

Preventing Traffic Injuries: Strategies That Work

David A. Sleet, Ph.D.

Ann Dellinger, Ph.D.

Division of Unintentional Injury Prevention
National Center for Injury Prevention and Control
Centers for Disease Control and Prevention
4770 Buford Highway, NE, F-62, Atlanta, GA 30341 USA
Email DSleet@cdc.gov 770-488-4699

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Abstract

Motor vehicle crashes result in more than 40,000 deaths and 4.3 million nonfatal injuries annually in the US. There are many known effective strategies to address these preventable deaths and injuries that are closely related to lifestyle factors. Public health can play a large part in supporting effective interventions in their practice; for example, by counseling patients about seat belt use. Public health can also have an impact in their community by supporting positive public policy change.

Magnitude of the Problem

Motor vehicle-related deaths and injuries take a heavy toll on the health care system in the United States. Motor vehicle crashes result in more than 40,000 deaths and it has been estimated that 4.3 million people sought medical care in a hospital emergency department for non-fatal motor vehicle-related injury in 2006. Injuries are the leading cause of death for children, youth, and young adults in America.¹

Motor vehicle occupants (drivers and passengers) represent the majority of motor vehicle-related deaths. Males have occupant death rates twice as high as females (8.2 vs. 4.1 per 100,000). The age distribution of occupant deaths is low among children too young to drive, highest in teenagers and young adults ages 15-24, and low again among persons in their 50's. Older adults are particularly vulnerable to death in a motor vehicle crash given their physical frailty.²

There are also racial and ethnic differences in motor vehicle-related death. Generally, Native American and Alaska Native populations have the highest death rates while Asian and Pacific Islander populations have the lowest; African American and white populations have similar death rates.¹ However, when adjusting for time on the road, or vehicle miles traveled, vehicle occupants who are African American and Hispanic have higher death rates than whites.³

Traffic Injuries and Lifestyle

America is a nation of drivers--driving is a part of the American lifestyle. We accept the risk motor vehicle travel poses as the price we pay for ease of travel, yet we also contribute to risks by the choices we make behind the wheel: we speed, drive aggressively, use cell phones and hand held communication devices; drive while fatigued and after drinking alcohol; we don't use seat belts. Our lifestyle also involves the type of vehicles we buy and drive; the choices we make about using public transport or bicycling and walking; how often and how far we travel; and our reluctance to address unsafe transportation infrastructure and vehicle safety issues.

The motor vehicle dominates all other modes of travel in the United States and also accounts for 95% of all transportation-related deaths.⁴ In the span of 100+ years, the number of registered automobiles in the United States grew from 8,000 in 1900 to 252 million in 2006, while the number of licensed drivers grew to nearly 203 million.⁵ The number of annual vehicle miles traveled (VMT) has reached 2.9 trillion.⁶ This remarkable expansion has brought a growing safety problem. However, despite the rapid growth in vehicles and VMT the deaths per 100 million VMT have declined by over 90% since 1925 in the United States—this is primarily due to advances in the safety of vehicles, roads and driver behavior⁷ which have mitigated the negative effects of increased motorization, and therefore, contributed to safety. But there are limits to how much more safety gain can be made in the face of rising exposure.

The fundamental role of medicine and public health in traffic injury prevention has been in applying an epidemiologic framework to the causes and prevention motor vehicle crashes.⁸ The agent (i.e., the vehicle), the environment (i.e., the roadways) and the host (i.e. driver, occupant or pedestrian) are equally important when designing prevention efforts. Traditionally, public health and clinical medicine focus on host behaviors, such as using seat belts, and putting children in child safety seats.⁹ A more contemporary role of medical practitioners, however, has included not only educating individuals, but also advocacy efforts to change public policy and support legislative reform to prevent injuries.¹⁰

While this paper focuses primarily on strategies designed to modify host behaviors, it also includes information on vehicles and public policies (such as legislation and enforcement), that address other countermeasures. Most all strategies, however, are ultimately designed to change the behavior of drivers, passengers, or pedestrians. The reader can refer to Staunton, et al.¹¹ and Elvik & Vaa¹² for syntheses of interventions related to roads and the built environment, and the National Highway Traffic Safety Administration (NHTSA)¹³ for an analysis of the effects of vehicle-related interventions, including vehicle safety standards resulting in improvements in vehicle design. The intent here is to provide a practical review of interventions designed to reduce motor vehicle-related deaths and injuries that can be supported by clinicians, whether through patient education in clinical settings or by advocacy to support effective public policy.

Interventions have been sorted into categories by level of effectiveness, starting with interventions with the strong evidence of effectiveness, promising interventions, those with insufficient evidence, and those deemed harmful.

Strategies with strong evidence of effectiveness

Alcohol-Impaired Driving

In 2007, 32% of all traffic fatalities (around 13,000 deaths) involved a driver with a blood alcohol concentration (BAC) of 0.08 g/dL or higher, a level illegal in every state.¹⁴ Interventions to reduce alcohol-impaired driving include:

Zero tolerance laws. These laws make it illegal for persons under age 21 to drive after any drinking, but the threshold is usually set at 0.02 g/dL BAC. These laws have been associated with declines in alcohol-related deaths.¹⁵⁻¹⁶ Voas, Tippetts and Fell found declines from 19-24% in underage drinking drivers in fatal crashes.¹⁷ All states have passed zero tolerance laws for young drivers.

Minimum Legal Drinking Age Laws. Minimum legal drinking age (MLDA) laws are effective in reducing alcohol-related crashes and injuries.¹⁶ This type of law is especially important given the high crash and death rates of young drivers.¹⁷⁻²⁰ At the same blood alcohol level, crash risk is higher for young drivers than older drivers.²¹ All states have increased their MLDA to 21 years. NHTSA estimates more than 700 lives saved among 18-20 year olds in 2008 due to MLDA laws.²²

Sobriety checkpoints. Alcohol roadside checkpoints, whether randomly or selectively implemented, are an effective law enforcement intervention. Sobriety checkpoints are generally paired with media efforts to publicize the effort which helps to increase the perceived risk of arrest. Sobriety checkpoints have been shown to decrease fatal and non-fatal injury crashes.¹⁶

Lower BAC. Blood alcohol concentration (BAC) laws make it illegal "per se" to operate a motor vehicle at or above a specified BAC. Originally set at 0.10 or 0.15, these laws have had their limits lowered over time; 0.08 g/dL BAC laws have been found effective in reducing alcohol-impaired driving.^{15-16,20} As of 2004, all 50 states have passed 0.08 g/dL BAC laws that place the legal "per se" limit for driving after drinking (for adults) below 0.08 g/dL.

Mass media. Only the highest quality mass media campaigns have been found effective to deter drinking and driving. These campaigns are carefully planned, theory-based, well executed, and have high saturation among the target audience. The content commonly included themes related to the fear of arrest, the legal consequences of arrest, personal and social impact, fear of harm to self or others, and the social stigmatization of drinking drivers. They were also conducted in conjunction with other alcohol-impaired driving activities such as enhanced law enforcement.²³

Ignition interlocks. These devices prevent a drinking driver from starting the vehicle by requiring the driver to provide a breath sample before starting the vehicle. If the breath sample exceeds a specified blood alcohol content, the ignition is locked and the vehicle will not start. Reports that have combined data from multiple studies estimate that interlocks account for 65% reductions in driving while impaired DWI recidivism, a beneficial effect that is usually limited to the period of installment.²⁴⁻²⁵

Server intervention training. Server intervention and training programs are designed to prevent patron intoxication and alcohol-impaired driving by offering food with drinks, delaying service to rapid drinkers, and refusing service to intoxicated patrons. Evidence for effectiveness comes from studies of establishments that volunteered to participate in training servers; therefore, management support was well established, and server training was intensive, high-quality, and face-to-face (not video-training).¹⁶

Screening and brief intervention. Screening for heavy alcohol use and subsequent brief intervention has been found effective in emergency departments,²⁶ trauma centers,²⁷ and primary care settings.²⁸ A study by Fleming et al. found that two 15-minute sessions with a physician followed by two 5-minute telephone calls from an office nurse resulted in sustained effects. The

treatment group had significant reductions in 7-day alcohol use, number of binge drinking episodes, and frequency of excessive drinking compared to controls. In addition, the treatment group had fewer days of hospitalization and fewer emergency department visits. The largest cost benefit was due to fewer motor vehicle-related events.²⁸ These results indicate that a modest investment in time and resources can have a clinically important effect that is maintained over several years.

Occupant Protection

Occupant restraints, including child safety seats (CSS), lap and shoulder belts, booster seats, and supplemental restraints such as air bags, are among the most effective injury prevention interventions available. All states require children to be restrained, although the specifics of coverage vary.²⁹ CSS are 71% effective in reducing fatalities among infants and 54% effective among toddlers. An estimated 358 children under 5 years were saved in 2007 by CSS.³⁰ Booster seats are 59% more effective than adult belts alone in reducing injury in age-appropriate children.³¹ Interventions to increase occupant protection include:

Child safety seats. CSS use laws require children to be restrained in federally approved safety seats appropriate for the child's age and size. CSS use laws were found to decrease fatal and nonfatal injury, and to increase child safety seat use. Distribution of safety seats, plus CSS education programs, in combination, were found to decrease fatal and nonfatal injury, increase CSS use, and increase possession of CSS. Community-wide information plus enhanced enforcement campaigns were found to increase child safety seat use. Finally, incentive plus education programs (including rewards for either parents or children for correctly using CSS) have been shown to increase CSS use.³²⁻³³

Booster Seats. Booster seats are designed to raise a child so that the vehicle lap and shoulder belts fit properly. They are recommended for children who are 4 up to 8 years old or who weigh at least 40 pounds and are up to 4 feet 9 inches tall. NHTSA estimated that in 2008 only 43% of children aged 4 to 7 were using booster seats.³⁴ A systematic review of the impact of various legislative, educational, and promotional interventions among children aged 4-8 years found that interventions that combined education with distribution of booster seats or incentives such as discounted coupons had the greatest positive impact.³⁵

Seat Belts. Seat belts provide by far the greatest protection available to the driver and occupant. The National Occupant Protection Use Survey conducted in 2007 found belt use to be 82% nationwide. To date, 49 states, the District of Columbia, Puerto Rico, and all U.S. territories have adult seat belt use laws in place. Primary enforcement laws allow a law enforcement officer to stop a motorist based on a belt violation alone, while secondary enforcement laws require another reason to stop a motorist other than a seat belt infraction. Both primary and secondary enforcement laws are effective in increasing belt use and reducing fatal and nonfatal injury, with primary laws showing the greatest effectiveness.³⁶⁻³⁸ As of July, 2009, 19 states still do not have primary laws.³⁹ Enhanced enforcement programs of seat belt laws, through more officers on patrol, or by increasing the number of citations issued, are also effective in reducing fatal and nonfatal injuries, and increasing belt use.³⁶

Rear Seating Position. The number of children sitting in the front seat is declining; in 2008, the proportion of children riding in the front seat was 1% for infants, 2% for toddlers, and 12% for booster-age children.⁴⁰ Although the catalyst for moving children to the rear seat was the danger from passenger-side air bags, rear seating position is still the safest place for children whether or not there is a passenger-side air bag present.⁴¹⁻⁴³ A recent study found that children in

the rear row(s) of the vehicle were one half to two thirds as likely to sustain injury than those in the front.⁴⁴

Air Bags. Driver and passenger air bags are designed as supplemental restraint systems to be used in conjunction with belts, giving added protection in frontal crashes. Front airbags do not protect occupants in side, rear or rollover crashes or in low speed crashes. The effectiveness of air bags for reducing fatalities in frontal crashes is 14% when no seat belt is used and 11% when used in conjunction with a seat belt.⁴⁵ Seat belts plus an air bag provide about 55%-60% overall protection in a frontal crash.

Motorcycle Helmets

Motorcycle helmets are estimated to be 37% effective in preventing fatal injury to motorcyclists,⁴⁶ and 72% effective in reducing head injury.⁴⁷ Helmet use is especially important since, per vehicle mile traveled, motorcyclists are about 35 times more likely to die in a crash than passenger car occupants. Motorcycle helmet use laws are effective. In states with mandatory or universal (covers riders of all ages) helmet use laws, nearly 100% of motorcyclists wear them -- without a law, use is 50% or lower. In 2007, 20 states required helmet use by all operators and passengers. When helmet use laws are repealed, helmet use declines. An estimated 71% of motorcyclists wore helmets in 2000, compared with only 58% in 2007.⁴⁸

Bicycle helmets

Bicycle helmets are effective in preventing head injury, brain injury, facial injury and death.^{12,49-50} Interventions designed to increase bicycle helmet use generally target children and adolescents, as does legislation requiring helmet use. Legislation with supporting helmet promotional activities has successfully increased observed helmet use and reduced injury and death in the United States and abroad.⁵¹⁻⁵⁴ Community-based interventions that included free helmets and an educational component had the strongest evidence of effectiveness, along with school-based interventions and those that subsidized helmets.⁵⁵

Graduated Driver Licensing Systems

Motor vehicle crashes are the leading cause of death among teenagers in the United States. Graduated drivers licensing (GDL) systems address the high risks faced by new drivers by requiring an apprenticeship of planned and supervised practice (learners permit stage), followed by a provisional license that places temporary restrictions on unsupervised driving.⁵⁶ Two commonly imposed restrictions are limits on nighttime driving and passenger limits. These restrictions are lifted as new drivers gain experience and teenage drivers mature (full licensure). Although the specific requirements for advancing through the three stages of GDL vary across jurisdictions, they provide a protective environment while new drivers become more experienced. GDL has proven effective in reducing new driver crash risk.⁵⁷⁻⁶⁰ The most restrictive GDL policies were associated with a 38% reduction in fatal crashes among 16 year old drivers.⁶¹

Automated Enforcement: Speed Cameras

Speed affects both the likelihood of a crash and the severity of a crash. Crashes at higher speeds are more severe and, therefore, the risk of injury is greater. For vulnerable road users such as pedestrians and cyclists, this is especially problematic. Automated enforcement is one way to obviate conventional enforcement, which requires law enforcement officers to stop drivers and

issue citations and the likelihood of being caught speeding is relatively low. Two systematic reviews of the effectiveness of speed cameras have found decreases in both crashes and injuries.^{12,62}

Promising strategies

Parental Monitoring of Young Drivers

There are few studies of the effect of parental monitoring on young driver safety. Moreover, results have varied from indicating no effect to modest effects on risky driving behaviors.⁶³ However, parents are in a strong position to delay licensure, and to restrict driving under higher risk conditions such as nighttime driving and driving with teenage passengers⁶⁴⁻⁶⁵ whether or not these restrictions are part of their states' GDL law. Research has shown that teens whose parents set and maintain strict limits are less likely to engage in risky driving behaviors, have traffic violations, or to crash during the first year of licensure.⁶⁵

Strategies with insufficient evidence of effectiveness

Legislation to Restrict Cell Phone Use While Driving

About a third of drivers report using a cell phone while driving.⁶⁶ Research has shown that drivers using cell phones are four times more likely to be involved in a serious crash,⁶⁷ and that the risk is comparable to driving with a BAC of 0.08 g/dL or higher.⁶⁸ Cell phone legislation varies with some states or localities banning hand-held devices, some banning use among young drivers or bus drivers, and some state bans including texting while driving. Although most would agree that using a cell phone while driving is unsafe, the effectiveness of legislation to address this problem has yielded inconsistent results.⁶³

Education-Only Programs for Child Safety Seat Use

Education only programs for CSS use provide information to parents, children or professional groups in the form of advice, brochures, and literature. While education is an accompaniant to many other types of interventions (i.e. distribution or incentive programs), education alone does not have sufficient high quality scientific evidence of effectiveness to support its use, apart from other interventions designed to change behavior.³²

Designated Driver Programs

A designated driver is a person who agrees to either abstain or limit alcoholic consumption and drive others home. Designated driver promotion programs set in restaurants or drinking establishments encourage individuals to act as designated drivers by offering incentives such as free nonalcoholic drinks, food, or free admission. Despite their widespread use in the United States, relatively few programs have been thoroughly evaluated. A systematic review of designated driver programs in drinking establishments found insufficient evidence of their effectiveness in reducing alcohol-impaired driving or alcohol-related crashes.⁶⁹

School-based Instructional Programs for Drinking and Driving

These programs vary widely in their focus; consequently, studies evaluating their effectiveness vary in the factors deemed important for program success, for example, length of exposure to the program, program content, and degree of interaction with students. While there is insufficient evidence to recommend current school-based instructional programs for reducing

drivers' use of alcohol before getting behind the wheel, there is some evidence that these programs reduce self-reported riding with a drinking driver.⁷⁰

Increasing Pedestrian and Bicyclist Visibility

Several interventions have been tried to increase the visibility of pedestrians and bicyclists on the road, including fluorescent materials in bright colors during the day, and lights and retro-reflective materials at night. Results suggest that these interventions can improve drivers' detection and recognition, but there is insufficient evidence of the effect on pedestrian and bicyclist crashes or injuries.⁷¹

Strategies with evidence of ineffectiveness:

School-Based Driver Education

A review by Vernick, et al.⁷² indicated that driver's education did not reduce violations or crashes among students, based on studies conducted in the late 1970s and early 1980s. A review by Roberts et al.⁷³ found similar results, adding one additional study. However, it is unclear how today's driver education programs differ from those reviewed, and whether these differences might affect violation or crashes among today's students. There is also evidence that driver education often leads to early licensure, which itself can be harmful, and may overshadow the effects of any school-based driver education.

Harmful strategies:

Air Bags and Children

Instead of being protective, air bags have been shown to be a risk factor for fatal injury to young children. From January, 1990 to January, 2005, 157 children under age 13 years were killed as passengers in low-speed, otherwise survivable crashes, when frontal airbags deployed. One analysis of NHTSA data⁷¹ found that children 14 and under were at higher risk for serious injury from air bags, whereas those 15 and over were at lower risk. However, the number of children killed has been decreasing, partially due to more children being placed in the back seat, more restrained children, and depowered air bags starting with 1998 model year vehicles.⁴²

Early Licensure for Novice Teenage Drivers

Early licensure can lead to increased exposure of inexperienced drivers and to more crashes. School-based driver education training can often lead to earlier licensure, which can be harmful. Studies by Levy,⁷⁵ Vernick, et al.,⁷² and Roberts and Kwan⁷³ have consistently indicated that young drivers who take driver education tend to get their licenses earlier than young drivers who do not. Any potential safety benefit from the training may be offset by this increased exposure.

Advanced Driver Performance Training Courses

Advanced driver performance training courses teach advanced driving maneuvers like skid control to young, novice drivers. At first, this appears to be a good way to extend the training of teenage drivers. However, the results regarding crash rates is troubling; two studies found that young males who had taken the advanced course had higher crash rates compared to a group who did not.⁷⁶

Implications for Primary Care Practice

Despite the great success in reducing motor vehicle-related death rates in the past 50 years, motor vehicle crashes remain the leading cause of injury-related deaths in the United States. Primary care practitioners have the opportunity to reduce death and injury using a variety of strategies, including screening and counseling.⁷⁷⁻⁷⁹ Practitioners also can help patients understand the importance of reducing exposure to risk on the road, selecting alternative travel modes and choosing safer modes of transportation such as public transport. Practitioners can support public policy initiatives for more efficient and safe land use policies, traffic calming measures that reduce speed and traffic volume, stronger drinking and driving laws, reducing the ease and convenience of alcohol purchase and consumption, stronger motorcycle and bicycle helmet laws and protection for pedestrians (such as pedestrian safety zones). Practitioners can support stronger occupant protection laws, especially for child passengers. Finally, medical care practitioners can strive to improve post-crash survival by supporting comprehensive trauma care systems, technology that can detect crashes and injuries as they occur, and improved emergency medical services, particularly in rural areas.

What Can Public Health Do?

At the Individual Level

- Include road safety in all your health promotion and disease prevention activities with patients.
- Set goals for your patients to reduce the risk of motor vehicle crashes by changing one behavior at a time (e.g. always wearing a safety belt on every trip).
- Expand your record keeping to collect and monitor patient risk factors that may contribute to a traffic injury (e.g. chart reminders & notes about teens or older drivers).
- Screen for alcohol misuse using existing tools such as brief intervention and motivational interviewing.
- Screen for appropriate use of child safety seats or booster seats—are they appropriate for the child's age and stature?
- Talk to parents and teens about graduated drivers licensing. When individual state laws are weak, encourage parents to initiate an active role monitoring their teen's driving.

At the Community Level

- Support efforts to strengthen road safety policy in your state such as stronger GDL laws, primary seat belt laws and motorcycle helmet laws.
- Discourage efforts to lower the minimum legal drinking age. The science supports age 21.
- Strengthen collaborative partnerships with local coalitions, such as Safe Kids, the National Safety Council, or the State office of Highway Safety.
- Support motor vehicle injury prevention as an efficient means to reduce health care costs.
- Support research on risk factors and interventions to reduce all forms of motor vehicle-related trauma, including factors that affect occupational driving.

Conclusions

Motor vehicle crashes and the injuries that result should not be the price we pay for motorization. Lifestyle is inextricably linked to traffic crashes and injuries: it's the cars and trucks we choose, the speeds we drive, our aggressiveness behind the wheel, texting and cell phone use while driving, our alertness or drowsiness behind the wheel, the alcohol we consume before driving, our use of seat belts and buckling children properly in the backseat. It's our choice of travel mode, the number of trips we take, and our complacency with poorly designed roads and intersections, enforcement levels, and safety features in our automobiles. As long as the enormous toll of motor vehicle injuries and deaths, and the behaviors that contribute to it are considered normal and acceptable, public health will make little progress toward prevention.

The preventive medicine practitioner has an important role in reversing this trend. At least in clinical practice, motor vehicle injury prevention can become a regular part of the practice of lifestyle medicine and integrated into care and preventive services. Science tells us that traffic injuries are not "accidents" -- they are predictable and preventable. Through efforts to educate and change behaviors, promote stronger traffic safety legislation and enforcement, and encourage more effective use of technology and engineering, public health and medicine can contribute to reducing traffic injuries and help promote a culture of safety.⁸⁰

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