Occupational Fatalities in Emergency Medical Services: A Hidden Crisis

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See editorial, p. 633.

Study objective: We estimate the occupational fatality rate among emergency medical services (EMS) personnel in the United States.

Methods: We undertook descriptive epidemiology of occupational fatalities among EMS providers. Analysis was conducted by using data from 3 independent fatality databases: the Census of Fatal Occupational Injuries (1992 to 1997), the National EMS Memorial Service (1992 to 1997), and the National Highway Traffic Safety Administration's Fatality Analysis Reporting System (1994 to 1997). These rates were compared with the occupational fatality rates of police and firefighters and with the rate of all employed persons in the United States.

Results: The Census of Fatal Occupational Injuries database documented 91 EMS provider occupational fatalities. The National EMS Memorial Service database contained 70 fatalities, and the Fatality Analysis Reporting System identified 8 ground-transportation EMS occupational fatalities. There was also wide variation in fatality counts by cause of injury. Using the highest cause-specific count from each of the databases, we estimate that there were at least 67 ground transportation–related fatalities, 19 air ambulance crash fatalities, 13 deaths resulting from cardiovascular incidents, 10 homicides, and 5 other causes, resulting in 114 EMS worker fatalities during these 6 years. We estimated a rate of 12.7 fatalities per 100,000 EMS workers annually, which compares with 14.2 for police, 16.5 for firefighters, and a national average of 5.0 during the same time period.

Conclusion: This study identifies an occupational fatality rate for EMS workers that exceeds that of the general population and is comparable with that of other emergency public service workers.

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INTRODUCTION

Emergency medical services (EMS) personnel are exposed to a wide variety of occupational hazards, including ambulance crashes, assaults, infectious disease, hearing loss, lower back injury, hazardous materials exposure, stress, extended work hours, and exposure to temperature extremes. These emergency medical technicians (EMTs) and paramedics respond to automobile crashes, shootings, medical emergencies, hazardous material incidents, and large-scale disasters. However, little is known regarding the risks associated with this occupation.

Because EMS personnel were not defined by a unique industry or occupational code, published data from the Bureau of Labor Statistics (BLS) cannot be routinely used to describe the risk of occupational illness or injury to these personnel. Therefore, the only information available were obtained from record reviews or surveys of EMS populations. It is also difficult to get a comprehensive injury profile from the published studies because the authors use different definitions of "injury" and use different denominators for their calculation of rates.

To date, few data are available to quantify the injury risk to EMS workers, in part because of a lack of specific codes to identify more workers in standard databases. This research was conducted to quantify the risk of fatality among providers of out-of-hospital care in the United States by combining data from 3 independent existing sources of data.

MATERIALS AND METHODS

The Census of Fatal Occupational Injuries (CFOI) is the central repository for information on fatal occupational injuries in the United States; occupational fatalities for particular groups can be identified by specific occupational codes. However, there is no specific occupational code used for EMS workers. Rather, EMS workers are mixed in with other occupational groups. We used CFOI to identify probable EMS injury fatalities from within 5 other occupational groups by using the methods described in this article. Because we believed our CFOI ascertainment was incomplete in identifying all EMS workers, we also examined 2 other databases. The Fatality Analysis Reporting System (FARS) is maintained by the US Department of Transportation, National Highway Traffic Safety Administration. The National Emergency Medical Services Memorial Service (NEMSMS) collects records of individual EMS fatalities. It is a private foundation associated with the National Association of Emergency Medical Technicians. The methods associated with each database are described in the following paragraphs.

The CFOI produces counts and descriptions of fatal work injuries.[1] The Bureau relies on multiple information sources and ensures that fatalities are work related by substantiating cases with 2 or more independent source documents or a source document and a follow-up questionnaire.

Because CFOI did not specifically identify EMS personnel as an occupational group,[2] 5 occupational groups likely to contain EMS workers were included in this research (see Table 1 for group descriptions). These groups were chosen for detailed examination after an author (BJM) identified at least one obvious EMS case in each of the categories. No obvious EMS cases were found among firefighters, the most likely other group to contain EMS cases.

Table 1.
Probable EMS fatalities from CFOI data, 1992 to 1997, by occupational group (n=91).

Occupational Code	Description	No. of Cases
106	Physician's assistants	3
207	Licensed practical nurses	9
208	Health technologists and technicians	37
446	Health aides, except nurses	9
447	Nursing aides, orderlies, and attendants	33

For the period from 1992 through 1997, there were 232 fatal-injury reports for these 5 occupational groups. The narratives of the 232 reports were read and evaluated by approximately 40 individuals, including paramedics, paramedic students, and EMS faculty in the Washington, DC, area. Each narrative was evaluated by using a Likert scale of 1 to 5 (1, highly unlikely that the subject is an EMS worker; 3, unknown; and 5, highly likely that the subject is an EMS worker). On the basis of these ratings, 91 cases were selected as probable EMS workers (average Likert scale score of ≥3.2). This cutoff point was chosen to include the cases that were more likely than not to be EMS workers while excluding the cases that were equally likely or less likely than not to be EMS workers. The EMS fatalities by CFOI occupational code are listed in Table 1.

The FARS 1994 to 1997 databases are available on the National Highway Traffic Safety Administration's Web page.[3] According to these databases, there were 345 case reports associated with 121 ambulance crashes between January 1994 and December 1997. These case reports include all individuals, injuries, and fatalities associated with any crash on a public road in which an ambulance was involved and at least one fatality resulted. Two hundred three of the case reports described occupants of the ambulance. Twenty-five of those occupants were fatally injured. Although the FARS database does not indicate the occupation of the decedent, 2 indicative criteria are included: it lists the vehicle that was occupied by the decedent, and it indicates whether the fatality occurred while the decedent was working. Of those 25 ambulance-occupant fatalities, 8 were classified as "fatal injury at work." This analysis includes only those 8 cases.

The NEMSMS Board created a Web site as a memorial to EMS providers who died in the line of duty.[4] In March 2000, this Web site listed the names and brief biographies of 154 EMS fatalities. The decedent's agency, coworkers, or friends voluntarily submit these cases and biographies. From the narratives, a database was created with the following items: date of incident, date of death, age, sex, occupation, type of incident, category of incident, subject activity at the time of incident, and employee status.

One hundred forty-five of the case reports noted the date of death. Cases that occurred before January 1992 or after December 1997 were not included in the study database. The 70 cases that occurred between 1992 and 1997 are included in this research.

Determining the number of EMS workers proved difficult because there is a wide disparity in the estimated number of EMS providers in the United States. In 1998, the BLS listed the number of employed EMTs as 150,000, which includes basic and intermediate EMTs and paramedics.[5] However, an article by Heightman[6] documented 832,503 certified EMS providers in the United States in 1999. Five possibilities account for the apparent discrepancy between the Heightman report and the BLS data. First, many certified EMS providers in the United States are volunteers who might perform EMS duty only a few hours per month. Second, many certified EMS personnel are not currently working in EMS. Third, individuals might hold multiple certifications in their home state. Fourth, some might be certified in more than one state. Fifth, many of the certifications might be held by individuals who work only as firefighters or police officers or in other professions, such as schoolteachers.

We recognize the current limitations of the BLS data for occupations such as EMS and firefighters in calculating rates on the basis of workers because many of those individuals work so sporadically that they might be counted in the denominator only after they appear in the numerator. We believe the BLS employment figure is more appropriate for calculating EMS fatality rates. It is also reasonable to use the BLS figure because the fatality rates for other occupations are calculated with BLS figures. The most pertinent example of this are the calculations of firefighter fatality rates by Clarke and Zak[7]; firefighting is another occupation in which there is a large number of volunteers.

At the time we began this project, we did not request institutional review board review because our study subjects were deceased and thus did not fall under the

scope of 45 CFR Part 46, which defines human subjects as living individuals. The George Washington University's institutional review board has informed us that if we had submitted this project for institutional review board review before data collection, this study would have been exempt.

RESULTS

For CFOI, 67 (74%) of the 91 probable EMS fatalities resulted from crashes. Ten (11%) fatalities were caused by assaults. In 7 of the 10 assault cases, the decedent was shot. The majority of these 10 victims were women. The 14 cases listed as "other" included cardiovascular incidents, air ambulance crashes, smoke inhalation, electrocution, falls, suicide, needle sticks, drowning, and injuries from other causes. These 14 cases are classified for this analysis as "other" because CFOI regulations preclude the identification of cells with fewer than 5 cases. Forty-six (51%) of the 91 probable EMS decedents were listed as driving at the time of the fatality.

For FARS, 2 of these 8 EMS transportation fatalities occurred in 1994, 4 in 1995, and 1 each in 1996 and 1997. Six of the incidents involved only 1 vehicle, 1 incident involved 3 vehicles, and 1 incident involved 4 vehicles.

Of the 70 fatalities identified from NEMSMS, 52 (74%) were transportation-related incidents. Of these, 33 (47% of total) were associated with ground-vehicle crashes or pedestrian fatalities. Twelve of the 33 decedents were driving, 8 were described as riding in the vehicle, 9 were listed as caring for patients, and 4 others were simply described as being in the vehicle or "other." Six of the 33 EMS workers in this group were struck by moving vehicles; 5 were listed as caring for patients and 1 was listed as "other." Nineteen (27%) decedents were members of air ambulance flight crews. Eighteen of these cases specified helicopter crash; 1 indicated only "air ambulance."

Twelve of the 70 narratives listed myocardial infarction as the cause of death, and one listed the cause of death as a pulmonary embolism. The 5 other fatalities resulted from needle sticks, electrocution, drowning, and other causes. Fifty-three (76%) of the 70 fatally injured workers were men; the sex of one was unknown.

The distribution by age is noted in Table 2 for fatalities from all 3 data sources. Approximately half the workers in each group were between 25 and 44 years of age.

As seen in Table 3, the majority of fatal injuries were related to ground-transportation incidents. This category includes vehicle crashes, as well as EMS workers struck by moving vehicles.

BLS regulations do not allow researchers to compare individual CFOI records with individual records from other sources. Therefore, we could not directly assess the overlap between CFOI, NEMSMS, and FARS data to identify unique cases. Instead, we used Table 3 to make an estimate of the minimum number of EMS fatalities from 1992 to 1997. To do this, the number of cases in each category from the data source with the largest number was recorded in the "fatality estimate" column. Thus, the "fatality estimate" column displays only cases that are known to be distinct. Because BLS policy precludes the identification of cells with fewer than 5 cases, the 14 cases listed as "other" are not included because their distribution might overlap with other cat-

Table 2.
Age distribution of EMS fatalities: CFOI, 1992 to 1997 (n=91); NEMSMS, 1992 to 1997 (n=70); and FARS, 1994 to 1997 (n=8)

	CFOI*	NEMSMS	FARS
Age, y	Cases, No. (%)	Cases, No. (%)	Cases, No. (%)
<20	†	2 (3)	0
20–24	11 (12)	9 (13)	2 (25)
25–34	22 (24)	20 (29)	1 (13)
35–44	27 (30)	14 (20)	4 (50)
45–54	15 (17)	8 (11)	1 (13)
55–64	11 (12)	3 (4)	0
>64	†	2 (3)	0
Other and unknown	5* (5)	12 (17)	0
Total	91 (100)	70 (100)	8 (100)

*CFOI regulations preclude the identification of cells with <5 cases.
†Does not meet BLS publication requirements.

egories. However, it is reasonable to assume that the actual number of distinct cases is greater than 114.

The BLS calculates occupational fatality rates per 100,000 employed workers per year. By using our 6-year minimum estimate of 114 fatalities and the BLS data for the denominator, the estimated EMS fatality rate is 12.7 per 100,000 workers per year (ie, [(114/6)/150,000]×100,000). Because of the potential sources of error in both the numerator and denominator, our estimated EMS fatality rate should be assumed to range between 2.3 (if we use the figures of 832,503 certified EMS providers for the denominator, as provided by Heightman[6]) and somewhat less than 18.8. This upper bound is based on the very unlikely assumption that all 169 of the cases found among the 3 numerator sources were unique, along with BLS employment data for the denominator.

During the period from 1992 to 1997, the national average occupational fatality rate in the United States was 5.0 per 100,000 workers per year.[7] Our estimated EMS average fatality rate for the same period is more than twice the national average and approaches the rates observed among police and firefighters, which were, respectively, 14.2 and 16.5 per 100,000 workers, calculated by using the same BLS employment data source for their denominators.

The leading cause of occupational fatalities for EMS personnel during this period was transportation incidents (86/114 fatalities). This is a rate of 9.6 fatalities per 100,000 EMS workers and compares with 6.1 for police and 5.7 for firefighters between 1992 and 1997.[7] As a midpoint year comparison, the transportation fatality rate for all workers in the United States was 2.0 per 100,000 workers per year in 1995.[8]

The estimated EMS fatality rate for fatal assaults is 1.1. This compares with a rate of 7.2 for police and 0.6 for firefighters (extrapolated from Clark and Zak[7]). The rate for all workers in 1995 was 0.8 (extrapolated from Toscano and Windau[8]). One other comparison is worth noting. Goodman et al[9] found that health care workers in the United States had a homicide rate of 0.15 in the 8-year period of 1983 to 1990. The EMS workers' homicide rate of 1.1 for 1992 to 1997 was thus more than 7 times higher than the average for all health care workers between 1983 and 1990. However, our estimated EMS rates are based on only 10 cases over a 6-year period and therefore must be interpreted very cautiously.

Table 3.
Distribution of EMS fatalities by cause: CFOI and NEMSMS data from 1992 to 1997 and FARS data from 1994 to 1997.

Cause	CFOI	NEMSMS	FARS	Fatality Estimate
Ground transportation	67	33	8	67
Air ambulance crash	*	19	0	19
Cardiovascular	*	13	0	13
Assault-homicide	10	0	0	10
Other	14†	5	0	5
Total	91	70	8	114

*Does not meet BLS publication requirements.
†There were 14 deaths other than ground transportation and assault; BLS policy precludes the identification of cells with <5 cases.

DISCUSSION

Little is known to date about the injury risks of EMS personnel. Only 4 studies have evaluated a broad spectrum of injuries. Gershon et al[10] evaluated injuries among EMS workers in Baltimore, MD, and found 226 occupational injuries per 197 employees per year. At face value, this equals a rate of 115 injuries per 100 full-time employees per year. However, the authors specified neither the definition of "injury" nor whether the denominator was based on full-time equivalent employment. By comparison, in 1995, the average occupational nonfatal-injury rate for all private industries in the United States was 8.1 per 100 full-time workers.[11]

Tortella and Lavery's[12] survey of EMS agencies in 200 major US cities reported "a rate of serious, disabling injuries requiring hospitalization of 1 per 31,616 dispatches." The survey by Schwartz et al[13] of a 2% randomly selected group of registered EMTs in 6 states calculated injury rates by the number of injuries per 100 EMTs per 6 months. However, because the categories they used do not appear to be mutually exclusive, it is not possible to calculate an overall injury rate. Hogya

and Ellis[14] studied duty records and injury report sheets for paramedics and EMTs in an urban EMS system during the period from January 1980 to June 1983 and described 254 injuries among the EMS personnel studied.

Several other studies have provided insights into specific injuries and illnesses experienced by EMS workers but do not allow calculation of rates. The injuries and illnesses include those resulting from ambulance crashes,[15] violence,[16-19] infectious disease and needle sticks,[20-23] hearing loss,[24] and psychiatric disorders.[25]

By contrast with previous studies, our study is based on data from 3 existing databases, and the resulting estimated EMS occupational fatality rate was 12.7 fatalities per 100,000 EMS workers per year, more than twice the national average for US workers and comparable with the rates for police and firefighters during the same period. These findings suggest that EMS is a far riskier occupation than has been generally believed.

The highest risk of on-duty fatality for EMS personnel is associated with vehicle crashes. This finding illustrates a number of safety concerns related to ambulances. Current occupancy protection and vehicle designs may be inadequate to protect passengers from injury in a crash. EMS vehicles are exempt from Federal Motor Vehicle Safety Standards[26] despite a recommendation from the National Transportation Safety Board (NTSB) in 1979 stating that EMS vehicles should be addressed with such an occupancy protection and vehicle design safety standard.[27] In that same document, the NTSB made other recommendations relating to EMS vehicle safety including mandatory driver training. However, in one author's experience (BJM), formal EMS driver training programs have ranged from nonexistent in some organizations to 15-hour lecture/video presentations in other organizations to 40-hour classes that include lectures, videos, and hands-on driving practice in few organizations. Further research is necessary to determine the difference in collision rates among drivers exposed to the various driver-training programs and drivers with no formal training. Many of the collisions may be related to lack of sleep associated with current scheduling practices; some EMS personnel are routinely scheduled to work 16, 24, or more consecutive hours. The large number of collision-related fatalities may also indicate that EMS vehicle maintenance programs may not be adequate, employers may need to change standards of screening drivers, current worker safety training may be inadequate, or that the industry should reevaluate its "lights and sirens" and other transportation-related policies.

Although the data are not specific enough to calculate the exact number of fatalities that occurred in the patient compartment, they do indicate that the patient compartment may be a high-risk environment. One of the contributing factors to this risk might be failure to wear seatbelts. One study found that less than 50% of paramedics wore seatbelts in the patient compartment of the ambulance.[28] Levick et al[29-31] demonstrated that, in the event of a crash, unbelted occupants of the patient compartment can be seriously injured and can seriously injure other occupants. Maguire and Porco[32] identified the need for additional safety devices in the patient compartment and found that lack of seatbelt use poses a risk to patients and increases the risk of litigation against EMS agencies and personnel.[33]

The second leading category of EMS fatalities was cardiovascular or cerebrovascular events. There are no standard criteria for classifying the work relatedness of sudden deaths caused by possible natural causes that occur at work,[34-36] and CFOI includes few such deaths. However, EMS personnel sustain high levels of physical and psychologic stress during calls, and the physical effects of such transient stresses might trigger myocardial infarctions or cerebrovascular events. Because cardiovascular and cerebrovascular deaths that occur on duty in similar occupations, such as firefighters, are likely to be accepted as work related by workers' compensation, we elected to include these events in our numerator. Even if they are excluded, the injury rate is high—11.2 fatalities per 100,000 EMS workers per year.

Our data showed homicide to be the third leading cause of occupational fatality for EMS workers. Because the majority of the assault victims were women (although based on a small number of cases), this raises a particular question about the safety of female EMS personnel. The sex difference is noteworthy, considering that the national occupational homicide rate between

1992 and 1996 was 3 times higher for men than for women (this same 3:1 ratio was found among police officers).[37] The cause of this disparity should be further investigated.

Suicide is virtually unaccounted for in the databases examined. Although largely unreported in the literature, suicide is an EMS occupational risk that might be engendered by factors such as the psychologically traumatic nature of EMS work.[38-41]

There are a number of limitations regarding the reliability and completeness of the source data. Because there was not a unique occupational or industrial classification used for EMS personnel, CFOI data could not be relied on exclusively for this research. Furthermore, because BLS regulations preclude the case-by-case comparison of the CFOI data with data from other databases, we could not compare individual cases in the 3 EMS data sources for possible overlap. Therefore, we could only develop estimates by using each broad cause category, as shown in Table 3. However, the actual number of EMS fatalities is likely to be larger than estimated on the basis of the minimum fatalities from the combined data.

The method used to identify EMS fatalities through the FARS data is likely to underestimate the actual number of cases. The FARS data did not contribute to the calculation of the fatality rate because the number of FARS-identified EMS fatalities was small relative to the number of transportation-related cases in the other 2 databases. The "fatal injury at work" variable is based on death certificate information; this variable is known to be underreported on the death certificate, particularly for motor vehicle crashes.[42] However, we included the information from FARS to demonstrate both the comprehensiveness of the case-finding methods we used and the difficulties associated with the currently available data.

A further source of error in the numerator arises from annual variation in the number of fatalities. During a 6-year period, an estimated 114 fatalities occurred, an average of 19 per year. However, the actual number of cases varied between 12 and 30, a fairly large range. The discrepancies in denominator estimates for the EMS workforce (see the "Methods" section) introduces yet another source of possible error into the calculation of fatality rates.

The undercounting of fatalities related to ground transportation and violence by the NEMSMS database might be explained by the higher profile of fatal air ambulance crashes and thus the likelihood that these events will be more completely directed to this voluntary reporting system.

Finally, because EMS personnel are exposed to some of the same toxic environments as firefighters, we also note Guidotti's[43] findings that firefighters have an increased occupational risk of fatality from certain cancers. If this risk exists for EMS personnel, it would not have been discovered with the available data. Fatalities from occupational exposure to diseases, such as hepatitis C and AIDS, would likewise not have been identified.

In summary, the use of multiple data sources allows us to estimate the occupational fatality risk for EMS workers. Their fatality rate exceeds that for all workers and is of similar magnitude to that of other emergency public service workers. Many thousands of EMS personnel put their lives on the line every day while providing EMS to the community, but little consideration is given to providing them with a safer work environment. Further research is necessary to develop and evaluate interventions to mitigate these risks.

Author contributions: BJM conceived and designed the study, conducted and supervised data collection, and managed the data, including quality control. KLH supervised the conduct of the study, provided methodological and study design advice, and analyzed the data. GSS and NRL also provided methodological and study design advice and contributed to the interpretation of the data. BJM drafted the manuscript, and all authors contributed substantially to its revision. BJM takes responsibility for the paper as a whole.

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