learning the English language (see www.nhtsa.gov/ESL). NHTSA is in the process of evaluating whether the program increases pedestrian and bicycle safety knowledge and intent to change behavior. In addition, the updated *Resident’s Guide for Creating Safer Communities for Walking and Biking* includes several case studies on inclusive approaches to outreach, community-based planning, and improving conditions for pedestrians (Sandt, Thomas, Langford, & Nabors, 2015).

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 increased 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 are 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 next NHTS is planned for 2015.

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 Center 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 between 2001 and 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 through implementing Complete Streets policies and designs, lower speed limits in urban areas, and other strategies. 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.

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.walkinginfo.org/pc/types.cfm). Of these pedestrian crashes:

- The largest major grouping was crashes at or within 50 feet of an intersection, accounting for 32% of all crashes. Of these intersection crashes, 30% involved a turning vehicle, 22% involved a pedestrian dashing into the intersection, and 16% involved a driver violation (e.g., running a red light). Older pedestrians were overrepresented in collisions with turning vehicles and motorist violations, while children were overrepresented in intersection dashes.
- The second major grouping was crashes occurring in the middle of a block, accounting for 26%. In one-third of these, the pedestrian ran into the street and the driver's view was not obscured; one-sixth 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 at midblock locations.
- Only 7% of the crashes involved a pedestrian walking along a roadway not on a sidewalk. In three-quarters of these crashes, the pedestrian was struck from behind while walking in the same direction as traffic. Darkness and rural locations were overrepresented in these types of collisions. This association is expected since rural areas are less likely to have sidewalks and supplemental street lighting.

Crash typing methodology has been used to develop a tool that communities or States may use to develop more information about pedestrian and bicycle crashes. The Pedestrian and Bicycle Crash Analysis Tool (PBCAT) software assists jurisdictions in typing pedestrian crashes and developing a database for analyzing pedestrian crash problems. States and communities can utilize the crash type information and other crash characteristics to help select appropriate countermeasures. It is important that field review of behaviors and site-specific characteristics be taken into consideration before determining whether specific enforcement, educational, or engineering countermeasures are appropriate (Zegeer, Sandt, & Scully, 2008). PBCAT may be downloaded from www.walkinginfo.org/facts/pbcat/index.cfm. Registration is requested for this free software so the user may receive software updates or important technical information.

Another consideration when analyzing crash data is that pedestrian 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 rights-of-way 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 health care 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 injuries, including those due to falls, collisions with bicycles, and others, likely go unreported to State crash databases (Stutts & Hunter, 1999a, 1999b), but up-to-date information is lacking. Research is also needed to better understand the causes of these types of injuries. Maintenance of surfaces and *Americans with Disabilities Act* (*ADA*) 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.

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), vehicle type and design, pedestrian and vehicle volumes/exposure, and elements of the built environment (including roadway design, presence of pedestrian facilities, and street-crossing facilities) 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). Enacting and implementing Complete Streets policies has been identified as one of the more low-cost and impactful countermeasures, as evidenced by numerous cities and States across the United States. For more on Complete Streets, visit www.smartgrowthamerica.org/complete-streets/. Also, search for a program in your State or city.

Recent 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 recent 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).

As mentioned above, 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). Speed-related countermeasures are presented in Chapter 3.

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 blood alcohol contents of drivers and pedestrians involved in crashes. It has been estimated that alcohol use—by either the driver or pedestrian—is a contributing factor in 49% of pedestrian fatalities (NHTSA, 2015b). Alcohol-related countermeasures that may also help address certain pedestrian crashes are presented in Chapter 1.

Cell phone and electronic device use are a source of distraction, not only for motorists, but for pedestrians. Talking on cell phones is associated with cognitive distraction that may undermine pedestrian safety, 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). Tests of students performing street crossings in a virtual (simulated) environment suggest that accessing the internet with electronic devices, listening to music, or texting while walking alters pedestrian behavior. These behaviors may increase missed opportunities to cross safely and increase potential risks by reducing looking left and right before crossing, and increasing time that eyes are away from the street environment (Byington & Schwebel, 2013). Schwebel et al. (2012) found that listening to music and texting were associated with more "virtual" hits by cars than among those not distracted; however, the group using phones was not more likely to be hit than were undistracted pedestrians.

The conditions of virtual experiments may not, however, reflect real world use or behaviors. Results from real-world observational studies are somewhat mixed. For example, Walker et al. (2012) found that (apparent) use of portable music devices (earbuds/headphones on ears) did not result in differences among females in looking behavior or walking speed before actual road crossings on a college campus, whereas males using devices looked for traffic more frequently than those not using the devices. Thompson, Rivara, Ayyagari, and Ebel (2013) found that pedestrians at real street crossings were less likely to look both ways while texting, and to a lesser degree while listening to music, talking with others (present), or engaged in other activities (e.g. pushing a stroller). However, talking on a phone did not increase the odds of failing to look. Thompson et al. (2013) sampled 20 high risk intersections in Seattle at systematically selected intervals and observed that nearly 30% of all pedestrians were using a mobile phone, texting, or using a portable music device. When all measured pedestrian safety behaviors (looking for traffic, using the crosswalk, and crossing with the walk signal) were grouped into an "optimal" pedestrian crossing behavior, only text messaging and being female were negatively associated with optimal crossings, with those who were text messaging being nearly four times more likely to exhibit at least one unsafe behavior. Only 26% of all pedestrians exhibited optimal behavior. Finally, text messaging and phone use were associated with slower crossing speeds, whereas music devices were associated with faster speeds. Pedestrians estimated to be 65 and older also exhibited slower crossings compared to other ages, regardless of device use.

As pointed out by some of the above studies, the type and nature of risks and perceptions posed by different types of devices or activities may be different (Schwebel et al., 2012). For example, some studies have suggested that music is less cognitively distracting for pedestrians or drivers than, for example, internet use or texting, but may affect auditory perception of the environment and potential threats.

Several studies observed 7% to 30% of pedestrians using varying types of portable electronic devices. A study by Cooper et al. (2011), performed throughout several locations in the San Francisco Bay Area, reported that pedestrian cell phone or mobile device use was between 7% and 15%. Data collected at 10 of NYC's highest crash intersections in May-June, 2013, found 1 in 4 pedestrians were talking on a mobile phone or smartphone, wearing head-phones, looking down and/or interacting with a mobile phone or smartphone, or engaging in more than one of these three behaviors (Basch, Ethan, Rajan, & Basch, 2014). And, as mentioned above, nearly 30% of all pedestrians systematically observed at intersections in Seattle were using a mobile phone, texting, or using a portable music device (Thompson et al., 2013). Nationally-representative estimates are unavailable, but would likely only capture a snapshot in time, as device use continues to grow in popularity.

No comprehensive pedestrian crash database studies of pedestrian distraction have been identified, but Lichetenstein et al. (2012) searched the National Electronic Injury Surveillance System (NEISS), the United States Consumer Product Safety Commission, Google News Archives, and Westlaw Campus Research databases for pedestrian-vehicle crashes involving portable music devices that occurred from January 1, 2004 to June 1, 2011. Of 116 total cases identified, 52 fatal or injury crashes involved motor vehicles (or bicycles) and 64 involved collisions with trains. Across all 116 incidents, most (62 incidents) involved pedestrians aged 15 to 24. In addition, 34 (29%) of the reports specifically mentioned horns or sirens being sounded prior to the victim being hit. FARS/GES data on pedestrian device use or involvement in pedestrian crashes is unavailable at the national level. For this update, no evaluations of countermeasures to address this issue have been identified. While numerous cities and States have passed driver cell phone/texting bans, at least a couple of cities (Rexburg, ID, and Fort Lee, NJ) have passed laws banning texting while walking; others are considering such a measure. Similarly, while a few communities have made efforts to educate pedestrians on the distraction issue (such as Philadelphia's "distracted pedestrian" lane: www.npr.org/2012/04/02/149829299/philadelphia-texting-while-walking-is-no-joke), we are unaware of any that have been formally evaluated by the time of this update.

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.

Basic countermeasure principles include:

- Reducing vehicle speed, which allows pedestrians and drivers more time to react and reduces impact forces if crashes do occur;
- Reducing exposure to known risky situations through behavioral and environmental countermeasures (without necessarily discouraging walking); and
- Increasing enforcement of pedestrian-friendly laws.

Countermeasures need to be tailored to diverse populations, including groups such as recent immigrants who may not be familiar with U.S. traffic laws, the U.S. traffic environment, or may not speak or read English. In addition, countermeasures should also address particular problems identified within communities or common to a target group, such as older adults or children of varying ages.

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 recently released a national pedestrian safety action plan summary. The plan focuses significant attention on built environment research and countermeasures (U.S. DOT, 2014). Key infrastructure resources are also included in the Resources section below.

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.

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. 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, individual risk of crashes with motor vehicles (crash rate) is lower as numbers of bicyclists and pedestrians 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 many European countries have adopted a toward zero deaths safety philosophy.

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 of 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). 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/Pedestrians
    - Research and Evaluation - www.nhtsa.gov/Driving+Safety/Research+&+Evaluation
    - Behavioral Safety Research Reports - ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Federal Highway Administration: www.fhwa.dot.gov/
    - Office of Planning, Environment, & Realty (Pedestrian and Bicycle Program) - www.fhwa.dot.gov/planning/processes/pedestrian_bicycle/

  - Safety Office, Pedestrian and Bicycle Safety - safety.fhwa.dot.gov/ped_bike/ped_focus/
  - 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/
- Pedestrian and Bicycle Information Center: www.pedbikeinfo.org
- 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
- Alliance for Walking and Biking: www.walkbikealliance.org
- Association of Pedestrian and Bicycle Professionals: www.apbp.org

Several specific resources that provide further information on engineering, enforcement, and educational strategies are:

- Child Pedestrian Safety Curriculum (NHTSA, 2011): www.nhtsa.gov/ChildPedestrianSafetyCurriculum
- Pedestrian Safer Journey: Skills for Safe Walking for Ages 5 to 18 www.pedbikeinfo.org/pedsaferjourney/
- Everyone is a Pedestrian on-line resource: www.nhtsa.gov/everyoneisapedestrian
- Uniform Guidelines for State Highway Safety Programs: Highway Safety Program Guideline No. 14: Pedestrian and Bicycle Safety: www.nhtsa.gov/nhtsa/whatsup/tea21/tea21programs/pages/PedBikeSafety.htm
- How to Develop a Pedestrian Safety Action Plan (FHWA & NHTSA, 2006): http://drusilla.hsrc.unc.edu/cms/downloads/howtoguide2006.pdf
- Pedestrian Safety Training for Law Enforcement (NHTSA, 2011): http://mcs.nhtsa.gov/index.cfm/product/786/nhtsa-pedestrian-safety-training-for-law-enforcement-cd-rom.cfm
- 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): http://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: http://katana.hsrc.unc.edu/cms/downloads/PBSPolicReview.pdf
- AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities: https://bookstore.transportation.org/item_details.aspx?id=119
- NCHRP Report 500 Guide for Reducing Collisions Involving Pedestrians (National

Cooperative Highway Research Program, 2004): onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_500v10.pdf

Resources released or updated since the last *Countermeasures That Work* update:

- National Center for Safe Routes to School. Enforcement: Role for Law Enforcement in SRTS - www.saferoutesinfo.org/program-tools/enforcement-role-law-enforcement-srts
- NHTSA, 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 - http://safety.fhwa.dot.gov/road_diets/info_guide/rdig.pdf
- FHWA, 2015: A Resident’s Guide for Creating Safer Communities for Walking and Biking - update to be released in early 2015.
- 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
- U.S. DOT website: Everyone is a Pedestrian – www.nhtsa.gov/nhtsa/everyoneisapedestrian/index.html
- World Health Organization, 2013: Pedestrian safety: a road safety manual for decision-makers and practitioners – http://apps.who.int/iris/bitstream/10665/79753/1/9789241505352_eng.pdf?ua=1

Countermeasures That Work

Countermeasures to improve pedestrian safety are listed below and discussed individually in the remainder of this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The symbols and terms used are described below. 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 on each item.

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 (SRTS)	★★	$	High	Short
2.3 Child school bus training	★★	$	High	Short

3. Impaired Pedestrians

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Communications and outreach	★★	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	★★★★	$$$	Low	Medium
4.2 Reduce and enforce speed limits	★★★	$	High	Varies
4.3 Conspicuity enhancement	★★★	$	Low	Medium
4.4 Targeted enforcement	★★★	$$	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 one year
Medium: more than three months but less than one year
Short: three 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

Young children have limited abilities to perceive, understand, and react appropriately to traffic hazards. 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 outcome 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, 2014b). 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, 2014b). 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 primary role models and trainers 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).

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.

One online game for parents and young children (Otto the Auto, from the California State Automobile Association) can be found at www.ottoclub.org. For a British traffic club source, see The Children's Traffic Club, www.childrenstrafficclub.com.

Use: The extent of use of child safety clubs in the United States is unknown.

Effectiveness: Safety clubs are one way to promote understanding and to teach a specific set of appropriate behaviors for young pedestrians. 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 (SES) 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

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. 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. Most recently, NHTSA released *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 ages 4 and older. This resource can be found on the Safe Routes to School website (www.saferoutesinfo.org/sites/default/files/TeachingChildrentoWalkSafely.pdf). Another NHTSA publication includes *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/Pedestrians) as does Safe Kids Worldwide, which provides 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 individuals 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

2.1 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. 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. This video is available at www.youtube.com/watch?v=ATyNXDMvBuE. The Willy Whistle film is available for download at www.nhtsa.gov/people/injury/willie/video.html.

Additional curricula have been developed for rural pedestrian concerns (Cleven & Blomberg, 1994). Furthermore, WalkSafe, a program adapted from many of these 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 et al., 2008a).

In 2011, NHTSA produced a Child Pedestrian Safety Curriculum for elementary age students along with an instructor guide (www.nhtsa.gov/ChildPedestrianSafetyCurriculum). 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, along with caregiver tip sheets, skills practice exercises, and student tests to evaluate knowledge change. Although the curriculum was pilot tested in schools when it was developed, a formal evaluation is currently underway.

School-based programs are useful to teach basic pedestrian concepts and safe behaviors at schools, churches, 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 on-line, video-training resource, Pedestrian Safer Journey, developed for the Federal Highway Administration. This resource provides separate video-based training modules for child pedestrians ages 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 ages 4 and older. This resource can be found at www.saferoutesinfo.org/sites/default/files/TeachingChildrentoWalkSafely.pdf. Other resources and tips for educators, parents, drivers, children, and even neighbors are available at http://guide.saferoutesinfo.org/education/

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 (www.nhtsa.gov/Pedestrians). 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.

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 play-mat 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 can be ordered (in limited quantities), or 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 curriculum, and train teachers. As indicated by the above research, the training needs to be repeatedly implemented in order 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, 3-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 2004 to 2013, 1,344 people were killed in school-transportation-related crashes—an average of 134 fatalities per year (NHTSA, 2015a). Since 2004, 116 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 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 reduce or eliminate risky elements of the traffic environment around primary and secondary schools so children can safely bicycle or walk to school.

From 2005-2012, SAFETEA-LU legislation required each State to have its own SRTS program including a full-time coordinator to manage Federal funds. Each year, up to 70% (but not more than 90%) of available Federal funding was to be allocated on infrastructure (engineering) improvements, and up to 30% (but not less than 10%) of funding on non-infrastructure projects to encourage walking and bicycling to school (public awareness and outreach, enforcement near schools, education, and training for volunteers). Educational resources to support these efforts are available online from NHTSA on the pedestrian and bicycle safety page, and on the National Center for Safe Routes to School (NCSRTS) website (www.saferoutesinfo.org). NCSRTS provides information, guidance, and support for community, State, and national SRTS efforts. A list of current State SRTS coordinators and funding levels may also be found at the NCSRTS website. 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. As a result of MAP 21, funds are no longer provided directly to States to fund SRTS activities. SRTS projects have been eligible, since October 2012, to compete for funding alongside other pedestrian and bicycle-related programs, including former Transportation Enhancements and Recreational Trails projects, as part of a new program called Transportation Alternatives, but States may determine funding priorities. Many States and localities continue SRTS safety efforts involving education, enforcement, and infrastructure; create or enhance partnerships; and develop creative approaches to continue to engage communities in SRTS. 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 initiated SRTS programs. According to the National Center for SRTS (NCSRTS) website, most State SRTS programs are in the process of determining how to handle MAP-21 legislation. Visit the websites above for details.

Effectiveness: SRTS efforts including education materials 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. SRTS programs also can be an effective means to increase knowledge and practice of safe behaviors among children and parents walking to school and driving around children (see Section 2.1 on Elementary-Age Child Pedestrian Training), improve traffic law enforcement (see Sections 4.2 and 4.4), and other safety efforts. It has not been possible to clearly demonstrate SRTS program effects on preventing crashes and injuries (Dumbaugh & Frank, 2007). 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). 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 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 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 walks to school under the supervision of adults. The program has been found 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. The National Center for Safe Routes to School has 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 http://apps.saferoutesinfo.org/training/walking_school_bus/.

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 (http://saferoutesinfo.org/program-tools/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 (http://saferoutesinfo.org/funding-portal). 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.

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. According to NHTSA, 116 school-aged pedestrians 18 and younger died in school-transportation-related crashes from 2004-2013 (NHTSA, 2015a). These fatalities represent 9% of all school-transportation-related fatalities, most of which (71%) involved occupants of non-school-bus vehicles. Of the 116 school-aged pedestrian fatalities, 67% were struck by school buses or vehicles functioning as school buses, and 33% by other vehicles (passenger cars, etc.). In 2013, 22 pedestrians of all ages were killed in school-bus-related crashes. Of those, 16 were struck by buses, and nine were struck by other vehicles (NHTSA, 2015a).

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 (http://guide.saferoutesinfo.org/education/index.cfm). NHTSA also has a refresher training module for school bus drivers (see www.nhtsa.gov/Driving+Safety/School+Buses/School+Bus+Driver+Training).

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 Impaired Pedestrians: Communications and Outreach

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

In 2013, 34% of all fatally injured pedestrians had BACs of .08 g/dL or higher, and 38% of all fatally injured pedestrians had positive BACs (NHTSA, 2015b).

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 very difficult audience for communications and outreach to have a meaningful effect on their behavior. 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 30-59 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

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.

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 individuals 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

4.1 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 high senior 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).

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).

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 (which may include road diets, traffic calming, and roundabouts), and by 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 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 speed-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 effectsand FHWA's new *Road Diet Informational Guide*, http://safety.fhwa.dot.gov/road_diets/info_guide/rdig.pdf.)

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. Just changing speed limits is of limited, though positive, effectiveness as described above.

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.

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 and when 72% of pedestrian fatalities occur nationally (NHTSA, 2015b). 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. Light-colored clothing, long a recommended solution, does little to improve conspicuity (NCHRP, 2004, Strategy B5). 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.

More than 15% of pedestrian fatalities in 2012 involved pedestrians who were not visible – dark clothing, no lighting, etc. (NHTSA, 2014a, 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/ChildPedestrianSafetyCurriculum.) 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.

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), can be detected hundreds of feet farther than can pedestrians in normal clothing, even with low-beam illumination (Karsh, Hedlund, Tyson & Leaf, 2012; NCHRP, 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 Targeted Enforcement

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

The purpose of targeted enforcement is to increase compliance with appropriate traffic laws by both pedestrians and motorists. Behavioral pedestrian safety initiatives require improvements in unsafe driver or 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. Although enforcement was implied or stated for many of the earlier countermeasures, targeted enforcement deserves additional discussion here.

Traffic enforcement is most effective when it is highly visible and publicized, to reinforce the message of 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.

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 goals and procedures, and educating prosecutors and judges so they understand the purposes of the campaign and are prepared for the increase in citations enforcement will produce. 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 has developed a training course aimed at teaching law enforcement personnel the basics of pedestrian safety and targeted enforcement techniques: http://mcs.nhtsa.gov/index.cfm/product/786/nhtsa-pedestrian-safety-training-for-law- enforcement-cd-rom.cfm. An additional resource for law enforcement is a guide to pedestrian safety enforcement operations which was released in early 2015: www.nhtsa.gov/staticfiles/nti/pdf/812059-PedestrianSafetyEnforceOpera HowToGuide.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: Targeted enforcement can be employed for a wide range of purposes in a wide range of circumstances, so effectiveness is context-dependent. In Queens, New York, enforcement was a key part of a campaign that included minor engineering adjustments and communications and outreach and reduced pedestrian fatalities (CDC, 1989). In Seattle, a variety of communications and outreach and enforcement combinations were tested in conjunction with a change in the law for drivers to yield to pedestrians at crosswalks; the authors concluded that enforcement was not successful in increasing driver yielding (Britt et al., 1995). 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 one 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). Maintenance effects of this effort are being conducted. 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 have not yet been documented.

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.

Time to implement: Short. Law enforcement resources can be diverted to targeted enforcement very quickly. Support equipment can take longer to acquire and deploy, as can developing a plan that coordinates law changes, environmental changes, or support communications and outreach with enforcement activities. 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 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 and more specific information on the status of the pedestrian in the traffic environment, right of way requirements for driver and pedestrian, 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 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" 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).

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 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.

Costs: 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

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).

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 age 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: $, varies	Use: High	Time: Medium

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 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. 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.

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 cyclists) 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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9. Bicycles

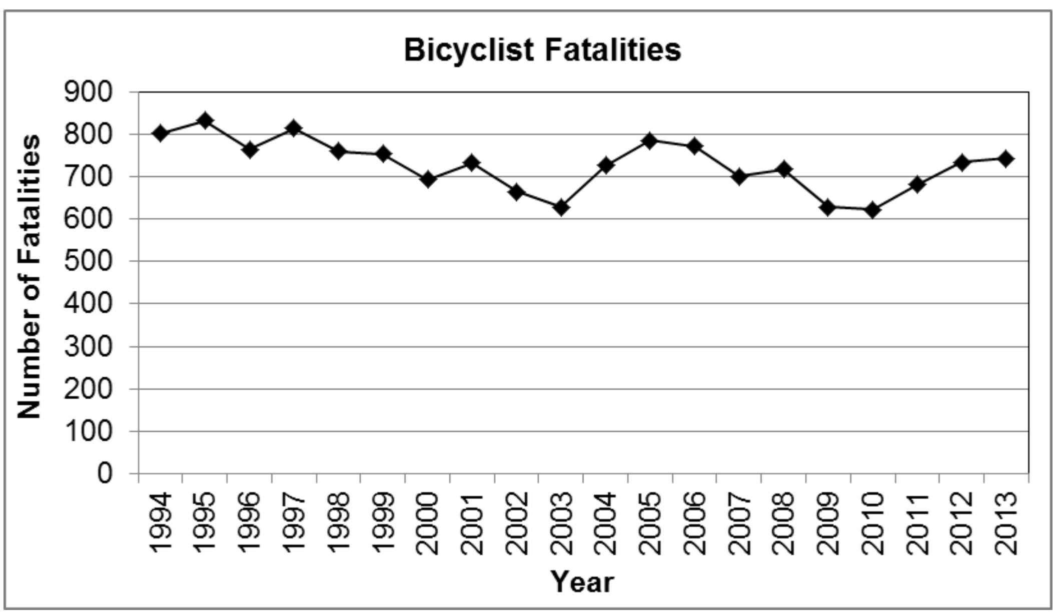
Overview

In 2013, 743 bicyclists died in traffic crashes nationwide, the highest number killed since 2006. In addition, approximately 48,000 bicyclists were injured. Bicyclists accounted for 2% of total traffic fatalities and 2% of total injuries (NCSA, 2015). Of the bicyclist fatalities during 2013 (NCSA, 2015):

- Children 14 and younger represented 7% of bicycle fatalities and 11% of injuries;
- Cyclists ages 25 to 64 represented 64% of all bicycle fatalities;
- 87% of the bicyclists killed and 83% of those injured were male;
- About 20% of bicyclists killed had BACs of .08 g/dL or higher, with alcohol use by either bicyclist, driver, or both reported in more than 29% of fatal crashes.

The majority of bicyclist fatalities occurred in urban areas (68% in 2013), and at non-intersection locations (57% in 2013). The number killed of bicyclists in urban areas has remained relatively stable over recent years.

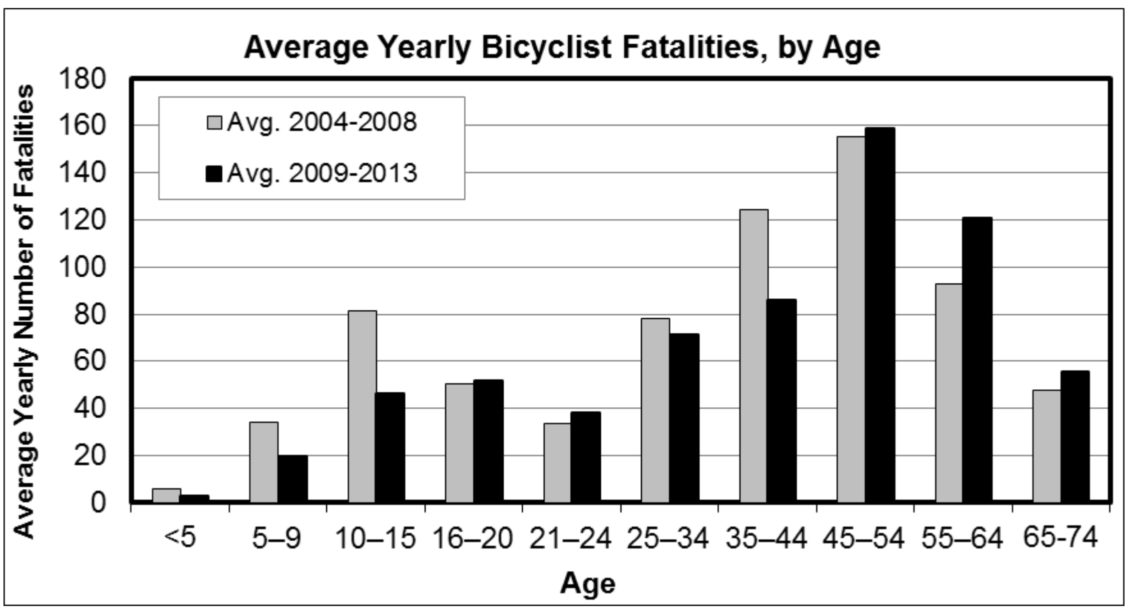
Crash Trends. Bicyclist fatalities have increased each of the last three years. The recent uptick in fatalities may reflect increases in riding. (See trends in riding below.) There are, however, substantial fluctuations in fatalities year-to-year that may not be explained only by exposure. Longer term, the trend in bicyclist fatalities is down. Compared to the five year period from 1994 to 1998 (an average of 795 fatalities), the average number of bicyclist fatalities over the most recent five year period was 14% lower (682 per year from 2009 to 2013).



Source: FARS data, NCSA (2015)

A recent 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. 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 (Hamann et al., 2013). 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 39 in 2004 to 41 in 2013 (NCSA, 2015). Comparing the five year period from 2009 to 2013 with the period from 2004 to 2008, fatalities increased most among bicyclists ages 45 and older, particularly those 55 to 64 (32% 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 40% for bicyclists under 16 years of age and among those aged 35 to 44 over this period.



Source: FARS data
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. Recent 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).

Estimates from the American Community Survey (ACS) 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), though 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). Results from the latest NHTS, conducted in April 2008 through May 2009, indicate that trips made by bicycle have again increased, up to 4.1 billion per year (Pucher, Buehler, Merom, & Bauman, 2011). The next NHTS is planned for 2015.

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, as well as the skill, knowledge and application of safe behaviors by the cyclist and the drivers around him or her. The risk of a crash may also be increased due to inattention, distraction, or impairment by either the bicyclist or driver. The severity of a crash also increases with higher impact speeds (AASHTO, 2010). 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 these 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 over-represented when the bicyclist failed to yield at an intersection and adult bicyclists were overrepresented in crashes at intersections where motorists turned across their path.
- Twenty-two percent of bicycle-motor vehicle crashes occurred at junctions with commercial and private driveways or alleys. Children were highly overrepresented in these crashes.
- Twenty-seven percent of bicycle-motor vehicle crashes 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.

In the Hunter et al. (1996) study, bicyclist factors contributing to crashes, especially at intersections or other junctions, included bicyclists riding wrong-way. Thirty-two percent of all bicyclists in the study were riding against traffic; for intersection collisions, the proportion was 42%. In 15% of crashes, bicyclist riding wrong-way was coded as a contributing factor to the crash (Hunter et al., 1996). Bicyclist failure to yield was coded in 21% of the study crashes and stop sign violations were coded in 8%. 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. The most common driver contributing factor was a yield violation at either an intersection or midblock location; however, as mentioned the bicyclist riding 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.

Bicyclist attributes: 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, are usually purchased without head lights and rear active lights attached, and 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/.) More recent 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.

Strategies to Reduce Bicycle Crashes and Injuries

Several strategies may be used to decrease bicycle crashes and injuries.

- Increase the use of properly fitted bicycle helmets by all bicyclists, including children and adults, and the enforcement of helmet laws to increase compliance.
- Increase the conspicuity of bicyclists.
- 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 target any type of impaired roadway use.
- Enact laws to facilitate safe, predictable, and efficient bicycling in traffic, to update and fill gaps in existing laws. Educate the public on any new laws.
- 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 decrease speeding, cutting off bicyclists, passing too closely, or blocking or driving in a designated bicycle lane by motorists.
- Educate motorists and bicyclists on how they should interact safely with each other and what the relevant laws require.
- 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, or may not speak or read English.

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.

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 (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.

- National Highway Traffic Safety Administration:
  - Bicycles - www.nhtsa.gov/Bicycles
  - Research and Evaluation - www.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: safety.fhwa.dot.gov/ped_bike/
- Centers for Disease Control and Prevention: www.cdc.gov/
- Pedestrian and Bicycle Information Center: www.pedbikeinfo.org/
- National Center for Safe Routes to School: www.saferoutesinfo.org
- 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
- League of American Bicyclists: www.bikeleague.org
- Alliance for Walking and Bicycling: www.bikewalkalliance.org

Specific resources that provide further information on engineering, enforcement, and educational strategies are:

- 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: katana.hsrc.unc.edu/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* (NCHRP, 2008). onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v18.pdf

Resources released or updated since the prior edition:

- Bicycle Safer Journey: Skills for Safe Bicycling for Ages 5 to 18. www.pedbikeinfo.org/bicyclesaferjourney/
- BIKESAFE: Bicycle Countermeasure Selection System. www.pedbikesafe.org/BIKESAFE/
- National Center for Safe Routes to School (SRTS), Enforcement: Role for Law Enforcement in SRTS. www.saferoutesinfo.org/program-tools/enforcement-role-law-enforcement-srts
- A Resident’s Guide for Creating a Safer Communities for Walking and Biking. www.safety.fhwa.dot.gov/ped_bike/ped_cmnity/ped_walkguide/index.cfm

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).

Countermeasures That Work

Countermeasures to improve bicycle safety are listed below and discussed individually in the remainder of this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The symbols and terms used are described below. 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 on each item.

All States are required by Congress and FHWA to have a full-time Pedestrian and Bicyclist Coordinator in their Department of Transportation. The coordinator will be aware of active programs within the State and will have access to resources for implementing many of the countermeasures listed below.

1. Children

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Bicycle helmet laws for children	★★★★★	$$	Medium	Short
1.2 Safe Routes to School (SRTS)	★★	$	High	Short
1.3 Bicycle safety education for children	★★	$	Unknown	Short
1.4 Cycling skills clinics, bike fairs, bike rodeos	★	$	Unknown	Short

2. Adult Bicyclists

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 one year
Medium: more than three months but less than one year
Short: three 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. 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), and Rodgers (2002). 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 July 2012, 22 States, the District of Columbia, and at least 201 municipalities or counties have child helmet laws (BHSI, 2014). 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 individuals 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.

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). Wesson et al. (2008) examined before and after trends in child and adult fatalities in Ontario, Canada following implementation of a law requiring helmets for riders under 18 years old. A reduction was found in child fatalities but not in adult bicycle-related deaths. Supporting data from one community suggested that the declines were not due to decreases in child bicycling. The authors attributed the lower child mortality rates to multiple factors including education, promotion, and general trends.

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. 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 that 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 (SRTS) Programs is to increase the amount of bicycling and walking 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 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 (NCSRTS) website (www.saferoutesinfo.org/program-tools/enforcement-role-law-enforcement-srts).

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, up to 70% (but not more than 90%) of available Federal funding was to be allocated on infrastructure (engineering) improvements, and up to 30% (but not less than 10%) of funding on non-infrastructure projects to encourage walking and bicycling to school (public awareness and outreach, enforcement near schools, education, and training for volunteers). Resources to support these efforts are available online from NHTSA on the pedestrian safety and bicycle safety pages and the NCSRTS website (www.saferoutesinfo.org). NCSRTS provides information, guidance, and support for community, State, and national SRTS efforts. A list of current State SRTS Coordinators may also be found at the NCSRTS website. 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. As a result of MAP-21, funds are no longer provided directly to States to fund SRTS activities. SRTS projects have instead been eligible, since October 2012, to compete for funding under a new program called Transportation Alternatives, alongside other pedestrian and bicycle-related programs including former Transportation Enhancements and Recreational Trails projects. Despite the altered funding structure, many States and localities pursue non-infrastructure programs, create or enhance partnerships, and develop creative approaches to engage communities in SRTS. 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 had initiated SRTS programs. At the time of this report publication, the details of how MAP-21 will affect State SRTS programs were being determined. Visit the website above for details and to find State contacts.

Effectiveness: SRTS materials can be effective in teaching children and their parents how to assess and choose the safest routes for walking or bicycling to and from school. The material is derived from analyses of types of crashes associated with trips to and from school, but it has not been possible to directly evaluate effects of these programs on crashes and injuries. 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). Dumbaugh and Frank (2007) found that many of the safety benefits associated with SRTS countermeasures are assumed rather than known.

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 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 limit risk-taking behaviors. They are also less skilled at riding than older children or adults. Young children should not ride without supervision until they are at least 10 years old and 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. 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 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 on 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 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, a helmet effectiveness demonstration, and an emphasis on 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 (Twisk et al., 2013).

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, a curriculum specifically designed for professional physical education teachers and recreation specialists is suited for middle to high school students of vary abilities and with special needs (AAHPERD, 2014).

A listing of many training programs and their characteristics can be found in the FHWA Bicycle Safety Education Resource Center, available on the PBIC website: www.pedbikeinfo.org/data/library/details.cfm?id=2800. See also the *Good Practices Guide for Bicycle Safety Education* (FHWA, 2005) and the *Bicycle and Pedestrian Curricula Guide* (Safe Routes to School, 2011). NHTSA has also produced publications on how to properly fit a bicycle helmet, rules of the road and games to educate children and parents on bicycle safety. The material is available in English and Spanish on NHTSA's Bicycles page. Bicycle Safer Journey is an updated series of web-based training videos and discussion guides targeted for bicyclists ages 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. 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, OR, and the Hawaii Bicycling League (Thomas, Masten, & Stutts, 2005). The prevalence of community-based programs is also unknown.

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 months 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 eligible. 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 National Center for Safe Routes to School website (http://saferoutesinfo.org/program-tools/find-state-contacts) or search individual States' DOT websites for information about TAP and SRTS funding. Other funding sources may also be identified through the SRTS Funding Portal web page (http://saferoutesinfo.org/funding-portal). 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

The purpose of cycling skills clinics, bike fairs, or bike rodeos is to teach children about traffic laws that apply to them 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. 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.

There are a number of bicycle safety courses and models for fairs, rodeos, and clinics. Examples include NHTSA (2011), Washington Area Bicyclist Association (undated), Chaplin (2005), Minnesota Safety Council (undated), and Williams and Burden (1994). In addition, the League of American Bicyclists has numerous League Certified Instructors across the country that can teach a variety of classroom-based and on-bicycle courses and new youth instructor training for those wishing to be certified to provide cycling skills clinics.

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.

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.

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

2.1 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 recent 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 recent 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 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 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 should fit properly, be worn properly, and be worn every time. NHTSA (www.nhtsa.gov/Bicycles) and the League of American Bicyclists (http://bikeleague.org/content/smart-cycling-tips-0), 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 as 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.

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. 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 (www.nhtsa.gov/Driving+Safety/Bicycles/Be+a+Roll+Model).

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

3.1 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 (NCHRP, 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 Consumer Product Safety Commission 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 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 (NCHRP, 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. Efforts to increase enforcement of laws requiring use of lights is needed to maximize use (NCHRP, vol. 18, 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.

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 (NCHRP, 2004, Strategy B5; NCHRP, 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. NCHRP (2008) suggests 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.

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 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, 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 inlude adults requires as well because crashes are not limited ot just children ot 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 years 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 individuals), 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

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 enforcement, may help to 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.)

The SHSO can help ensure correct riding through communications and outreach campaigns and through training law enforcement officers about the laws, the safety benefits of obeying the laws, and how to enforce bicycle safety-related laws. 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, 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. 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): www.nhtsa.gov/Driving+Safety/Bicycles/Enhancing+Bicycle+Safety:+Law+Enforcement's+Role
- Pedestrian and Bicycle Information Center: www.pedbikeinfo.org/programs/enforcement.cfm
- Safe Routes to School's *Enforcement: Role for Law Enforcement in SRTS*: www.saferoutesinfo.org/program-tools/enforcement-role-law-enforcement-srts

These products can satisfy the needs of departments regardless of how they choose to emphasize bicycle safety. Additional training for prosecutors and judges is critical as well so that there is appropriate follow-up for citations throughout the judicial system. Educational diversion programs are an alternative to other penalties, 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. 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, enabling 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. The CD-ROM training can be taken by officers on their work or personal computer. It has been designed to allow them eligibility for in-service training hours. The longer in-person courses take officers away from their regular duties or require overtime commitment and may incur a financial cost, making the on-line courses a cost effective option. Many States or localities are developing their own training to reflect State and local laws. In-person courses may be an added value if they include observations of bicycle-motorist interactions, on-bicycle experience, and/or training of bicycle safety enforcement operation. SHSOs may be able to provide funding for departments to participate in longer training courses. 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

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 August 2014, 25 States are known to have enacted bicyclist passing laws requiring drivers to leave a space of more than three feet (National Conference of State Legislatures, 2014). Nineteen 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.

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

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 could and are being used to increase the emphasis on safe driving around bicyclists. 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 (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 materials such as those 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

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.

Use: Unknown.

Effectiveness: Share the Road awareness materials can be effective in increasing knowledge and appropriate attitudes, but as with other awareness programs, there is no evidence of behavior change or reductions in crashes.

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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