American College of Emergency Physicians®
ADVANCING EMERGENCY CARE

Motor Vehicle Safety

Policy Resource and Education Paper (PREP)

This policy resource and education paper (PREP) is an explication of the policy statement "Motor Vehicle Safety"

INTRODUCTION

Motor vehicle crashes continue to be a significant burden to health in the United States (US) and worldwide.[1,2] Internationally, it is estimated that road traffic injuries disable 20-50 million persons each year with almost 1.3 million being fatally injured.[2] Almost 93% of these fatalities are reported from low and middle-income countries. A National Highway Traffic Safety Administration (NHTSA) study from 2010 reported $240 billion dollars of cost due to motor vehicle crashes in the USA, translating to 1.6% of the United States Gross Domestic Product.[3] In the US, there were over 42,000 fatalities due to motor vehicle crashes in 2021, a 16-year high.[4]

Utilizing the Haddon Matrix, as conceptualized by William Haddon in 1968, various host, agent, physical, and social environmental factors can be assessed in pre-event, event, and post-event phases of motor vehicle injuries (Figure 1). These can then be applied to educational, environmental, economics, enforcement, and health equity models of injury prevention and safety strategies.[5,6] Emergency physicians (EPs) are in the unique position to provide care for such patients and act as advocates and resources for prevention strategies within the community beyond emergency departments. This PREP will discuss various interactions between these phases and advocacy related to motor vehicle safety.

Figure 1. Haddon Matrix

PHASE	Human Factors	Vehicle/Equipment Factors	Physical Environment	Socioeconomic Environment
PRE-EVENT	• Impaired and distracted driving • Graduated learning • Speeding	• Tire traction • Vehicle-vehicle and vehicle-pedestrian crash prevention systems • Headlight technology	• Road design • Traffic calming measures • Red light cameras • Speed cameras • Red light signs	• Regulations and deterrence • DMV reporting and medical advisory boards
EVENT	• Safety equipment and use • High risk drivers and passengers	• Vehicle safety equipment and design	• Road hazards	• Motorcycle helmet laws and incentives • Seat belt laws and design • Child safety seat laws

POST-EVENT	• Trauma care research related to safety, morbidity, and mortality	• Automatic crash notification	• Trauma care systems	• Federal and state level funding

PRE-EVENT PHASE

Motor vehicle safety is a continuum between the pre-event, event, and post event variables, all tied together to have an impact on the morbidity and mortality associated with it. From the knowledge gained via research of how a cascade of events can lead to a motor vehicle crash, one can address these factors in the pre-event phase for injury prevention. These pre-event phase variables can be categorized into human, vehicle, and environment categories (Figure 1).

Human Factors

Impaired and Distracted Driving: Effects of Alcohol, Drug, Medications, Medical Issues, and Technology

Alcohol Use

Alcohol related crashes cost $51 billion dollars a year and account for 32% of all traffic related deaths.[7,8] The relative risk of a motor vehicle crash for an intoxicated driver increases with increasing blood alcohol concentration (BAC) levels (RR= 2.69 at 0.08 BAC, 29.48 at 0.16 and 153.68 for BAC greater than 0.25).[9] An analysis of various state laws demonstrates that lowering the minimum BAC is associated with the largest declines in motor vehicle crash fatality for all ages and especially for those >65 years old.[10] Having a social host, or a "designated driver" can significantly reduce deaths in those under 55 years old. Similarly, smartphone app-based rideshare use is associated with a 24% decreased rate of motor vehicle traumas.[11] Lowering the BAC legal limit is one measure that has been found to reduce alcohol-related crash occurrences in several countries.[12]

Sedating Medications

Numerous medications can cause sedation and have been shown to impair driving performance. Benzodiazepines, often prescribed for insomnia and anxiety, are associated with worsened driving performance in driving stimulations and on-road tests.[13] Benzodiazepines are also associated with increased risk of motor vehicle crashes.[14] Opioid medications are also a commonly prescribed medication for pain with sedating effects. While prescription rates have dropped with increased awareness of the opioid epidemic, there were 43 opioid prescriptions per 100 people in the US in 2020.[15] Opioid medications on their own are also associated with mild decreases in tracking and visual acuity but can interact with other drugs, such as alcohol, to significantly increase the risk of motor vehicle crashes.[13] Other drugs, such as muscle relaxant medications and over-the-counter first-generation antihistamines, also have sedating effects, and use is associated with a likelihood of motor vehicle crashes over twice that of baseline.[16]

Marijuana

Tetrahydrocannabinol (THC) is the active ingredient in marijuana and synthetic marijuana that leads to intoxicating effects. Similar to alcohol, intoxication with THC can lead to poor driving performance. A recent randomized trial showed a consistent decrease in performance in driving simulators for those under the influence of THC that persisted for multiple hours after smoking.[17] The impairment persisted beyond

the time when participants felt comfortable to drive, suggesting that they might not be aware of their own impairment. Measuring the level of intoxication with THC remains under study.

Distracted Driving

Driver inattention is the leading cause of motor vehicle crashes. Nearly 80% of crashes and 65% of near crashes involve some form of driver inattention within three seconds of the event.[18] This same study found that reaching for a moving object increases the risk of a crash/near crash by 8.82 times, drowsy driving by 6.23 times, reading by 3.38 times, applying makeup by 3.13 times, cell phone dialing by 2.79 times, inserting/removing a CD by 2.25 times, eating by 1.57 times and talking/listening to cell phone by 1.29 times.[18]

Bans on hand-held cell phone usage while driving may be effective. As of 2021, twenty-four states prohibit hand held cell phone usage while driving.[19] McEvoy found that the risk of crashing with hands free phone was 3.8 and handheld phone was 4.9.[20] Although hands free lowers the risk, it does not eliminate the distraction of cell phone usage. State laws banning texting, handheld use, and even younger driver texting bans showed mixed results in reducing fatalities.[21]

Speeding

The economic cost of speeding-related crashes is estimated to be $41 billion dollars a year.[22,23] In addition to monetary costs, speeding plays a role in 30% of all fatal crashes, in part because higher crash speeds reduce the effectiveness of vehicle restraint systems and roadways safety guardrails to protect the vehicle occupants.[22] Speeding-related factors have been increasing on roads with speed limits of 65 mph and higher since the repeal of the national maximum speed limit of 55 in December 1995.[23] Shafi found a 13% increase in fatalities with the 65 mph speed limit and the Insurance Institute for Highway Safety found a 38% increase in fatalities with the 75 mph speed limit.[24,25] Furthermore, as road conditions worsen, speeding plays a larger role in fatal crashes. Speeding accounts for 28% of the fatal crashes on dry roads, 33% on wet roads, 51% on snow slush roads and 58% on icy roads.[22]

With higher speeds associated with higher crash fatalities, utilizing strategies to reduce the driving speed should result in fewer fatal crashes. Speeding enforced by detection devices has been introduced in the past two decades and, although requiring more rigorous studies, has resulted in a reduction of crashes, fatalities, and the proportion of vehicles speeding.[26] Kaplan found a 31% reduction in speeding vehicles in the vicinity of the patrol car, even if it is unmanned.[27] Similarly, aerial enforcement of speeding limits was associated with a 22% reduction in vehicle crashes, while the posting of speeding enforcement signs was associated with a 17% reduction.[28,29] Automated speed enforcement represents another effective enforcement to reduce speed related injuries and fatalities. The Cochrane Systematic Review found that speed cameras reduce fatal crashes from 13% to 58%, injury crashes from 7% to 30%, and all crashes from 9% to 35%.[26] Unfortunately, a regression analysis of state laws on speed cameras, as opposed to red light cameras, shows no reduction in mortality from motor vehicle crashes.[21,30]

> ***Advocacy Statement -*** *ACEP encourages public education about the dangers of impaired, intoxicated, and distracted driving. Specifically, states should adopt and enforce legislation to prohibit alcohol-impaired driving, since a blood alcohol concentration (BAC) of 0.08 g/dL is evidence of driving while impaired; a BAC of 0.05 g/dL is presumptive evidence of impaired driving; and any measurable level of BAC while driving shall be illegal in persons younger than the legal drinking age in each state. States should adopt and enforce state legislation to prohibit driving while impaired by other intoxicating substances. Emergency physicians should screen relevant patients for misuse of alcohol and other substances and offer referrals and treatment when indicated. States should enforce existing speed limits and oppose further increases in speed limits.*

Vehicle Factors and Innovations

Anti-Lock Brakes System (ABS)/Automatic Traction Control (ATC)

ABS is a braking system that enables the driver to maintain steering and direction while braking suddenly, especially in wet conditions, and has been required on vehicles sold in America since 2004. ATC can improve vehicle stability and control for heavy commercial trucks on slippery surfaces at highway speeds.[31] Similarly, electronic stability control (ESC) has been found to reduce the risk of rollover in passenger cars, SUVs, and vans.[32]

Headlight Technology

In early 2022, the US Federal Motor Vehicle Safety Standards regulations were updated to allow selectively adaptable drive beams, a system already in use in Japan, Canada and Europe, to reduce glare perceived by oncoming traffic while simultaneously providing strong illumination to the sides of the road.[33] This technology may reduce pedestrian deaths by 9 out of 2,334 deaths each year due to low light.[34]

Tire Traction

In the US, 664 motor vehicle crash fatalities in 2020 were tire related.[35] Although tire pressure monitoring systems (TPMS) are federally mandated and help alert the driver to improper pressures, poor maintenance can lead to blowouts or sudden tread separations. Tire inspections should be conducted monthly, especially if TPMS systems are not used.

Vehicle-to-Vehicle and Vehicle-to-Pedestrian Crash Prevention Systems

Countermeasures for driver inattention currently available and being researched include lane tracking systems, driver's eye tracking systems, and collision alert systems. Front crash prevention has advanced with vehicle sensors with automatic emergency braking to avoid and reduce crash morbidity against vehicles or pedestrians. While testing can provide information to consumers and manufacturers about vehicle safety features, the test only includes dry roads and speeds less than 40 mph. There are no laws currently requiring features such as lane departure warning, lane keeping assist, forward collision warning or automatic emergency braking, although many features are offered as options and some manufacturers make them standard. The effectiveness of "self-driving" features remains under study.

> ***Advocacy Statement -*** *In addition to adopting and enforcing distracted driving by handheld electronic devices, ACEP supports the development of innovative technologies that detect driver impairment and reduce distraction from safe motor vehicle operation. Other technologies that ACEP supports include antilock brakes, headlight and tire innovations, and vehicle-to-vehicle/vehicle-to-pedestrian crash prevention systems.*

Environmental Factors

Road Design

Road design is an important factor in driver behavior. Traffic calming strategies, such as median barriers, speed bumps, and roundabout traffic circles are frequently utilized to require drivers to reduce speed. A systematic review and meta-analysis of area wide traffic calming schemes found an 11% decrease in fatal and non-fatal road traffic injuries.[36] While positive, further evaluation of these techniques and further development of additional environmental measures is warranted. Narrower lanes at intersections decrease the distance pedestrians must cross and provide sidewalk space, with a psychological effect on drivers by making the driver more aware of pedestrian risk.[35,37–39] Chicanes are artificial turns which force drivers to slow down and pay closer attention. Speed humps have the greatest impact on slowing traffic, are inexpensive, and can be combined with raised crossings.[40] One environmental strategy to reduce crashes from driver inattention is road rumble strips. Shoulder rumble strips decrease the off-the-road driver

inattention crashes by 18-21%, and centerline rumble strips on rural two lane roads decreases opposing direction crashes by 25%.[40]

Regulations, Safety Enhancements, and Deterrence

Red Light Cameras

Intersection cameras have been introduced to record all infractions in which a driver disregards a stop sign or red light. Red light camera enforcement has moderate aggregate crash cost benefit and contributes to some decrease in injuries and crashes.[30] Municipal level identification of high-risk areas for motor vehicle crashes and installation of red-light cameras can inhibit speeding. Additional prompts to slow down or reduce speeds at high risk intersections may also aid in these efforts. Research has shown that areas with absence of red light cameras have seen higher motor vehicle crash-related childhood mortality (3.73%, $p<0.001$).[41] An analysis of state laws demonstrates significant reduction in deaths from motor vehicle crashes in those 65 years old and younger.[21]

Alcohol Deterrence and Regulations

Another measure to prevent alcohol related crashes is the establishment of police regulated sobriety checkpoints, which has been found to contribute to a 20% reduction in alcohol related crashes. Another effective enforcement strategy is the suspension of the driver license in those aged 21 years and older, but Voas found that up to 75% of the repeated offenders may drive illegally.[21,42] Other than driver license suspension, vehicle impoundment can reduce crashes by 37.6% in repeat offenders during the vehicle impoundment, but further review shows mixed benefits from impoundment laws.[21]

Although not impoundment, a breath alcohol ignition interlock can be employed to make it impossible to start a car without passing the alcohol breathalyzer device. A review of state laws shows mixed benefits from ignition interlock laws.[21] Bjerre found a 60% reduction in the rate of repeat DWI and 80% reduction in police reported traffic accidents among DWI offenders during the interlock period.[43] Once the interlock is removed, Raub found that 50% of these drivers were involved in a crash or re-arrested for drunk driving within three years.[44] Educational strategies have also been utilized at both the community and individual levels, and studies have shown that brief motivational interventions in emergency department for injured patients with risky alcohol use can decrease future impaired driving.[45]

Graduated Learning

Motor vehicle crashes are the leading cause of death among 15- to 20-year-old drivers.[35] 16-year-old drivers have a crash rate that is almost ten times the rate for drivers aged 30-59.[36] Even when adjustments are made for experience, teen drivers are much more prone to be involved in a crash than adults.[39] Teens drive faster, overtake other vehicles with too much risk, merge too quickly, follow too closely, and violate traffic signals more often. In the first several weeks after receiving their licenses, teenagers are 12 times more likely to be in a crash than otherwise.[40] One effective countermeasure is graduated driver learning (GDL) programs, which reduce crashes in novice drivers by 31% and fatal crashes by 16%.[37,38] Chen found that the most effective components of GDL were: minimum age of 15 ½ to obtain a learners permit, minimum age of 16 to obtain an intermediate license, minimum age of 17 for full licensing, minimum of 30 hours of supervised driving, nighttime driving restrictions, and a restriction on carrying passengers.[38] GDL laws vary from state to state and are most effective with 16- to 20-year-olds, in combination with passenger restrictions and permit periods.[21]

Industry Advocacy

When lobbying for changes, knowing allies in the mission to reduce motor vehicle deaths can help align messages. The Insurance Institute for Highway Safety is an independent, non-profit, scientific and educational organization dedicated to reducing deaths, injuries, and property damage from motor vehicle crashes through research, evaluation, and education of consumers, policymakers and safety professionals.[46]

EPs can contribute to a positive change in the socio-economic climate of motor vehicle safety by serving as traffic safety advocates on legislative issues. EPs are in an optimal position to use facts, clinical experiences, and moral persuasion to persuade the community to do more to minimize motor vehicle crashes. They can educate the community, patients and their families, and policy makers on motor vehicle crash prevention. However, advocating and passing stronger traffic safety laws are only part of the solution. In order for change to occur, these laws must be enforced. EPs should work with law enforcement to make traffic safety a priority and resources are allocated to allow this to happen. Other pre-event factors that NHTSA has been tasked to evaluate include crash avoidance and driver distraction mitigation technology, along with advanced drink and impaired driving prevention technology.[47]

Department of Motor Vehicle (DMV) Reporting and Evaluation by Medical Advisory Boards

DMV reporting is another pre-event action for EPs to utilize in many states. Reporting patients with medical conditions that pose a public danger should the patient continue to drive is mandatory in six states and permitted in 25 states.[48] The remaining states have no policy. [48] The dilemma posed by reporting is that the physician-patient relationship is undermined when confidentiality is breached and particularly when that breach will lead to loss of an essential societal privilege like driving.[41] The American Medical Association advised that "When reporting is mandatory, the physician has little choice." When it is not mandatory "…If the physician fails to report, a victim of the patient's further reckless driving due to medical impairment-may hold the physician responsible for failure to report."[42] Immunity for reporting a patient is provided by law in some states. The American Medical Association (AMA) resolution also advises that "the physician must identify and document physical and mental impairments that clearly relate to the ability to drive, and the driver must pose a clear risk to the public safety." The NTSA Board pointed out that alternatives must be put in place for people who cannot be permitted to drive, particularly in rural areas.[43]

Medical advisory boards are used by 32 states, and there is guidance in helping to determine a person's fitness for driving, especially for assessing and counseling older drivers.[49] In-person renewal should be considered for older drivers beginning at the age of 70, and there are lower crash fatality rates for drivers 85 or older in states that have in-person renewal, since there is an opportunity for direct interaction with licensing personnel that allows them to observe gross functioning and make referrals for further in-depth assessments although not all states allow counter personnel to report.[12] Six states require mandatory physician reporting, but not all states provide protection of confidentiality and legal protection to reporting physicians.[50]

> ***Advocacy Statement -*** *ACEP supports research and development to prevent motor vehicle injury through innovative roadway and recreation area design. ACEP can partner with industry allies to align messages and provide guidance for evaluation by medical advisory boards to determine drive fitness.*

EVENT PHASE

Use of Protective Equipment

Seat Belt

When used, three-point lap and shoulder seat belts reduce the risk of fatal injury to front-seat passenger car occupants by 45% and the risk of moderate-to-critical injury by 50%.[51] For light-truck occupants, seat belts reduce the risk of fatal injury by 60% and moderate-to-critical injury by 65%. In 2019, seat belt use averaged 92.0% in the 34 states and District of Columbia, with primary belt laws and 86.2% in states with secondary or no enforcement laws.[52] New Hampshire is the only state without a seat belt law covering adult drivers or passengers. Laws requiring seat belt use are either "primary" or "secondary" enforcement laws. Primary

enforcement laws allow police officers to pull over drivers and issue tickets just because the drivers or their passengers aren't wearing seat belts. Secondary enforcement laws only allow police officers to issue tickets for seat belt violations if drivers have been pulled over for some other offense.

> ***Advocacy Statement*** *- ACEP recommends adoption and enforcement of primary safety-belt use laws and to extend them to cover all seating positions in all motorized vehicles, where feasible.*

Car Seats

NHTSA estimates that correctly used child restraints are even more effective than seat belts in reducing fatalities to children. Child restraints reduce fatalities by 71% for infants younger than one year old and by 54% for children one to four years old in passenger cars. In light trucks, the fatality reductions are 58% for infants and 59% for children one to four years old.[53,54] 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 by 45% to children four to eight years in crashes when compared to the effectiveness of seat belts alone.[55] Premature transition from one restraint type to another not appropriate for a child's age, height, and weight should be prevented. Restraint-use errors varied by restraint type and include errors with installation of the car seat/booster to the vehicle or restraining the child in a manner that could reduce the protection of the car seat/booster in the event of a crash. Overall misuse was estimated to be 46%. Estimated misuse by restraint type was 61% for forward-facing car seats, 49% for rear-facing car seats, 44% for rear-facing convertible car seats, 24% for backless booster seats, and 16% for high-back booster seats.[56]

> ***Advocacy Statement*** *- ACEP supports strengthening and enforcing existing child safety seat laws and their use in appropriate locations within motor vehicles, consistent with current guideline recommendations (ie, rear-facing child seats until children are two to four years old, rear seat use until children are 14 years old). To minimize misuse, ACEP supports the efforts of NHTSA Standardized Child Passenger Safety Training Course as a process to support choosing and installing the proper car seat for child passengers.*

Motorcyclist and Helmets

Motorcyclists are at high risk for head injury when involved in a crash. A review of studies concluded that helmets reduce the risk of head injury by approximately 69% and death by approximately 42%.[57] At this time, there is insufficient evidence to compare the effectiveness of different types of helmet; however, some studies have suggested helmets may protect against facial injury but have no effect on neck injury.

> ***Advocacy Statement*** *- ACEP supports adoption and enforcement of laws requiring all motorcyclists, bicyclists, and other wheeled recreational equipment users to wear appropriate "helmets."*

Road Rage

Aggressive driving by drivers and angry responses can escalate to road rage, leading to increased risks of motor vehicle collisions or even shootings by firearms. While speeding and running red lights are considered aggressive driving, so is cutting in front of another driver suddenly and slowing down or blocking merge attempts. According to the American Automobile Association Foundation for Traffic Safety, 25% of drivers have admitted to driving aggressively, which in combination with increased firearm access, has recently led to a doubling of firearm-related rage incidents from 2019 to 2021 nationwide.[58]

> ***Advocacy Statement -*** *ACEP supports more research into reduction and prevention of road rage incidents and to enhance public health messaging related to prevention of road rage and its effect on motor vehicle safety.*

High Visibility Enforcement
States are beginning to enact laws to prevent texting while driving and implementing hands-free laws. While the effectiveness of these interventions still needs further study, the NHTSA conducted a high-visibility enforcement project in four communities with observed driver cell phone use decreasing in all communities: Sacramento Valley Region of California decreased from 4.1% to 2.7%, Hartford, Connecticut decreased from 6.8% to 2.9%, the state of Delaware decreased from 4.5% to 3.0%, and Syracuse, New York decreased from 3.7% to 2.5%.[59] Automated enforcement with the implementation of speed and red-light cameras reduce crashes and injuries, particularly at intersections.[60] Speed cameras decrease speed-related crashes by 12%; whereas, red-light cameras have demonstrated a 17% decrease in fatalities associated with intersection crashes.[61]

> ***Advocacy Statement*** *- ACEP promotes use of newer technologies to support traffic safety laws enforcement to have an impact on motor vehicle safety.*

Road Hazards
Safety on US roadways are the result of deliberate efforts to increase usability and visibility. Adequate street lighting may prevent road traffic crashes, injuries, and fatalities.[62] Medians and guardrails, including concrete, steel and/or wire rope barriers, reduce the impact of run-off-road conditions. Crash cushions are devices intended to absorb the colliding vehicle's kinetic energy. Area-wide traffic calming in towns and cities may be a promising intervention for reducing the number of road traffic injuries and deaths.[63] Roundabouts, instituted in place of intersections, were associated with a reduction of 30% to 50% in the number of injury accidents, and fatal accidents were reduced by 50% to 70%.[64]

An estimated one to two million crashes between motor vehicles and large animals occur every year in the US, resulting in approximately 200 fatalities and 26,000 injuries.[65] Roadways alter the natural landscape and cause habitat fragmentation, and when combined with reduced visibility and poor weather conditions, wildlife collisions may occur. Large wildlife crossing structures, such as underpasses and overpasses, paired with US roadways are an effective strategy in reducing animal-vehicle collision.[66] These structures often require guiding systems such as fencing to lead animals into safe passage.

Road maintenance requires keeping the road in good driving condition by carrying out scheduled repairs and reinforcement work. Specific roadside safety treatments include flattening side slopes, increasing distance between the edge and fixed obstacles, or removal of such obstacles to give drivers greater opportunity to regain control in the event of a run-off road. Interventions targeting black spots, abnormally high crash sites, or hazardous road locations, have resulted in approximately 15% reduction in urban and rural crashes.[67]

> ***Advocacy Statement*** *- ACEP supports federal and state level funding to improve transportation infrastructures and universal availability of safer road designs.*

Vehicle Design
Vehicle design can be a large driver for significant reduction in traffic collisions and subsequent injuries and deaths. Electronic stability control is an active safety device installed within vehicles to improve driving dynamics and to prevent accidents which result from loss of control.[31] Anti-locking braking systems and traction control systems are key components of electronic stability control safety innovations. Daytime running headlights reduce the occurrence of multivehicle daytime crashes by approximately 6%.[68] The under-run protection bar on trucks or trailers enables small and large vehicles to make bumper-to-bumper contact thus preventing the smaller and lower vehicles from "riding under" the large vehicles. Advanced vehicle technologies that reduce or prevent vehicles from colliding with other vehicles or roadway obstacles, including lane keeping systems and autonomous emergency braking, are highly effective in reducing collisions.

Advocacy Statement - *ACEP promotes the development, implementation, evaluation, continuous improvement, and advances in vehicle safety technologies.*

POST EVENT VARIABLES

Lack of advances and improvements in "post event variables" have impacts on improving care related to motor vehicle crashes. These variables include, but are not limited to, the need for seamless transfer of accident information to pre-hospital and hospital care providers, universal availability of automatic crash notification and intelligent transportation technologies, advances in vehicle and accident research, enhancement of trauma care centers and trauma preparedness of non-trauma centers, and funding for research in the field of trauma care.

Automatic Crash Notification and Intelligent Transport System

Universal availability and utilization of advances in technology to enhance responses to motor vehicle crashes can reduce patient mortality and morbidity. Advanced Automatic Crash Notification (AACN) systems can transmit real time data from a vehicle about its occupants, use of safety features of vehicle, speed of crash, and the location of accident via global positioning system (GPS) coordinates, and summon help, which can result in efficient and effective mobilization of emergency medical resources and trauma center notifications.[69,70] When a crash has occurred (as determined by various sensors such as airbag deployment or seatbelt pretensioners), the AACN initiates an emergency wireless call to a telematics service provider to deliver the vehicle's GPS location. As the AACN records crash related data, it can send this data (vehicle speed, delta velocity, number of occupants, mechanism of accident, number of impacts) to the telematic service. Voice communications can be established utilizing AACNs to an emergency call center and can be used to determine the status of injured, age and number of occupants, and information provided by bystanders. This system can be utilized to its full potential by integration into the EMS system, allowing for the seamless transfer of voice, video, and text data to the 911 network. This will allow for efficient triaging of resources and planned transfer of expected injured patients to various levels of hospitals available in the catchment area. Studies have shown the impact of AACN with earlier EMS notification leading to better utilization of resources and patient outcomes, especially in less urban and rural settings, with fatalities reduced by between 1.6 - 3.3% per year.[71–73] Knowing the efficacy of the AACN, from a policy perspective, there is also a need to address the cost that is associated with having such a system at the individual and community level, for having and then maintenance of the system.

Advocacy Statement - *ACEP supports the development and implementation of programs, policies, legislation, and regulations that promote the use of AACNs and intelligent transportation systems. It is essential to have universal standard availability of these systems in automobiles. In addition, federal and state level funding to have an innovative and technologically updated 911 response system in all urban or rural settings is much needed.*

Research Networks and Research Data

The NHTSA has various research initiatives and national surveillance systems to learn from motor vehicle crashes, perform laboratory research, and recommend safety mandates ("vehicle safety research"). It is through these constant data gathering efforts that we know the disparity between the rural and urban trauma related injuries, with a higher burden on rural communities but limited resources for care and prevention.[74] The Fatality Analysis Reporting System (FARS) creates a census of motor vehicle crash deaths and their associated characteristics.[35] The National Automotive Sampling Systems directs research involving links between crashes and details of vehicle design, particular road conditions, the behavior of drivers, and the injuries that occur. NHTSA's Special Crash Investigations Program (SCI) investigates special interest crashes and relies on receiving notification by interested parties, such as police, EMS, or emergency physicians, of the occurrence of events that fit SCI's mission.[35,75] The Crash Injury Research and

Engineering Network (CIREN) utilizes the medical and engineering information to understand the causation of an accident and uses this information to work on prevention and management of motor vehicle injuries.[76] In addition, research performed under the Department of Transportation Intelligent Transportation Systems Joint Program Office helps to enhance utilization of these advances for motor vehicle safety.[77] All of these research data and networks help with pre-hospital and hospital care and thus need to have continued support and funding.

> ***Advocacy Statement -*** *ACEP advocates for continued support and funding of trauma research networks and research. Injury prevention due to motor vehicle crashes requires assessment of trends over time so there are expected goals and benchmark measures to assess improvements.*

Trauma Care Systems

Trauma care systems model on rapid notification and response by EMS, on site emergency medical care, transport to a trauma care facility, emergency department treatment, acute hospital care and rehabilitation services.[78] There is a need for trauma centers to develop trauma care systems, as this has a direct impact on reducing patient mortality and other improved outcomes.[79–81] But these systems require constant support and funding, especially in areas where the catchment areas are large and where there are limited resources to establish such a system. Other issues include sustenance of these systems, staffing, reimbursements, and spatial locations and accessibility. Algorithms to select suitable patients and agreements between hospitals are needed to ensure transport without delay. Recent studies have documented disparities and the lack of sufficient funding of trauma care centers.[82] Trauma care and trauma center funding are consistently inadequate because of care to a disproportionate number of economically, disadvantaged people and reimbursement variation. Trauma systems often overlap state boundaries which can magnify problems of financial support and organization. In 2019, 725 million dollars were funded by the National Institutes of Health (NIH) for trauma research which is <2% of the NIH budget despite the significantly higher burden of morbidity and mortality due to trauma compared to other illnesses.[83] Additionally, there is a need for a standardized approach to prepare non-trauma centers, especially in rural settings, to stabilize and transfer trauma patients in an effective, safe and expeditious manner. Such a process works best in the presence of regional trauma care systems with the utilization of validated teaching curricula and the presence of local trauma care coordinators who work with regional trauma teams.

> ***Advocacy Statement -*** *ACEP advocates for funding and sustenance of existing trauma care systems and funding for increasing the numbers of such systems, especially in underserved communities and areas. ACEP supports education for rural facilities that do not have resources to obtain trauma center designation. Such education includes the American College of Surgeons' Committee on Trauma, Rural Trauma Team Development Course (RTTDC).*[84]

CONCLUSION

Injury prevention and control from motor vehicle crashes is a complex issue with significant impact on morbidity and mortality, and effective strategies at different stages can reduce this burden. EPs can assume an important role in motor vehicle safety to prevent future motor vehicle related injury and death. They can advocate for safety at the bedside and bring their experience to national legislation and research efforts. The lessons learned with research apply internationally, and ACEP recognizes the efforts of NHTSA and international partners in improving motor vehicle safety for all motorists and passengers.

Created by members of the Public Health and Injury Prevention Committee (Siraj Amanullah, William Weber, Joseph Reardon, Courtney Edwards, Dahlia Hassani, Antony Hsu) – August 2022

Reviewed by the ACEP Board of Directors – October 2022

REFERENCES

1. Centers for Disease Control and Prevention. *Injury Prevention and Control: Motor Vehicle Safety*. Centers for Disease Control; 2020. Accessed May 19, 2022. https://www.cdc.gov/injury/erpo/icrc/topic_motor-vehicle-safety.html
2. World Health Organization. *Global Status Report on Road Safety 2018*. World Health Organization; 2019.
3. The Economic and Societal Impact of Motor Vehicle Crashes, 2010 (Revised)1. *Annals of Emergency Medicine*. 2015;66(2):194-196. doi:10.1016/j.annemergmed.2015.06.011
4. National Highway Traffic Safety Administration. *Early Estimates of Motor Vehicle Traffic Fatalities And Fatality Rate by Sub-Categories in 2021*. U.S. Department of Transportation; 2022. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813298
5. Mace SE, Gerardi MJ, Dietrich AM, et al. Injury prevention and control in children. *Ann Emerg Med*. 2001;38(4):405-414.
6. Giles A, Bauer MEE, Jull J. Equity as the fourth "E" in the "3 E"s' approach to injury prevention. *Inj Prev*. 2020;26(1):82-84.
7. Facts TS. Alcohol-Impaired Driving. *National Highway Traffic Safety Administration Reports*. Published online 2014. https://safetrec.berkeley.edu/sites/default/files/publications/safetrecfactsalcohol_summer2021.pdf
8. Blincoe L, Seay A, Zaloshnja E, et al. The Economic Impact of Motor Vehicle Crashes, 2000. 2002. *National Highway Traffic Safety Administration: Washington, DC*. Published online 2012:94.
9. Blomberg R, Peck R, Moskowitz H, Burns M, Fiorentino D. Crash risk of alcohol impaired driving: A case-control study. *Manuscript, Dunlap and Associates*. Published online 2005.
10. Rand MR, Sabol WJ, Sinclair M, Snyder H. Alcohol and Crime: Data from 2002 to 2008. *Washington DC: Bureau of Justice Statistics*. Published online 2010. https://www.ojp.gov/library/abstracts/alcohol-and-crime-data-2002-2008
11. Conner CR, Ray HM, McCormack RM, et al. Association of Rideshare Use With Alcohol-Associated Motor Vehicle Crash Trauma. *JAMA Surg*. 2021;156(8):731-738.
12. Fell JC, Voas RB. The effectiveness of reducing illegal blood alcohol concentration (BAC) limits for driving: evidence for lowering the limit to .05 BAC. *J Safety Res*. 2006;37(3):233-243.
13. Leung SY. Benzodiazepines, opioids and driving: an overview of the experimental research. *Drug Alcohol Rev*. 2011;30(3):281-286.
14. Smink BE, Egberts ACG, Lusthof KJ, Uges DRA, de Gier JJ. The relationship between benzodiazepine use and traffic accidents: A systematic literature review. *CNS Drugs*. 2010;24(8):639-653.
15. U.S. opioid dispensing rate maps. Published November 10, 2021. Accessed March 8, 2022. https://www.cdc.gov/drugoverdose/rxrate-maps/index.html
16. Leroy A, Morse MM. Exploratory study of the relationship be-tween multiple medications and vehicle crashes. Published online 2008.
17. Marcotte TD, Umlauf A, Grelotti DJ, et al. Driving Performance and Cannabis Users' Perception of Safety: A Randomized Clinical Trial. *JAMA Psychiatry*. 2022;79(3):201-209.
18. Klauer SG, Dingus TA, Neale VL, Sudweeks JD, Ramsey DJ. The Impact of Driver Inattention on Near-Crash/Crash Risk: An Analysis Using the 100-Car Naturalistic Driving Study Data. *PsycEXTRA Dataset*. Published online 2006. doi:10.1037/e729262011-001
19. Zuckerman M. *Cell Phone Use and Distracted Driving Laws*.; 2014.
20. McEvoy SP, Stevenson MR, McCartt AT, et al. Role of mobile phones in motor vehicle crashes resulting in hospital attendance: a case-crossover study. *BMJ*. 2005;331(7514):428.
21. Notrica DM, Sayrs LW, Krishna N, Rowe D, Jaroszewski DE, McMahon LE. The impact of state laws on motor vehicle fatality rates, 1999-2015. *J Trauma Acute Care Surg*. 2020;88(6):760-769.
22. National Highway Traffic Safety Administration. *Traffic Safety Facts: Speeding*. US Department of Transportation; 2021. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/810998

23. Liu C. *Analysis of Speeding-Related Fatal Motor Vehicle Traffic Crashes*.; 2005.
24. Shafi S, Gentilello L. A nationwide speed limit < or = 65 miles per hour will save thousands of lives. *Am J Surg*. 2007;193(6):719-722.
25. Insurance Institute for Highway Safety. *Faster Travel and the Price We Pay*. Federal Highway Administration; 2003. https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa09028/resources/Faster%20travel%20and%20the%20price%20we%20pay.pdf
26. Wilson C, Willis C, Hendrikz JK, Bellamy N. Speed enforcement detection devices for preventing road traffic injuries. *Cochrane Database Syst Rev*. 2006;(2):CD004607.
27. Kaplan JL, Wright MJ, Lazarus L, et al. Use of an unmanned police car to reduce traffic speed. *J Trauma*. 2000;49(1):43-46.
28. Kearns IB, Kearns I, Webster KA. *The Effect of Aerial Speed Enforcement on Traffic Crashes*.; 1988.
29. Stuster JW. *Experimental Evaluation of Municipal Speed Enforcement Programs. Final Report*.; 1995.
30. Hu W, McCartt AT, Teoh ER. Effects of red light camera enforcement on fatal crashes in large U.S. cities. *J Safety Res*. 2011;42(4):277-282.
31. Erke A. Effects of electronic stability control (ESC) on accidents: a review of empirical evidence. *Accid Anal Prev*. 2008;40(1):167-173.
32. MacLennan PA, Marshall T, Griffin R, Purcell M, McGwin G, Rue LW. Vehicle rollover risk and electronic stability control systems. *Inj Prev*. 2008;14(3):154-158.
33. National Highway Travel Safety Administration. NHTSA to Allow Adaptive Driving Beam Headlights on New Vehicles, Improving Safety for Drivers, Pedestrians, and Cyclists. *US Department of Transportation*. https://www.nhtsa.gov/press-releases/nhtsa-allow-adaptive-driving-beam-headlights-new-vehicles-improving-safety-drivers. Published February 15, 2022.
34. Sullivan JM, Flannagan MJ. The role of ambient light level in fatal crashes: inferences from daylight saving time transitions. *Accid Anal Prev*. 2002;34(4):487-498.
35. National Highway Traffic Safety Administration. Fatality Analysis Reporting System (FARS). *Fatality Analysis Reporting System (FARS)*. Accessed February 16, 2022. https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars
36. Bunn F, Collier T, Frost C, Ker K, Roberts I, Wentz R. Traffic calming for the prevention of road traffic injuries: systematic review and meta-analysis. *Inj Prev*. 2003;9(3):200-204.
37. Karim. Narrower Lanes, Safer Streets. In: *Conference: Canadian Institute of Transportation Engineers*. Canadian Institute of Transportation Engineers; 2015:6.
38. Lee C, Abdel-Aty M, Park J, Wang JH. Development of crash modification factors for changing lane width on roadway segments using generalized nonlinear models. *Accid Anal Prev*. 2015;76:83-91.
39. Wood JS, Gooch JP, Donnell ET. Estimating the safety effects of lane widths on urban streets in Nebraska using the propensity scores-potential outcomes framework. *Accid Anal Prev*. 2015;82:180-191.
40. Federal Highway Administration. Toolbox of Individual Traffic Calming Measures. In: Xu G, ed. *Traffic Calming ePrimer*. US Department of Transportation; 2019.
41. Wolf LL, Chowdhury R, Tweed J, et al. Factors Associated with Pediatric Mortality from Motor Vehicle Crashes in the United States: A State-Based Analysis. *J Pediatr*. 2017;187:295-302.e3.
42. Voas RB, Deyoung DJ. Vehicle action: effective policy for controlling drunk and other high-risk drivers? *Accid Anal Prev*. 2002;34(3):263-270.
43. Bjerre B, Thorsson U. Is an alcohol ignition interlock programme a useful tool for changing the alcohol and driving habits of drink-drivers? *Accid Anal Prev*. 2008;40(1):267-273.
44. Raub RA, Lucke RE, Wark RI. Breath alcohol ignition interlock devices: controlling the recidivist. *Traffic Inj Prev*. 2003;4 Suppl 1:28-34.
45. Woolard R, Cherpitel C, Kathleen T. Brief Intervention for Emergency Department Patients with Alcohol Misuse: Implications for Current Practice. *Alcohol Treat Q*. 2011;29(2):146-157.

46. Insurance Institute for Highway Safety. Insurance Institute for Highway Safety - Highway Loss Data Institute. Insurance Institute for Highway Safety. Accessed May 18, 2022. https://www.iihs.org/
47. National Highway Travel Safety Administration. Bipartisan infrastructure law. National Highway Travel Safety Administration. Accessed July 14, 2022. https://www.nhtsa.gov/bipartisan-infrastructure-law
48. Traffic tech. NHTSA. Accessed July 15, 2022. https://www.nhtsa.gov/traffic-tech/34901
49. National Highway Transportation Safety Administration. *Medical Review Practices For Driver Licensing*. US Department of Transportation; 2017. https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/812402_medicalreviewdriverlicense.pdf
50. Molnar L, Eby D, Zakrajsek J, et al. *Identifying Policy Approaches to Extending the Safe Mobility of Older Adults*. University of Michigan Transportation Research Institute; 2021.
51. Kahane CJ. Lives saved by vehicle safety technologies and associated Federal Motor Vehicle Safety Standards, 1960 to 2012--Passenger cars and LTVs--With reviews of 26 FMVSS and the effectiveness of their associated safety technologies in reducing fatalities, injuries, and crashes. *Report No DOT HS*. 2015;812:069.
52. National Highway Traffic Safety Administration. Traffic Safety Facts: Seatbelt Use in 2019 - Overall Results. *US Department of Transportation: Traffic Safety Facts Research Note*. 2019;DOT HS 812 875. https://crashstats.nhtsa.dot.gov/Api/Public/Publication/812875
53. National Highway Traffic Safety Administration. *Transportation Recall Enhancement, Accountability, and Documentation Act: Child Restraint Systems*. U.S. Department of Transportation; 2004. https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/tread.pdf
54. National Highway Traffic Safety Administration. *Lives Saved by the Federal Motor Vehicle Safety Standards and Other Vehicle Safety Technologies, 1960-2002: Passenger Cars and Light Trucks With a Review of 19 Fmvss and Their Effectiveness in Reducing Fatalities, Injuries and Crashes*. CreateSpace; 2013.
55. Arbogast KB, Jermakian JS, Kallan MJ, Durbin DR. Effectiveness of belt positioning booster seats: an updated assessment. *Pediatrics*. 2009;124(5):1281-1286.
56. National Highway Traffic Safety Administration. *Results of the National Child Restraint Use Special Study*. US Department of Transportation; 2015. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812142
57. Liu BC, Ivers R, Norton R, Boufous S, Blows S, Lo SK. Helmets for preventing injury in motorcycle riders. *Cochrane Database Syst Rev*. 2008;(1):CD004333.
58. Burd-Sharps S, Bistline K. Reports of Road Rage Shootings are on the Rise. Everytown Research and Policy. Published April 4, 2022. Accessed July 14, 2022. https://everytownresearch.org/reports-of-road-rage-shootings-are-on-the-rise/
59. CDC Injury Center. *Motor Vehicle Safety: Distracted Driving*. Centers for Disease Control and Prevention; 2022. https://www.cdc.gov/transportationsafety/Distracted_Driving/index.html
60. Aeron-Thomas AS, Hess S. Red-light cameras for the prevention of road traffic crashes. *Cochrane Database Syst Rev*. 2005;(2):CD003862.
61. Ecola L, Batorsky B, Ringel J, et al. A New Tool to Help Decisionmakers Select Interventions to Reduce Traffic Crash Deaths and Injuries. Published online 2015. doi:10.7249/rb9827
62. Beyer FR, Ker K. Street lighting for preventing road traffic injuries. *Cochrane Database Syst Rev*. 2009;(1):CD004728.
63. Bunn F, Collier T, Frost C, Ker K, Roberts I, Wentz R. Area-wide traffic calming for preventing traffic related injuries. *Cochrane Database Syst Rev*. 2003;(1):CD003110.
64. Elvik R. Effects on Road Safety of Converting Intersections to Roundabouts: Review of Evidence from Non-U.S. Studies. *Transportation Research Record: Journal of the Transportation Research Board*. 2003;1847(1):1-10. doi:10.3141/1847-01
65. *Wildlife-Vehicle Collision Reduction Study: Report to Congress*.; 2008.
66. Oddone Aquino AGHE, Nkomo SL. Spatio-Temporal Patterns and Consequences of Road Kills: A Review. *Animals (Basel)*. 2021;11(3). doi:10.3390/ani11030799

67. Meuleners LB, Hendrie D, Lee AH, Legge M. Effectiveness of the black spot programs in Western Australia. *Accid Anal Prev*. 2008;40(3):1211-1216.
68. Elvik R. A meta-analysis of studies concerning the safety effects of daytime running lights on cars. *Accid Anal Prev*. 1996;28(6):685-694.
69. Advanced Automatic Collision Notification Research Report. https://trid.trb.org/view/1637990. Accessed May 19, 2022. https://trid.trb.org/view/1637990
70. He K, Zhang P, Wang SC. Crash Telemetry-Based Injury Severity Prediction is Equivalent to or Out-Performs Field Protocols in Triage of Planar Vehicle Collisions. *Prehospital and Disaster Medicine*. 2019;34(04):356-362. doi:10.1017/s1049023x19004515
71. Plevin RE, Kaufman R, Fraade-Blanar L, Bulger EM. Evaluating the Potential Benefits of Advanced Automatic Crash Notification. *Prehosp Disaster Med*. 2017;32(2):156-164.
72. Griffin RL, Carroll S, Jansen JO. Automatic collision notification availability and emergency response times following vehicle collision-an analysis of the 2017 crash investigation sampling system. *Traffic Inj Prev*. 2020;21(sup1):S135-S139.
73. Lee E, Wu J, Kang T, Craig M. Estimate of mortality reduction with implementation of advanced automatic collision notification. *Traffic Inj Prev*. 2017;18(sup1):S24-S30.
74. National Highway Traffic Safety Administration. *Rural/Urban Comparison of Motor Vehicle Traffic Fatalities*. U.S. Department of Transportation; 2021. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813206
75. The National Highway Traffic Safety Administration and special crash investigations. *Ann Emerg Med*. 2003;41(4):576-578.
76. National Highway Traffic Safety Association. Crash Injury Research and Engineering Network (CIREN). Crash Injury Research and Engineering Network (CIREN). https://one.nhtsa.gov/Research/Crash-Injury-Research-(CIREN)
77. United States Department of Transportation. Intelligent Transportation Systems Joint Program Office. Intelligent Transportation Systems: Deployment and Evaluation. Accessed April 17, 2022. https://www.its.dot.gov/index.htm
78. Pigneri DA, Beldowicz B, Jurkovich GJ. Trauma Systems: Origins, Evolution, and Current Challenges. *Surg Clin North Am*. 2017;97(5):947-959.
79. Alharbi RJ, Shrestha S, Lewis V, Miller C. The effectiveness of trauma care systems at different stages of development in reducing mortality: a systematic review and meta-analysis. *World J Emerg Surg*. 2021;16(1):38.
80. Choi J, Carlos G, Nassar AK, Knowlton LM, Spain DA. The impact of trauma systems on patient outcomes. *Current Problems in Surgery*. 2021;58(1):100840. doi:10.1016/j.cpsurg.2020.100840
81. Myers SR, Branas CC, French B, Nance ML, Carr BG. A National Analysis of Pediatric Trauma Care Utilization and Outcomes in the United States. *Pediatric Emergency Care*. 2019;35(1):1-7. doi:10.1097/pec.0000000000000902
82. Grossman Verner HM, Figueroa BA, Salgado Crespo M, Lorenzo M, Amos JD. Trauma center funding: time for an update. *Trauma Surg Acute Care Open*. 2021;6(1):e000596.
83. Dowd B, McKenney M, Boneva D, Elkbuli A. Disparities in National Institute of Health trauma research funding: The search for sufficient funding opportunities. *Medicine* . 2020;99(6):e19027.
84. Rural Trauma Team Development Course. ACS. Accessed July 15, 2022. https://www.facs.org/quality-programs/trauma/education/rttdc