

Searching for Ambulance Safety: Where is the literature?

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ABSTRACT

Objective: To identify epidemiology, risk management and engineering publications regarding ambulance transport safety, ambulance collisions, morbidity, mortality, and adverse events resulting from ambulance collisions.

Methods: Using MEDLINE (January 1, 1966 to June 1, 2005), a review was conducted to identify articles relating to ambulance collisions or ambulance safety. Non-peer reviewed articles were excluded from analysis. Automotive databases were searched to meet these criteria in addition to consultation with ambulance automotive safety expertise to identify additional engineering publications. Total fatal ambulance collisions, injuries, and fatalities incidence per 100 million miles traveled were estimated for each relevant study and costs identified.

Results: Identified via MEDLINE were 29 epidemiological, 5 risk management, 1 peer-reviewed ergonomic paper, 4 editorials and no peer-reviewed engineering papers. Identified via the other search approaches were 6 peer-reviewed engineering papers, 2 standards, 2 guidelines, 1 report, 1 technical symposium's proceedings, 1 specification and 2 editorials. The data reviewed demonstrated that approximately 5136 collisions, 6 fatal collisions, 11 fatalities and 1453 injuries occur per 100 million miles traveled. Risk factors identified were use of warning lights and sirens, drivers with a prior collision history, lack of use of restraints by personnel, and driving through red lights at intersections. Ambulance collisions are the highest liability cost in EMS.

Conclusions: Ambulance transport is hazardous and adverse vehicle events expensive. Even though the majority of ambulance safety literature is very recent, most studies fail to use a common denominator to characterize rates of incidents, injuries and fatalities. This is especially problematic when attempting to compare studies across time, different services and geographical regions. Furthermore, there is an overall failure of the MEDLINE electronically indexed database to integrate important peer-reviewed engineering articles addressing ambulance safety. Studies reviewed suggest that enforcement of driving regulations, changing ambulance operators' behavior and that head protection and improved engineering of the rear compartment may reduce injuries, fatalities and financial costs associated with collisions. Given the high cost and the frequency of these adverse events, ensuring standard common denominators in epidemiological studies and improving access to the engineering literature may assist the process for making positive change within the industry.

OBJECTIVE

To identify epidemiology, risk management and engineering publications regarding ambulance transport safety, ambulance collisions, morbidity, mortality, and adverse events resulting from ambulance collisions.

BACKGROUND

Emergency medical services (EMS) in the United States (US) have a short history compared to other professions such as law enforcement and fire services. Since before the 1960s, EMS were regulated by the Federal Government under the auspice of the Department of Transportation and the National Highway Traffic Safety Administration. Even though EMS were established to reduce the number of injuries and fatalities, the occupational fatality rate for pre-hospital care workers is substantially higher than the general public. Many emergency medical service personnel die of transportation related injuries. Many studies have documented risk factors associated with ambulance collisions. To date, there has been no published comprehensive review of ambulance safety from epidemiological, engineering, and financial viewpoints. This study will attempt to unify all the current research and studies into one comprehensive report that allows the data from one study to be comparable with all the published studies.

METHODS

Using MEDLINE (January 1, 1966 to June 1, 2005), a review was conducted to identify articles relating to ambulance collisions or ambulance safety. Non-peer reviewed articles were excluded from analysis. Automotive databases were searched to meet these criteria in addition to consultation with ambulance automotive safety expertise to identify additional engineering publications. Total fatal ambulance collisions, injuries, and fatalities incidence per 100 million miles traveled were estimated for each relevant epidemiological study and costs identified from the risk management papers. Key engineering issues identified from the engineering publications.

RESULTS

Identified via MEDLINE were 29 epidemiological, 5 risk management, 1 peer-reviewed ergonomic paper, 4 editorials and no peer-reviewed engineering papers (Fig. 1 identifies the data sources used in a number of the key epidemiological papers). Identified via the other search approaches were 6 peer-reviewed engineering papers, 2 standards, 2 guidelines, 1 report, 1 technical symposium's proceedings, 1 specification and 2 editorials. The data reviewed demonstrated that estimates of approximately 5136 collisions, 6 fatal collisions, 11 fatalities and 1453 injuries occur per 100 million miles traveled (Fig. 2). Risk factors identified were use of warning lights and sirens, drivers with a prior collision history, lack of use of restraints by personnel, and driving through red lights at intersections. Ambulance collisions are the highest liability cost in EMS and far exceed malpractice costs. The single ergonomic paper (from the UK) outlined clearly the challenges to the ergonomic safety of the EMS rear compartment in the UK environment. No USA ambulance vehicle safety standard was identified, one vehicle safety standard was European and the other was Australian. All engineering publications identified the rear ambulance compartment as hazardous. The engineering publications identified the need for and scope for changing ambulance operators' behavior, standards and design for head protection, and improved engineering of the rear compartment.

Figure 1:

Author	Publication Year	Location	Years Studied	Database Used
Weiss	2001	Tennessee	Aug 1993-March 1997	State Reporting
Kahn	2001	United States	1987-1997	FARS
Maguire	2002	United States	1994-1997	FARS, NEMSMS
Becker	2002	United States	1988-1997	FARS & GES
CDC	2003	United States	1991-2000	FARS
Custalow	2004	Denver, Colorado	1989-1997	Local Municipality
Biggers	1996	Houston, Texas	1993	Local Municipality
Calle	1999	Flanders, Belgium	1992-1996	Local Municipality
Auerbach	1987	Tennessee	Jan 1983-July 1996	State Reporting
Saunders	1994	San Francisco, California	June 1989-August 1991	Local Municipality
Pirallo	1994	United States	1987-1990	FARS
Elling	1989	New York	1984-1987	NYS DMV
King	2002	Undetermined	1995-2000 ?	Local Municipality

Figure 2:

Investigator	Ambulance Crashes per Million Person Years	Fatal Ambulance Crashes per Million Person Years	Fatalities per Million Person Years	Injuries per Million Person Years
Weiss	10.7	0	0	4.55
CDC	#	1.1	0.131	0.29
Kahn	1.8	1.2	0	0.27
Maguire	#	0.4	0.129	#
Becker	13.2	1.1	0.128	8.32
Custalow	41.3	#	0	15.84
Biggers	43	0	0	8.5
Calle	#	#	0.060	0.24
Auerbach	6.1	#	0	3.88
Saunders	80	0	0.113	11.85
Pirallo	#	0.4	0.084	#
Elling	19.7	0	0	26.45
King	#	0	#	#

Data unreported or could not be determined based on available information

DISCUSSION

Many studies use various denominators to report injuries, ambulance accidents, or fatalities such as person years, trips, emergency calls, or simply raw numbers without use of a common denominator. Lack of a common denominator in these studies makes the data incongruent and not comparable to each other. This study attempts to rectify the current problem in the literature by using a common denominator: incidents per 100 million miles traveled. This denominator avoids common confusions resulting from using emergency calls or trips. Trips are undefined and some emergency calls ultimately do not result in transport of patients. It appears that future studies regarding ambulance collisions should use a common denominator such as this when describing fatalities, injuries, or collisions in addition to providing raw numbers.

That warning lights and sirens increase the risk of collisions, and collisions resulting in injuries or fatalities is of serious concern - as were the failure of patients and emergency medical personnel to use restraints in the rear compartment. It would appear that the large financial burdens following ambulance collisions could be substantially mitigated with very simple initiatives pertaining to training and education and driver monitoring and feedback devices, as well as the use of personal protective equipment such as seat belts and helmets.

CONCLUSION

- Ambulance transport is hazardous and adverse vehicle events are expensive.
- Even though the majority of ambulance safety literature is very recent, most epidemiology studies fail to use a common denominator to characterize rates of incidents, injuries and fatalities. This is especially problematic when attempting to compare studies across time, different services and geographical regions.
- Ambulance safety is a multidisciplinary issue with important contributions from epidemiology, ergonomics, risk management and engineering research
- Furthermore, there is an overall failure of the MEDLINE electronically indexed database to integrate important peer-reviewed engineering articles addressing ambulance safety.
- Studies reviewed suggest that the following may reduce injuries, fatalities and financial costs associated with collisions:
 - enforcement of driving regulations (partic. Intersections)
 - changing ambulance operators' behavior
 - use of seat belts and securing of equipment
 - head protection
 - improved engineering of the rear compartment
- Given the high cost and the frequency of these adverse events, ensuring standard common denominators in epidemiological studies and improving access to the engineering literature may assist the process for making positive change within the industry.

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