**Chapter 22
Ambulance safety**

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**Introduction**

Ambulance crashes and the resulting injuries, fatalities, and liability have elevated the discussion of ambulance safety to an urgent level. This chapter includes an introduction to the issue and an exploration of the factors related to crashes, and concludes with recommendations for ways in which EMS professionals, medical directors, and agency administrators can help mitigate this serious problem.

**Risks to providers**

Transportation-related events result in high rates of injury and fatality among EMS professionals. These events include ambulance crashes, EMS personnel being struck by moving vehicles, and air ambulance crashes. The vast majority of these events are ambulance crashes ([Figure 22.1](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c22.xhtml#c22-fig-0001)). Maguire et al. found that transportation-related events cause 59% of all EMS occupational fatalities [1]; there are about ten transportation-related fatalities per year among EMS personnel in the US [2]. According to the National EMS Memorial Service, 21 EMS personnel died in 2012; nine of the fatalities were from ambulance crashes [3].



[**Figure 22.1**](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c22.xhtml#R_c22-fig-0001) The author, in jeans, was an ambulance service administrator in New York City; he is pictured at the scene of a crash of one of his ambulances in 1994. The two paramedics in the vehicle were responding to an emergency call at the time of the collision. When the fire department arrived the medics were found hanging upside down from their seat belts. They were extricated and transported to the hospital. Fortunately both were discharged later that day with no more than minor injuries.

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Kahn et al. studied the characteristics of fatal ambulance crashes in the United States involving 89 ambulance occupant fatalities and 592 non-fatal ambulance occupant injuries during one 11-year period. They found that most crashes and fatalities occur during emergency use and that most of the fatal and serious injuries among ambulance occupants occurred in the patient compartment [4].

Maguire et al. found that the rate of transportation-related occupational injuries for EMS personnel is more than 30 times higher than the national average; 9% of all EMS occupational injuries are secondary to transportation-related events; and 20% of (crash-related) cases resulted in 31 or more lost work days [2,5,6]. Saunders and Heye found an overall collision injury rate of 22.2 EMS worker injuries per 100,000 emergency (lights and sirens) responses [7]. Gershon et al. found nine collision-related injuries among 197 EMS field personnel in one year; they noted that the resulting injuries were “particularly severe and resulted in extended loss of work time” [8]. Every year 15 Australian paramedics are seriously injured in crashes [9].

**Risks to others**

Crashes involving ambulances on public roads in the US produce twice as many casualties as the national average [10]. Evidence also suggests that civilians make up a large portion of the victims. Kahn et al. found that “the greatest burden of serious injury and death fell upon persons not in the ambulance,” with 89 fatalities among ambulance occupants but 316 among non-ambulance occupants [4]. Sanddal et al. found that “persons in other vehicles involved in collisions with ambulances were the most likely to die as a result of crashes” [11]. Maguire et al. described 25 ambulance occupant fatalities in the US between 1994 and 1997; eight were described as EMS personnel, and 68% of the fatalities were non-EMS personnel including patients, family members, and friends [1].

**Legal risks**

The risks associated with ambulance crashes extend beyond injuries and fatalities. For example, the proportion of EMS agency lawsuits that relate to ambulance crashes has been reported to be between 45% and 100% [12–14].

**Other considerations**

While grieving for lost colleagues and civilians or coping with catastrophic medical bills, companies are simultaneously attempting to cover lost workdays and train replacement workers. It is conceivable that these stresses cause further distractions, which may lead to more deaths, crashes, injuries, costs, and lost workdays.

In a state-wide study, Weiss et al. found that there were more ambulance injuries in the urban environment, but the severity of injury was greater in rural environments [15]. For all vehicle crashes, the injury fatality rate is “almost three times higher in rural areas” [16].

Elling examined New York State data between 1984 and 1987 and found that 1,894 ambulance occupants were injured in 1,412 ambulance collisions [17]. Becker et al. found a significant difference in risk of fatality or serious injury between restrained and unrestrained ambulance passengers [18]. Ray and Kupas found that the highest-risk locations for ambulance crashes are at intersections and traffic signals [19]. The same authors found that “operator error was the most common cause of crashes” [20].

Maguire found an average of over 70 injuries and fatalities per year in ambulance crashes that involved at least one fatality on major roads in the United States [10]. Clawson et al. found that ambulance “wake-effect” collisions may occur with greater frequency than collisions involving ambulances [21]. Therefore, there may be over 140 people killed or injured in ambulance-related collisions every year. With a reported 31 million EMS calls in the US during 2004 [22] and 37 million calls in 2010 [23], the risks to personnel, patients, and the public are growing.

**Contributing factors**

Although insufficient data exist to quantify factors contributing to ambulance crashes, Haddon’s Matrix provides a logical approach to categorizing and describing factors that seem likely to contribute to the risks [24]. In [Table 22.1](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c22.xhtml#c22-tbl-0001), the matrix is adapted to identify factors related specifically to ambulance crashes [25]. Human factors include fatigue, poor driver training, distractions, stress, poor driving skills, and diesel fume exposure. Vehicle factors include poor maintenance before the event, and protruding objects, sharp corners, and unsecured equipment during the event. Examples of environmental issues include both the ambulance’s environment at the time of the event and the environment (culture) of the agency. For example, poor visibility and hazardous road conditions relate to the crash environment while inadequate agency policies and/or enforcement of policies (e.g. related to speed or seat belts) are examples of inadequacies in the agency culture, as is insufficient support for research and prevention.

[**Table 22.1**](https://jigsaw.vitalsource.com/books/9781118990827/epub/OPS/Vol2/c22.xhtml#R_c22-tbl-0001) Haddon Matrix for emergency vehicle collisions

Source: Maguire BJ. *EMS Manager and Supervisor* 2003;5:4–7. Reproduced with permission of Elsevier.

|  | **Human/host** | **Vehicle/agent** | **Environment** |
| --- | --- | --- | --- |
| **Pre-event (preinjury)** | FatiguePoor driver trainingImpaired hearingAlcohol/substance abuseNon-use of seat beltsDistractionsStressPoor driving skillsDiesel fume exposureSmokingSpeed | Poor maintenancePoor designInappropriate tires or tire pressureLack of functional seat beltsLack of driver’s compartment airbags | Poor visibilityHazardous conditionsUrban vs ruralInadequate agency policies and/or enforcementInadequate funding for research and prevention |
| **Event** | Employee’s healthResistance to energy | Protruding objectsSharp cornersUnsecured equipment | Lack of vehicle restraining walls/rails on roadside |
| **Post-event** | Employee’s healthPriority given to other’s care over self-care | Presence of hazardous materials | Availability of ambulancesTrauma center |

**Fatigue**

*Joseph Neal Sherman was a 25-year-old paramedic. He was killed in an ambulance crash on March 16, 2001* [26]*. The night before the crash, his partner had worked the overnight shift at a volunteer fire department. At the time of the crash, Neal was caring for a patient in the back of the ambulance. His partner fell asleep, veered off the road, and struck a guardrail* [27]*. The vehicle rolled 300 feet, flipping over several times before landing upside down in a ditch. The other three ambulance occupants were injured. Neal was killed; he left behind a wife and an unborn child.*

A growing body of literature links fatigue to a host of occupational risks, including crashes. Dawson and Reid found that “moderate levels of fatigue produce higher levels of impairment than the proscribed level of alcohol” [28]. Arnedt et al. found that 21 hours of wakefulness produces impairment of the same magnitude as a 0.08% blood alcohol concentration (BAC) [29]; the legal limit for commercial drivers in the United States is 0.04% BAC [30]. A 2007 report by the International Association of Fire Chiefs noted that sleep deprivation is an important factor contributing to injuries within the fire service; several studies were cited noting that alertness and postural stability decline during extended shifts, leading to increased worker stress and more crashes [31]. The National Highway Traffic Safety Administration (NHTSA) National EMS Advisory Council, Safety Committee, noted that “poor sleep and fatigue among EMS workers represent potential threats to patient care, provider wellbeing, and the public’s health” [32]. NHTSA notes that “fatigued drivers were twice as likely to make performance errors as compared to drivers who were not fatigued” [33].

Patterson et al. found a “3.6 greater odds of safety compromising behavior among fatigued respondents versus non-fatigued respondents” [34]. Studnek and Fernandez found that the odds of involvement in an ambulance crash within the past year were significantly higher for those reporting sleep problems [35]. In one survey, “almost half (48%, n = 29) of paramedics answered yes to having nodded off or fallen asleep whilst driving” [36]. The *JEMS* 2012 survey of 200 cities found “85.9% of respondents (are) working 24-hour shifts” [37]. Although long shifts may be less problematic for workers in slower areas who may be able to have extended sleep periods, it is likely a significant problem for busier units and systems.

**Poor driver training**

Anecdotal evidence suggests that many ambulance driver training programs (perhaps thousands) exist in the United States. These programs range from a short orientation to courses of over 40 hours, incorporating classroom presentations and discussion, driving practice on a dedicated track, and field internship with a driver-training mentor. However, no research was found that demonstrates efficacy or any difference in outcomes between these various programs.

**Passenger restraint**

Larmon et al. found that seat belt usage is low among EMS providers working in the patient compartment. They noted that the following issues may account for the low usage:

* the providers perceive that seat belts in the patient compartment are ineffective (that the seat belts were designed for forward-facing passengers and, as such, provide minimal protection for and may even cause additional harm to side-facing passengers)
* they perceive that the use of seat belts will decrease their ability to care for their patients
* some believe there is minimal risk of injury or death associated with the provision of emergency medical care [38].

Johnson found that two-thirds of EMS respondents “reported not wearing their seatbelt on the squad bench while treating patients” [39].

Maguire and Porco found that at least four of 13 EMS workers injured in collisions were not wearing restraints [40]. Proudfoot reviewed 25 fatal ambulance collisions resulting in 27 fatalities and found that 22% of EMS workers killed while riding in the patient compartment were not wearing restraints, and 26% who died while driving the ambulance were unrestrained [41]. Becker et al. found that “restrained ambulance occupants involved in a crash were significantly less likely to be killed or seriously injured than unrestrained occupants” [18]. So it is shocking to find that “most states do not require patients of any age to be restrained in ambulances” [42].

**Distractions**

Emergency medical services personnel are confronted with many distractions while driving ambulances. These include “multiple radios, a computer, and warning system controls, in addition to all the usual controls found in a typical vehicle. The driver of the ambulance may be expected to operate several devices while driving on busy streets with a vehicle full of distraught patients and family members” [10]. NHTSA estimates that distractions account for 20–30% of passenger car crashes [43,44]. Saunders and Heye found that a major cause of ambulance crashes in an urban environment was “inattention” [7].

**Ambulance structural design**

In 2003, Maguire reported that “the crashworthiness of ambulances is largely unknown. The integrity of vehicle structures, the vehicle's ability to protect occupants from fatal and serious injuries, the vehicle’s ability to prevent occupant compartment intrusion or ejection of passengers, and the vehicle’s ability to prevent or reduce injuries from occupant impact with interior surfaces (especially sharp cabinet corners, IV holders, and oxygen ports) probably varies significantly from manufacturer to manufacturer. The compatibility of structural crash performance with occupant restraint systems is also largely unknown” [10]. Levick and Yannaccone evaluated ambulance patient compartments under crash conditions and demonstrated the need for special testing to be done for the ambulance patient compartment [45].

**Diesel fumes**

Although the US nationwide ambulance fleet has been largely converted to diesel, nothing is known about the effects this may be having on the EMS workforce. Mills et al. describe an increased coronary risk associated with diesel fume exposure [46]. The Environmental Protection Agency reports that short-term exposure can cause neurophysiological symptoms (e.g. lightheadedness, nausea) [47]. Kilburn found that workers exposed to diesel fumes had “significantly impaired reaction time” [48].

**Recommendations**

Any intervention designed to improve the health of the population should be subject to the same rigorous scientific evaluation as an intervention designed to improve the health of an individual. We would never consider administering a drug that had not gone through rigorous scientific evaluation. Sadly, we are not much further along than “grandma’s home remedies” when it comes to interventions designed to save the lives of paramedics. Years of well-intentioned interventions have resulted in a variety of unproven solutions, including possibly thousands of driver training programs. Many of these courses could, for all we know, be *increasing* the risks of collisions, injuries, and fatalities.

In all the literature, only two papers were found that describe interventions to reduce ambulance collisions, with one focusing on outcomes and the other on process. The first is a 1997 paper by Maguire and Porco that describes a bimodal intervention. The authors concurrently introduced a standardized driver training program and a change in department policy. The pre- and posttest evaluation found that the ambulance collision rate changed from one collision per 1,146 calls during the 12 months before the interventions to one collision per 2,940 calls during the 12 months after the interventions [40]. Levick and Swanson described an 18-month evaluation of 36 vehicles in a metropolitan EMS group using an “onboard computer-monitoring device.” “In >1.9 million recorded miles, performance improved from a baseline low of 0.018 miles between penalty counts to a high of 15.8 miles between counts. Seatbelt violations dropped from 13,500 to 4” [49].

Before we begin any efforts to improve ambulance safety we must first and foremost accept that ambulance crashes are largely preventable. We have both the responsibility and the ability to drastically reduce the number and severity of ambulance crashes. We can no longer delude ourselves by thinking “accidents” are unavoidable. Instead we must use the tools and abilities we have to make the changes necessary to reduce the risks for ourselves, our employees, our patients, and our communities.

**Using the four Es of injury prevention: Education, Engineering, and the Enactment and Enforcement of risk reduction policies**

*A turning point in EMS history came about in 1994 when a group of paramedics noticed that the pediatric drowning rate was increasing in their county. It is a turning point in history because, instead of asking how can we get there faster or what new drugs or tools can we use, someone asked: “how can we prevent them?” They did a retrospective analysis of the circumstances surrounding the cases. Then they used the four Es.*

* *They educated the community about the problem and the ways to prevent drowning.*
* *They called for engineering interventions in the form of fences around swimming pools.*
* *They worked with elected officials and enacted and enforced policies related to fences around swimming pools.*

*A postintervention analysis showed that the pediatric drowning rate decreased by 50%!*[50]

As related to improving ambulance safety, the four Es mean:

* educating the workforce
* evaluating engineering interventions such as electronic monitoring
* enactment and enforcement of policies on topics such as speeding, safe driving, and safety measures such as requiring slow ambulance speed when occupants are unbelted.

The World Health Organization has laid out a logical approach to reducing crashes and injuries [51].

* Conduct surveillance to determine as much as possible about all aspects of the crashes and injuries
* Research causes of crashes and injuries
* Explore ways to prevent crashes and reduce the severity of injuries by designing, implementing, monitoring, and evaluating appropriate interventions
* Implement interventions that appear promising
* Conduct cost-benefit analyses
* Disseminate (i.e. publish in peer-reviewed journals) the results
* Translate effective science-based information into policies and practices that protect pedestrians, cyclists, and vehicle occupants
* Promote capacity building in all these areas, particularly in the gathering of information and in research

What follows are suggestions for interventions that seem to be effective, but should still be evaluated before large-scale deployment. It should be noted that single-construct approaches to any given problem often fail to account for the breadth, complexity, and nuances of that problem. Brice et al., for example, recommended that “the unique challenges of ambulance safety may be met by analyzing systems and incorporating process improvements” [52]. This section focuses on multimodal risk reduction strategies projected to have maximal effect for improving ambulance safety.

**Fatigue**

There is now no doubt that extended shifts place EMS workers, EMS agencies, patients, and the community at increased risk for injury and death. Therefore, shifts of no more than 12 hours must become the standard in the industry. Training to educate the workforce about the risks associated with fatigue must be implemented and continued. Policies that address the issues of adequate sleep time between multiple employers, and how to address unplanned sleep loss (such as caring for a sick child all night), should also be developed.

*In 1997, Heather Brewster was 23 years old, a former college volleyball star and a graduate student with a promising life ahead of her. All the promises vanished abruptly as her car was rear-ended in a tragic collision. Heather received massive brain injuries that have left her permanently disabled* [53].

*Although the incident had nothing to do with EMS, it raised issues that may have a profound effect on the future of EMS operations.*

*The crash was caused by a medical resident who had just come off a 36-hour shift. The family sued the hospital on the grounds that the hospital had at least as much responsibility as a bartender and should not have allowed an impaired person to drive* [54]*. Although an appellate court found for the hospital* [55]*, at least two states (Oregon and West Virginia) have ruled that “an employer’s responsibility for fatigue-related crashes can continue even after they have left work*” [53]*. Research on medical residents found a 2.3-times greater risk of collision on the way home from extended (>24-hour) shifts than after non-extended shifts* [56]*.*

An indisputable body of research now proves that fatigue increases the risk of self-harm and harm to others, including patients, occupants of the ambulance, and other vehicles and pedestrians. However, changing to 8-hour shifts alone, for example, would not necessarily eliminate the problems. Neal Sherman was killed when the driver of the ambulance fell asleep; the driver had worked just an 8-hour shift the day before but then worked all night at a volunteer firehouse before returning to work the day of the crash [27]. Nor is the risk limited to those with multiple jobs; for example, being up all night with a sick child could have the same effect.

Clearly there must be an agreement for shared responsibility between employee and employer, for clearly there are shared risks. Both EMS employers and EMS employees are at risk of legal liability for fatigue-related crashes both during and after shifts. Only through research, education, and a change in culture toward a shared responsibility for safety can this problem be mitigated.

**Driver training**

Without research to determine the effectiveness of the many ambulance driver training programs currently used, no logical recommendations can be made. Therefore, research must be supported that will allow EMS professionals, medical directors, and agency administrators to implement driver training programs proven to reduce the risk of ambulance collisions as well as crash-related injuries among EMS personnel, ambulance occupants, occupants of other involved vehicles, and pedestrians.

**Use of red lights and sirens**

In 1994, the National Association of EMS Physicians and the National Association of State EMS Directors (now the National Association of State EMS Officials) released a joint position statement and noted the risks associated with the use of warning lights and sirens (WLS) [57]. Custalow and Gravitz found a disproportionate percentage of crashes occurred during WLS operations [58]. Despite the published concerns, no subsequent reports have been found to indicate that the rate of WLS has changed.

There are many factors that may contribute to this apparent disregard for safety. EMS field personnel may consider WLS necessary in congested areas to help facilitate response and transport. Dispatchers and medical directors have concerns about delays in providing medical care to critically ill patients. The public often has an expectation that emergency vehicles will arrive with active warning devices and may voice dissatisfaction that their call for help was not “taken seriously” if vehicles arrive in non-emergency mode. A blanket policy is unlikely to change the use of WLS. Instead, all stakeholder groups require education and training that will give them the ability to make appropriate risk decisions related to vehicle operations. Improved education, as well as improved communication and coordination among various stakeholders, may finally allow for a reduction in the use of WLS.

**Passenger restraints**

There is no question that the use of safety belts, in addition to being good practice and required by law, is a proven method for reducing fatalities and serious injuries in a collision. From an evidentiary standpoint, there is no reason for EMS personnel to be unrestrained while in ambulances, yet many EMS personnel choose not to wear safety belts in ambulances, despite laws and agency regulations to the contrary. Further rule making, by itself, is likely to prove futile. Instead, personnel must be educated about the risks so that they can make appropriate risk/benefit decisions. Part of this education should include considerations of alternative risk reduction strategies. For example, adopting a practice of notifying the driver whenever a medic is unrestrained would allow the driver to immediately reduce speed and take added precautions.

**Driving history**

Custalow and Gravitz found that 71% of the emergency vehicle drivers involved in collisions had histories of prior emergency vehicle collisions [58].

Kahn et al. found that a significant portion of ambulance operators had prior records of traffic violations and crashes [4]. Although this number was not significantly different from that in the general population, it may be that providing additional, targeted education to these drivers (or perhaps not giving driving privileges to personnel with particularly worrisome driving records) could result in a reduced rate of crashes. Further, many agencies, even those that do conduct initial driving background checks, do not do background driving checks on a regular basis. As a result, it is possible that a significant change in an EMS worker’s driving record (such as a suspension, serious crash, or driving under the influence conviction) could occur without the agency’s knowledge. EMS agencies are encouraged to implement regular programs of assessing driving records and driving ability.

**Sex and age**

A 2011 study of EMS transportation-related injuries and fatalities found that females were the victims in 53% of the cases, yet females only accounted for 27% of the study population [59]. The disparity echoed earlier findings that female EMS personnel have a higher rate of injuries than male EMS personnel [6,60]. These findings warrant specific research on sex differences in EMS. In addition to determining any differences in injury rates, future research should investigate differences in ambulance crash causative factors by sex. As an example, Baker et al. found that “there are large gender differences in the types of pilot error involved in general aviation crashes” [61]. If there are significant sex differences in ambulance crash causative factors, then sex-specific ambulance driving training programs may be needed. Clearly, more research is needed in this area.

Reasons for crashes also vary by the age group of the driver [33]. As a result, we should also investigate the utility of age group-specific ambulance driver training.

**Vehicular design**

Although the chassis and front compartment of an ambulance are regulated by the Federal Motor Vehicle Safety Standards, exemptions apply to the rear compartment [43]. The Ambulance Manufacturers Division of the National Truck Equipment Association (AMD) has issued a set of standards to help define when an ambulance is considered safe [62,63]. Controversy exists as to whether these standards are sufficient. In addition to being the most dangerous area of the ambulance, the rear compartment is also the least regulated.

One of the factors involved with the death of Neal Sherman was that he was struck by an oxygen bottle at some point during the crash or subsequent rollover of the ambulance. Any equipment in the ambulance must be secured in such a way as to not come loose during a crash or rollover. Sharp corners and hard surfaces should be padded. The inside of the vehicle should be free of protruding objects. A metal IV pole hanging from the ceiling could result in a punctured skull; an oxygen nipple protruding from the wall could be as deadly as a knife if someone is thrown against it during a crash.

Back-up alarms are essential for any large vehicle; adding rear-vision cameras and the safety sensor systems now available on some automobiles may help reduce injuries associated with driving the ambulance in reverse. Having a live person behind the ambulance to direct the driver during reverse driving should always be the rule.

Improving the visibility of the vehicle for use during day and night, and emergency and non-emergency operations, in both normal and harsh conditions should continue to be a priority.

Changes to the interior design of the ambulance must consider safety during crashes as well as ergonomic factors affecting EMS personnel on a daily basis [64,65].

It is unlikely that significant improvements to ambulance design can be made without partnerships between national organizations, government agencies, ambulance manufacturers, engineers, researchers, EMS agencies, and EMS professionals. Many manufacturers have attempted to improve the safety of ambulances through design changes such as better equipment tie-downs, increased padding on corners, rounding of corners, and more ergonomic considerations of seat placement and restraints. The National Institute for Occupational Safety and Health (NIOSH) has been working to develop designs for safer ambulances [66]. There are insufficient data, however, to help drive these changes in an evidence-based fashion. Further, there are significant questions regarding the design of restraints for the rear compartment that will likely not be satisfactorily resolved without rigorous research.

The partnership should also consider design changes from the international community. For example, other nations have adopted significantly different ambulance designs. Although data are currently lacking to promote one design over another, further research on these alternative designs may lead to improvements in vehicle structure and operational safety.

**Diesel fumes**

As with all potential exposures, we should monitor our providers to assure they are not suffering from short- or long-term complications from these fumes. In the meantime, ambulance garages should be kept well ventilated and ambulances should be kept idling for as little time as possible.

**Vehicle safety**

One recent innovation in ambulance safety is a device similar to the “black box” used in airplanes. It is a real-time monitor of speed, acceleration, seat belt use, and other safe driving parameters. Unsafe use is noted by warning tones from the monitor, with a change in tone indicating a highly unsafe condition. These data are logged and individually identified. The device combines real-time feedback, allowing self-correction of potentially hazardous conditions. Such a device may help “modify the risk-taking behavior” of EMS drivers [67] and “improve driver safety” [68]. With appropriate oversight, EMS agency administrators can determine if particular drivers require further education or revocation of driving privileges. One report using the technology with ambulances showed a remarkable drop in the number of dangerous conditions; as an additional benefit, maintenance costs were sharply decreased due to less mechanically stressful driving conditions [49].

In 1997 and 1998, a new ambulance occupant restraint device was described, called the Kicker Vest [40,69]. Although the initial reviews were promising, an engineer noted that the device might result in a fatal injury if the paramedic was, for example, turned to face the squad bench at the time of the collision. The Kicker Vest is one example of a new piece of equipment, designed to protect ambulance personnel and patients, which is well meant but may not function as intended and may even be dangerous. The example also reemphasizes the need for reliable, rigorous research before new devices, policies, or interventions are adopted.

The Centers for Disease Control and Prevention recommended that “Ambulance manufacturers should evaluate and develop occupant protection systems designed to increase the crash survivability of EMS workers and patients in ambulance patient compartments and ensure that such systems allow EMS workers mobility to access patients and equipment” [70]. This is not, by itself, a reasonable solution. Individual ambulance manufacturers do not have the resources to undertake a project of this magnitude. Instead, a partnership of manufacturers, industry, and government must work together to develop realistic solutions.

**Research**

Judging by the publication dates of the references used for this chapter, it appears that the rate of research on ambulance crashes is increasing; however, many questions remain.

Over a decade ago, NHTSA noted the importance of dedicated funding in order to conduct EMS research and develop EMS researchers [71]. Today, there remains a paucity of EMS research funding and little incentive or support for EMS professionals to become researchers.

Reliable solutions for EMS problems can only be achieved following rigorous research. We in the EMS community must take it upon ourselves to create the support needed for these efforts. Coalitions of individuals, agencies, researchers, associations, manufacturers, and government must be formed to help mitigate this serious national problem through effective research, testing, sharing findings, and implementing best practices. In order to conduct that research, funding will be required and research teams will need access to comprehensive data.

An agency-based systems approach to the problem must include considerations for human factors, vehicle factors, and environmental factors. For example, each agency should have a team dedicated to ambulance safety. Members of the team must be well-trained collision investigators. The ambulance safety team should:

* ensure that the agency has a reliable, comprehensive data collection system
* determine the agency’s historical risks, e.g. crashes per year (or per thousand calls or million miles driven) for the past few years
* set goals for improvement
* develop and test interventions
* celebrate accomplishments
* work with state, national, and international groups to develop, evaluate, and share best practices.

**Conclusion**

An average of ten EMS professionals die every year and hundreds more are injured in transportation-related events in the US alone. Many of those injuries may result in the end of a career that was dedicated to helping the community. These are not “accidents,” they are predictable, preventable events.

Emergency medical services professionals are not the only victims in these events. Based on the cited ambulance safety research, we can estimate that ambulance-related incidents result in 20 civilian fatalities and hundreds of non-fatal injuries among our patients, passengers, and community members every year in the US alone.

Working together, we can pursue a vision of improved ambulance safety and zero fatalities from ambulance crashes. This means EMS professionals working with engineers, epidemiologists, researchers, physicians, manufacturers, government officials, and others to analyze the problems and to develop, test, and implement solutions.

Development of effective strategies to improve ambulance safety and the means to conduct effective research to monitor the implementation of these strategies requires the efforts of a broad coalition of individuals, manufacturers, industry, and government.

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