Fatal and Nonfatal Injuries Among Emergency Medical Technicians and Paramedics

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Abstract

Background. Emergency medical technicians (EMTs) and paramedics serve as primary providers of urgent medical care and are integral components in disaster response. They are at risk for fatal and nonfatal injuries during these activities. **Objectives.** To describe fatal and nonfatal injuries occurring to EMTs and paramedics. **Methods.** We analyzed data from the Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries (CFOI) and the occupational supplement to the National Electronic Injury Surveillance System (NEISS–Work) for the period 2003–2007. **Results.** We identified 99,400 (95% confidence interval [CI], 71,700, 127,100) nonfatal injuries treated in emergency departments and 65 fatal injuries from the period 2003–2007. Most fatalities were related to motor vehicle incidents (45%) and aircraft crashes (31%). Among compensated EMTs and paramedics, the rate of fatal injuries was 6.3 per 100,000 full-time equivalents. Nonfatal injuries were primarily associated with stress on some part of the body from motion or overexertion (33%). Among all nonfatal injuries, the most common diagnosis was sprains and strains (38%). **Conclusions.** Emergency medical technicians and paramedics have higher fatal injury rates when compared with all workers. To reduce fatalities, targeted efforts should be made to prevent ground and air transportation incidents. Reducing nonfatal injuries may be accomplished by developing and evaluating interventions to prevent bodily stress and overexertion injuries. **Key words:** paramedics; emergency medical technicians; occupational injuries; occupational exposure; occupational safety

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Introduction

Emergency medical technicians (EMTs) and paramedics perform a variety of job duties that put them at risk for fatal and nonfatal occupational injuries and illnesses. Their regular duties include lifting patients and equipment, treating patients with infectious illnesses, handling hazardous chemical and body substances, and participating in the emergency transport of patients in ground and air vehicles. These activities are essential to fulfilling their roles as primary providers of emergency medical care and are critical components of disaster response.

From 1992 to 1997, there were an estimated 114 fatalities to emergency medical services (EMS) workers.[1] Primary causes of these fatalities were ground transportation and air medical crashes. While risks during ground transportation continue to remain a concern for EMS providers,[2] the risks for fatalities during air medical transportation have drawn increased attention. From 1997 to 2001, 47 air medical crashes were recorded, with 40 fatalities occurring as a result of those crashes.[3]

Several studies over the last decade have described the nonfatal injury and illness burden to EMS providers. In 2000 and 2001, an annual average of 21,900 emergency department (ED)-treated injuries and illnesses occurred to EMS providers in the United States.[4] From 1999 to 2005, the annual incidence of EMS injuries and illnesses resulting in at least one missed workday was estimated to be 8.1 per 100 EMS providers per year.[5] A 2005 survey determined that almost 30% of EMS respondents had at least one injury in the previous year.[6]

To contextualize the number of injuries occurring to EMTs and paramedics, it is helpful to know the magnitude of the EMT and paramedic workforce. However, this workforce is difficult to enumerate, as workers can be either paid or volunteer and national registration is not uniformly required.[4] The Current Population Survey (CPS), a primary source of U.S. labor force statistics, regularly captures paid workers, but it excludes volunteers. From 2003 to 2007, CPS estimated an annual average of approximately 177,000 full-time employed EMTs, paramedics, and ambulance

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The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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drivers and attendants.[7] Using numbers from multiple data sources, the National Highway Traffic Safety Administration (NHTSA) estimated there were between 244,000 and 273,000 volunteer EMTs and paramedics in 2003.[8]

The EMT and paramedic workforce is projected to grow in the number of needed workers, but difficulties in recruitment and retention have already been reported, especially in rural areas.[9] The retention of EMTs and paramedics may be negatively impacted by the effects of injuries and illnesses. The goals of this study are 1) to provide data on fatal and nonfatal injuries and illnesses to EMTs and paramedics to identify the most prevalent issues currently being faced and 2) to describe fatal and nonfatal issues based on national surveillance, eliminating potential geographic, agency, or respondent biases.

METHODS

Fatal Injuries

We examined data from the Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries (CFOI) to describe fatal occupational injuries occurring to EMTs during the period from 2003 to 2007. We used CFOI research files provided to the National Institute for Occupational Safety and Health (NIOSH) under a Memorandum of Understanding with BLS. The BLS collects CFOI data from multiple federal, state, and local source documents, including death certificates, workers' compensation reports, medical examiner reports, and police reports.[10] A fatality is included if the decedent was employed for pay or other compensation at the time of the event and engaged in a legal work activity or present at a site as a job requirement. The CFOI also includes deaths of volunteer workers and workers regardless of industry or worker age. The occupation recorded in CFOI reflects the job being performed at the time of death. Starting in 2003, detailed occupation information in CFOI was coded based on the 2000 Standard Occupational Classification (SOC).[11] The SOC has four aggregated levels of occupational classification that were created to reflect the current occupational structure in the United States. For this study, EMT cases were defined and identified by two detailed occupation codes: 29-2041 (EMTs and paramedics) and 53-3011 (ambulance drivers and attendants). The CFOI collects data on both civilian and military worker deaths, but our case definition limited the analysis to civilian workers. To remain consistent with our case definition for EMT fatalities, further references to EMTs in this article include paramedics and ambulance drivers and attendants, unless otherwise specified.

Each fatality record includes a nonstandardized narrative description of the injury circumstances based on the source documents available. The BLS considered this information when they reviewed each worker fatality recorded in CFOI and assigned source of injury and event or exposure codes accordingly. These codes are classified based on the Occupational Injury and Illness Classification System (OIICS).[12] We also used the narrative description to determine additional factors that may have contributed to fatalities.

To calculate fatality rates, we used labor force estimates from the BLS CPS as the denominator.[7] Because CPS does not include volunteers in these estimates, we removed volunteers from the CFOI numerator when calculating rates. Fatality rate calculations used only the compensated-worker fatality totals for 2003–2007 and the combined 2003–2007 estimate of 883,000 full-time equivalent (FTE) EMTs. Each FTE represents 2,000 hours worked per year. We calculated 95% confidence intervals (CIs) for the rates to account for the variance in the CPS data.

Nonfatal Injuries

We analyzed data from the occupational supplement to the National Electronic Injury Surveillance System (NEISS–Work) for 2003–2007 to describe nonfatal injuries and illnesses occurring to EMTs. The core NEISS is administered by the Consumer Product Safety Commission (CPSC) and is restricted to product-related injuries that occur outside of work and are treated in hospital EDs. In addition to these core data, CPSC facilitates the collection of NEISS–Work data for NIOSH. This system captures all ED-treated occupational-related injuries, illnesses, and exposures to civilians through a hospital subsample without restriction to consumer product involvement. Data collection for NEISS–Work is considered a public health surveillance activity and did not require institutional review board approval.[13] As the majority of the NEISS–Work cases are injuries,[14] the term "injuries" is used throughout this paper in place of "injuries, illnesses, and exposures." The injuries captured in NEISS–Work may or may not have resulted in the worker's needing to take days off from work.

The NEISS–Work is based on a national probability sample of noninstitutional U.S. hospitals with 24-hour EDs.[13] The sample consists of 67 hospitals stratified by the number of ED visits. The number of reporting hospitals varied during the five-year study period because of the closing of hospitals and other factors resulting in nonparticipation and nonresponse. Each NEISS–Work case is assigned a statistical weight reflecting the probability of selecting the treating hospital within its sample stratum. Using stratified random-sampling equations,[15] we summed the weighted cases to produce national estimates and calculated 95% CIs that accounted for the variance of the stratified NEISS–Work sample. All calculations were performed using SAS

version 9.2 (SAS Institute Inc., Cary, NC). Except where specified, all reported nonfatal estimates account for the total number of injuries during 2003–2007. We did not estimate nonfatal injury rates for compensated EMTs because NEISS–Work did not consistently identify whether the injured worker was a compensated employee or a volunteer.

For this study, the nonfatal case definition captured injuries identified in NEISS–Work if they occurred to EMTs during the performance of paid or volunteer EMS duties. Physical training injuries were included as some EMS organizations have employee fitness requirements. To identify probable cases involving nonfatal injuries to EMTs, we used an automated program to search the NEISS–Work text fields describing the industry, the occupation, and the injury incident for key words related to EMTs. We reviewed all probable cases identified by the automated program to confirm if they were EMTs and engaged in EMS work at the time of injury. Cases with an occupation of "firefighter" were included if the incident described them as performing EMS duties such as patient care, patient transport, patient rescue, or working in an ambulance. To ensure accurate case identification, two additional researchers who work in the field of EMS and an individual involved in EMS research and practice reviewed any cases that were not assuredly EMTs.

In addition to coding occupation, NIOSH staff reviewed each case and assigned an event and source code based on the information in the injury incident text field. Event and source codes were assigned based on OIICS.[12]

Results

Fatal Injuries

During the five years, 2003 to 2007, there were a total of 65 fatalities among EMTs, an average of 13 fatalities per year. Eighty-six percent (56) of the fatally injured EMTs worked for pay (Table 1). The fatality rate for compensated EMTs was 6.3 per 100,000 FTE workers (95% CI, 4.0, 8.7), 1.4 times greater than the rate for all workers (4.0 per 100,000 FTE workers) during the same time period.[16] Emergency medical technicians and paramedics accounted for 60 of the 65 deaths, while ambulance drivers and attendants accounted for the remainder (Table 1).

Distributions of EMT workplace deaths by gender and age were similar to distributions of EMTs within the CPS employment data (Table 1).[7] The greatest number of fatalities was in EMTs aged 25–34 years (37%). Compared with EMTs who were 24 years or younger, work-related death rates were two times higher for EMTs aged 25–34 years and 2.6 times higher for EMTs who were 45 years or older. Although female workers made up only 7% (0.6 per 100,000 FTE compensated workers) of all worker fatalities over this period, they represented 26% of EMT deaths at a rate of 5.5 per 100,000 compensated workers (95% CI, 1.6, 9.5). The average annual fatality rate for female EMTs was lower than the rate for male EMTs (6.6 per 100,000 FTE compensated workers [95% CI, 3.7, 9.6]).

Forty-five percent (29) of EMT deaths resulted from highway incidents, mostly due to vehicle collisions. Collisions included incidents where a vehicle struck another vehicle, mobile or stationary equipment, or stationary object. Although CFOI does not specifically identify multiple fatality events, a review of individual case data suggested that less than 15% of the highway incidents involved two or more EMT deaths. Factors involved in highway incidents, as recorded in CFOI, included failure of another vehicle to yield, lack of seat belt use, and wet or icy roads. Also noted was the use of lights and sirens during travel, which may involve potential risks of high-speed travel and failure of other drivers to demonstrate awareness of the emergency vehicle or allow the emergency vehicle the right of way.

Thirty-one percent (20) of EMT fatalities involved air transportation incidents. Nearly all aircraft incidents involving EMT fatalities resulted in multiple deaths. We identified 30 air ambulance pilots, nurses, and other responders who died in these incidents along with an EMT. We also identified 19 deaths of other responders in air medical crashes that did not involve the fatality of an EMT. Incidents involved both fixed-wing and rotary-wing aircraft. Factors noted in CFOI that might have contributed to these incidents included adverse weather conditions and mountainous terrain.

One-fourth (16) of EMT fatalities were not highway or aircraft incidents. Eight of these fatalities involved other transportation incidents, including those in which an EMT was injured when struck by a vehicle. The remaining eight fatalities resulted from several other nontransportation causes.

Nonfatal Injuries

The estimated number of ED-treated nonfatal injuries to EMTs from 2003 to 2007 was 99,400 (95% CI, 71,700, 127,100). This number remained relatively stable throughout the five-year time span, averaging approximately 19,900 injuries per year (95% CI,14,300, 25,400) (Table 2), with 99% of the EMTs with these injuries being treated and released. Additional annual averages are provided in Table 2; further results reflect five-year total estimates.

The majority of nonfatal injuries occurred to males (69%) and to EMTs aged 25–34 years (36%). As noted for EMT fatalities, the distributions of nonfatal ED-treated injuries to EMTs by gender and age were comparable to the gender and age distributions of compensated EMTs.[7] Based on our analysis of the month and day of the week on which treatment

TABLE 1. Numbers and Rates of Fatal Injuries to Emergency Medical Technicians by Selected Characteristics, 2003–2007

	Total Fatalities to Compensated and Volunteer EMTs		FTE Compensated EMTs*		Fatality Rates per 100,000 Compensated EMTs†	
	No.	%	No.	%	Rate	95% CI
Total‡	65	100	883,500	100	6.3	(4.0, 8.7)
Occupation						
EMT/paramedic	60	92	823,500	93	6.2	(3.9, 8.5)
Ambulance driver/attendant	5	8	59,900	7	8.3	(> 0, 20.4)
Employment status						
Compensated	56	86	883,500	100	6.3	(4.0, 8.7)
Volunteer	9	14	NA	NA	NA	NA
Gender						
Male	48	74	648,300	73	6.6	(3.7, 9.6)
Female	17	26	235,200	27	5.5	(1.6, 9.5)
Age groups						
≤24 years	8	12	167,300	19	3.6	(2.3, 4.9)
25–34 years	24	37	300,600	34	7.3	(4.6, 10.0)
35–44 years	13	20	244,800	28	4.9	(3.1, 6.7)
≥45 years	20	31	170,600	19	9.4	(6.0, 12.8)
Year of injury						
2003	8	12	144,300	16	5.5	(5.5, 5.6)
2004	21	32	162,400	18	11.7	(11.5, 11.9)
2005	13	20	185,500	21	5.9	(5.8, 6.0)
2006	10	15	190,400	22	5.3	(5.2, 5.3)
2007	13	20	200,800	23	4.0	(3.9, 4.0)
Region						
Northeast	10	15	178,900	20	3.9	(0.7, 7.1)
Midwest	11	17	172,000	19	4.1	(0.7, 7.4)
South	24	37	347,200	39	6.6	(2.8, 10.5)
West	20	31	185,300	21	10.3	(2.1, 18.4)
Event§□						
Transportation incidents (4)	57	88	NA	NA	5.5	(3.5, 7.6)
Highway (41)	29	45	NA	NA	2.6	(1.7, 3.6)
Air (46)	20	31	NA	NA	2.3	(1.4, 3.1)
Other transportation incidents¶	8	12	NA	NA	1.5	(0.9, 2.0)

*U.S Census Bureau. Current Population Survey. Available at: http://www.census.gov/cps/. Accessed February 15, 2011.
†The numerator includes only those EMTs who were compensated ($n = 56$).
‡Numbers and percentages might not add to totals or 100% because of rounding.
§Summation of numbers will not reflect total fatal injuries because of omission of some events not meeting reporting requirements.
□Events are coded using the Occupational Injury and Illness Classification Manual (OIICS) (U.S. Department of Labor/Bureau of Labor Statistics. Occupational Injury and Illness Classification Manual. 1992. Available at: http://www.bls.gov/iif/oshwc/oiicm.pdf. Accessed February 15, 2011). The numbers in parentheses after each category represent codes in the OIICS hierarchical coding structure.
¶Includes workers outside of vehicle, struck by a vehicle.
CI = confidence interval; EMT = emergency medical technician; FTE = full-time equivalent; NA = not applicable.

occurred, we found a fairly even distribution of injuries across time of year and within a week.

Nonfatal injuries were primarily associated with stress on some part of the body from motion or overexertion (33%), with 84% of these incidents resulting in sprains and strains (27,300 [95% CI, 18,300, 36,200]). Approximately half of these incidents involved interaction with or movement of another person, usually a patient. The second most common event associated with nonfatal injury was exposure to a harmful substance or environment (21%); about three-fourths of these events involved exposure to bodily fluids or substances from another person or exposure to a needle or syringe.

The main source associated with nonfatal injury was persons, plants, animals, and minerals, representing 44% of all nonfatal injuries (Table 2). Nearly three-fourths of injuries from this source category were specifically attributed to another person, primarily health care patients. Tools, instruments, and equipment were the second leading source associated with nonfatal injury (18%). This category was largely composed of injuries from needles and syringes and from health care and orthopedic equipment.

During 2003–2007, EMTs were most often treated for sprains and strains (38,200 [95% CI, 26,200, 50,200); 42% of these injuries (16,100 [95% CI, 9,700, 22,500) affected the lower trunk. Other common nonfatal injuries were contusions and abrasions (16,500 [95% CI, 11,000, 22,000] and lacerations and punctures (14,100 [95% CI, 9,900, 18,400]). In general, nonfatal injuries affected the hand and fingers (20,700 [95% CI, 14,500, 26,800]), mostly the fingers, and the lower trunk (19,900 [95% CI, 12,700, 27,100]).

TABLE 2. Numbers of Nonfatal Emergency Department–Treated Injuries to Emergency Medical Technicians by Selected Characteristics, 2003–2007

	Total Nonfatal Injuries	Annual Average	Annual Average 95% CI	% Nonfatal Injuries
Total*	99,400	19,900	(14,300, 25,400)	100
Gender				
Male	68,700	13,700	(9,700, 17,800)	69
Female	30,700	6,100	(4,400, 7,900)	31
Age groups				
≤24 years	23,800	4,800	(2,800, 6,800)	24
25–34 years	36,200	7,200	(5,100, 9,400)	36
35–44 years	25,700	5,100	(3,900, 6,300)	26
≥45 years	13,700	2,700	(1,900, 3,600)	14
Year of injury				
2003	NA	21,000	(14,400, 27,600)	21
2004	NA	22,100	(14,400, 29,800)	22
2005	NA	17,000	(11,100, 22,900)	17
2006	NA	18,700	(11,100, 26,300)	19
2007	NA	20,500	(15,600, 25,400)	21
Event†‡				
Bodily reaction and exertion (2)	32,500	6,500	(4,400, 8,500)	33
Exposure to harmful substances or environments (3)	20,800	4,200	(2,400, 5,900)	21
Contact with objects and equipment (0)	17,800	3,600	(2,500, 4,600)	18
Source†‡				
Persons, plants, animals, and minerals (5)	43,400	8,700	(6,000, 11,400)	44
Tools, instruments, and equipment (7)	17,800	3,600	(2,600, 4,500)	18
Vehicles (8)	13,800	2,800	(1,900, 3,600)	14
Structures and surfaces (6)	11,900	2,400	(1,400, 3,300)	12
Diagnosis†				
Sprain/strain	38,200	7,600	(5,200, 10,000)	38
Contusions/abrasions	16,500	3,300	(2,200, 4,400)	17
Lacerations and puncture	14,100	2,800	(2,000, 3,700)	14
Body part†				
Neck and back	30,600	6,100	(4,100, 8,100)	31
Hand and fingers	20,700	4,100	(2,900, 5,400)	21
Leg and foot	13,800	2,800	(2,000, 3,500)	14
Arm	13,200	2,600	(1,800, 3,400)	13

*Numbers and percentages might not add to totals or 100% because of rounding.
† Summation of numbers will not reflect total nonfatal injuries because of omission of data not meeting reporting requirements.
‡Events and sources are coded using the Occupational Injury and Illness Classification Manual (OIICS) (U.S. Department of Labor/Bureau of Labor Statistics. Occupational Injury and Illness Classification Manual. 1992. Available at: http://www.bls.gov/iif/oshwc/oiicm.pdf. Accessed February 15, 2011). The numbers in parentheses after each category represent codes in the OIICS hierarchical coding structure.
CI = confidence interval; NA = not applicable.

Discussion

Our analysis reaffirms the idea that the EMS workforce continues to be affected by highway and air transportation incidents, and sprains and strains. It has been suggested that these injuries influence the retention of EMS workers, but the extent of the true impact is unknown because of the paucity of data.[8]

The use of CFOI data facilitates standardized fatality rate comparisons with workers who are not EMTs.[16] The annual compensated-firefighter fatality rate, computed from the 97 fatalities and the summed FTEs for 2003–2006, was 6.1 per 100,000 FTE firefighters.[17] This was slightly lower than the compensated-EMT fatality rate of 7.0 per 100,000 FTE EMTs (95% CI, 4.7, 9.3) for the same four-year period. The fatality rate for female EMTs was nine times higher than the fatality rate for all female workers from 2003–2007.[16] The uniquely high distribution of fatalities among female EMTs corresponds to the female distribution within the EMT workforce, and indicates that female EMTs face risks similar to those faced by their male counterparts.

Fatalities to EMTs were most often caused by highway and air transportation incidents. These incidents may also involve fatalities and injuries to patients and other medical workers. Furthermore, ambulance incidents may also involve fatalities and injuries to occupants of other vehicles.[2] Measures taken to mitigate factors potentially contributing to ambulance incidents include on-board computer monitoring devices, worker training, and improvements in seat belt design and use.[2,18] Suggested prevention efforts for air medical incidents include improving technology, practices, and safeguards; and using air medical services only when the benefits outweigh the risks.[19–21]

Other studies of EMS workers reinforce the finding that sprains and strains are the most common nonfatal injury.[22,23] In 2007, the BLS reported that 65% of all injuries to private-industry EMTs resulting in days away from work involved sprains, strains, or tears.

The corresponding rate for sprains, strains, and tears was 217.8 per 10,000 FTE EMTs, much higher than the rate of 47.3 per 10,000 FTEs reported for all private industry workers.[22] The current study suggests that sprains and strains were often the result of lifting or moving a patient. A few studies specific to EMS workers have evaluated equipment and interventions in patient handling and made recommendations on equipment that may be safest for specific types of transfers and lifts.[24–26] However, additional research is still needed, especially to examine techniques for safe handling when patients are located in awkward or confined spaces in homes, vehicles, or other prehospital environments.[27] Also, EMS worker strength, flexibility, and physical fitness have been postulated to be influential on musculoskeletal injuries in EMS workers and have the potential to be modified to reduce injury occurrence.[27]

In addition to addressing risk factors for transportation incidents and sprains and strains, EMS agencies should consider assessing workplace safety culture. A study of workplace organizational culture and climate in residential health care facilities concluded that workers in facilities with low staff injury rates had more positive perceptions of the organizational culture and climate at their facility.[28] A recent study modified an existing tool and measured EMS workplace safety culture.[29] Statistically significant differences were found among many safety domains and agency characteristics. Assessing workplace safety culture could provide valuable insight into needed agency-based injury-prevention efforts.

LIMITATIONS

Whereas our results provide a national overview of the injuries occurring to EMTs, they are constrained by some limitations. First, NEISS–Work data capture only those cases in which the injured EMTs or paramedics were treated in EDs. Estimates may be biased by the presence of EMTs in the ED as part of their job, increasing the likelihood of treatment in this venue. Second, there may be an undercount of nonfatal injuries because of EMTs' treating themselves or colleagues or because an injury was not reported as work-related. Third, a limitation in both the NEISS–Work and CFOI is a potential undercount of affected EMTs due to complexities in case identification, often related to assigning an accurate occupation to a worker cross-trained as both an EMT and a firefighter. Finally, whereas the EMS workforce is inclusive of occupations beyond EMTs, fatal and nonfatal injury estimates are provided only for EMTs, paramedics, ground ambulance drivers, and attendants.

CONCLUSION

Our findings indicate that the compensated EMT and paramedic workforce has higher rates of fatal injuries compared with the general working population as well as the compensated firefighter population. To reduce the leading causes of death to EMTs, ground ambulance and air medical transportation need continued safety improvements. Prevention efforts to reduce sprains and strains, the primary nonfatal injury, also need further development and evaluation. Ongoing efforts to protect and improve the health and safety of EMTs are critical to ensure that EMTs can continue providing emergency medical care services to the U.S. population.

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