A Cohort Study of Occupational Fatalities among Paramedicine Clinicians: 2003 through 2020

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Abbreviations:
CFOI: Census of Fatal Occupational Injuries
COVID-19: coronavirus disease 2019
DOL: United States Department of Labor
EMS: Emergency Medical Services
EMT: emergency medical technician
NYC: New York City

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Abstract

Introduction/Study Objectives: Emergency medical technicians (EMTs) and paramedics respond to 40 million calls for assistance every year in the United States; these paramedicine clinicians are a critical component of the nation's health care, disaster response, public safety, and public health systems. The study objective is to identify the risks of occupational fatalities among paramedicine clinicians working in the United States.

Methods: To determine fatality rates and relative risks, this cohort study focused on 2003 through 2020 data of individuals classified as EMTs and paramedics by the United States Department of Labor (DOL). Data provided by the DOL and accessed through its website were used for the analyses. The DOL classifies EMTs and paramedics who have the job title of fire fighter as fire fighters and so they were not included in this analysis. It is unknown how many paramedicine clinicians employed by hospitals, police departments, or other agencies are classified as health workers, police officers, or other and were not included in this analysis.

Results: An average of 206,000 paramedicine clinicians per year were employed in the United States during the study period; approximately one-third were women. Thirty percent (30%) were employed by local governments. Of the 204 total fatalities, 153 (75%) were transportation-related incidents. Over one-half of the 204 cases were classified as "multiple traumatic injuries and disorders." The fatality rate for men was three-times higher than for women (95% confidence interval [CI], 1.4 to 6.3). The fatality rate for paramedicine clinicians was eight-times higher than the rate for other health care practitioners (95% CI, 5.8 to 10.1) and 60% higher than the rate for all United States workers (95% CI, 1.24 to 2.04).

Conclusions: Approximately 11 paramedicine clinicians are documented as dying every year. The highest risk is from transportation-related events. However, the methods used by the DOL for tracking occupational fatalities means that many cases among paramedicine clinicians are not included. A better data system, and paramedicine clinician-specific research, are needed to inform the development and implementation of evidence-based interventions to prevent occupational fatalities. Research, and the resulting evidence-based interventions, are needed to meet what should be the ultimate goal of zero occupational fatalities for paramedicine clinicians in the United States and internationally.

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Introduction

Background

A review of work-related deaths among ambulance service personnel noted: "Over the past five years alone, 34 paramedicine clinicians, including 23 members of the [New York City] fire department's Bureau of Emergency Medical Services, died in service to the citizens of New York City."[1] The first report of occupational fatality rates for paramedicine clinicians published in 2002 revealed that paramedicine clinicians had an occupational fatality rate of 12.7 per 100,000 workers annually, compared to the rate of 5.0 for all workers in the United States, and comparable to the rates for police officers (14.2) and fire fighters (16.5).[2] A study in 2013 reported that paramedicine clinicians had an average of almost 12 fatalities each year for the years 2003 through 2007.[3]

Importance

Almost one million paramedicine clinicians work in approximately 20,000 Emergency Medical Services (EMS) agencies in the United States.[4,5] They include emergency medical technicians (EMTs), advanced EMTs, and paramedics. Paramedicine clinicians typically work for EMS agencies, but may also work in primary care or in public health related community paramedicine roles.[6] In 2020, just over 261,000 of the paramedicine clinicians were employed; most of the rest are believed to be volunteers.[5] These clinicians respond to medical emergencies, injuries, crashes, and fires, as well as to terrorist attacks, pandemics, and other disasters.

Paramedicine clinicians often enter patients' workplaces and homes, or treat them in dangerous situations such as shootings, multi-vehicle collisions, and disasters. Hundreds of paramedicine clinicians also experience violence and transportation-related injuries every year in the United States.[7–10] Their rate of non-fatal occupational injuries is around three-times higher than the average for all workers in the United States,[3] and is higher than the rates for fire fighters and police officers.[11] The United States is not alone in seeing these high risks; in Australia, no occupational group has a higher occupational injury or fatality rate than paramedics.[12]

Paramedicine clinicians are also regularly exposed to infectious diseases including Methicillin-resistant Staphylococcus aureus (MRSA) and may work in vehicles that are potentially colonized by multiple microorganisms.[13–16] Likely as a result of their occupational exposure to infectious diseases, these clinicians had high rates of coronavirus disease 2019 (COVID-19)-related fatality; researchers documented 36 fatalities of paramedicine clinicians in 2020 due to COVID-19,[17] including 11 in New York City (NYC; New York USA) alone.[18] In 2022, the 100th paramedicine clinician died as a result of the September 11, 2001 terrorist attack on NYC.[1]

Identifying risk is a necessary precursor to any efforts to mitigate those risks. Considering the multiple risks they face on duty every day, an update on their risks of occupational fatality is critically important. Reducing occupational risks for this group will enhance their work environment, improve the health of the workforce, increase communities' access to care, and ultimately help these clinicians to provide the best possible care to the 40 million people who call for their help every year in the United States.[5] A better understanding of the risks of occupational fatalities can inform both clinicians and system leaders, leading to improved management of, and ultimately a reduction of, these risks.

Objectives

The objectives of this study are to analyze the currently available data, to identify the recent causes of occupational fatality among paramedicine clinicians, to evaluate how their fatality rates changed over time, to determine how the rates of occupational fatality for these clinicians compare to other occupations and to the national average for all workers, to inform paramedicine clinicians of the life-threatening hazards associated with their work, to provide system leaders with knowledge that can improve workplace safety, and ultimately, to provide information that can be used to help prevent fatalities in the future.

Methods

Study Design and Setting

This retrospective database analysis follows workers identified by the United States Department of Labor (DOL; Washington, DC USA), Bureau of Labor Statistics as "Emergency Medical Technicians and Paramedics" and describes occupational fatalities in the group for the years 2003 through 2020. In addition, fatality rates were calculated over time and relative risks compared to other occupations. Emergency medical technicians and paramedics are herein referred to collectively as paramedicine clinicians.

Data Sources

The DOL has collected occupational injury and fatality data since before World War I and has published industry data since 1972 and occupation data since 1992. Workers have no options to opt in or opt out of the process. The DOL uses multiple sources from all 50 States and the District of Columbia to identify, verify, and profile fatal occupational injuries.[19] Fatality data are managed by the DOL Census of Fatal Occupational Injuries (CFOI): "A workplace fatality must meet the following criteria to be included in CFOI: It must have resulted from a traumatic injury; the incident that led to the death must have occurred in the United States, its territories, or its territorial waters or airspace; and it must be related to work."[20] The DOL uses the 2018 Standard Occupational Classification System to classify members of an occupation.[21] This classification system has been revised in 2000 and 2018, but the definition for EMTs and paramedics have remained reasonably similar. Beyond the DOL procedural concerns noted in the Limitations section, there is every reason to believe that the DOL data are reasonably reliable.[22]

A DOL employee provided tables of fatalities for paramedicine clinicians from 2003 through 2018 in response to a request from the first author. The provided Excel file (Version 365, Microsoft Corporation; Redmond, Washington USA) described total cases by: Employee Status (wage and salary workers, self-employed); Gender; Age; Race or Ethnic Origin; Event or Exposure; Primary Source; Secondary Source; Nature; Part of Body; Worker Activity; Location; Industry; and Government. The first author accessed additional data, including number of employees and data from 2019 and 2020, through the DOL data portal.[23] The DOL data include multiple criteria including the nature of injuries, body part injured, and employer. The data include no personally identifiable information. Not all data fields were available for all years.

For an examination of how risks for paramedicine clinicians compared to risks for other occupations, the numerator data came from a DOL CFOI report[24] and denominator data from the DOL's Occupational Employment and Wage Statistics site.[25]

All of the data used for these analyses were from publicly available sources.

Participants

The inclusion criterion for paramedicine clinicians was all individuals categorized by DOL as "Emergency Medical Technicians and Paramedics." The DOL also has an occupational group identified as "Ambulance Drivers and Attendants, except Emergency Medical Technicians;"[26] that group was not included in these calculations. In 2020, there were 14,200 people employed in the ambulance driver occupational group. In order to be able to make the most reliable comparisons to previous research that focused exclusively on the DOL category of EMTs and paramedics, this study focuses solely on the EMT and paramedic group.

For comparison purposes, occupational groups that were classified by DOL as fire fighters, police officers, health care practitioners and technical occupations, registered nurses, and all United States workers were chosen.

Bias and Study Size

The most recognized bias in retrospective analyses is selection bias.[27] There is undoubtedly selection bias in the DOL data.

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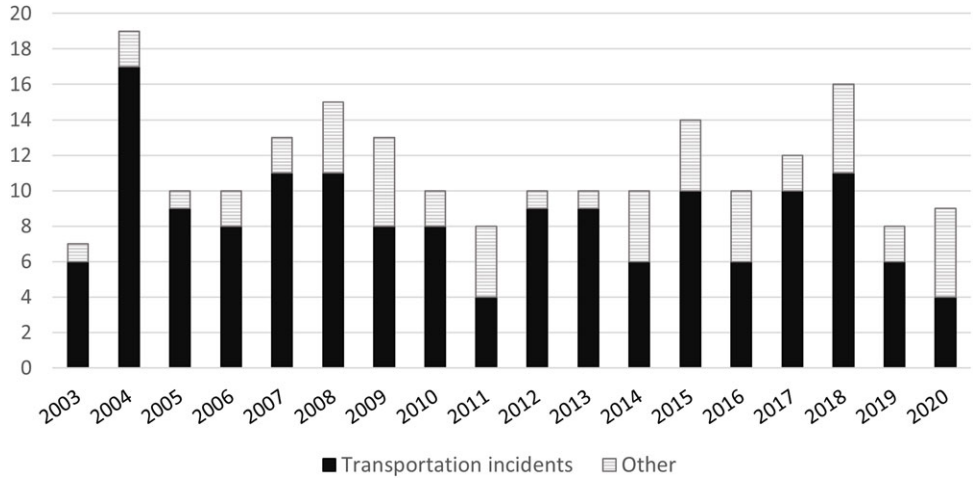

Figure 1. Number of Occupational Fatalities due to Transportation Events and Other, for Paramedicine Clinicians by Year (2003-2020).

According to personal communication from the DOL to the first author, they affirmed that any fire fighter would be classified as a fire fighter even if the person was working in a full-time EMS capacity.[28] Left undetermined is the question of how non-fire-fighter paramedics employed by fire departments were classified. Any other bias was minimized as much as possible by using 100% of the data the DOL had available for this occupational group during this time period. There were, on average, 206,000 EMS personnel in the group during each of the study years.

Variables

Occupational fatalities are described by exposure (eg, transportation event) and source of injury (eg, vehicle).

Outcomes

The primary outcome was to determine the number of fatality cases and to use them to calculate rates over time for paramedicine clinicians. Other outcomes were to determine the classification of the fatality (eg, nature of injury, event type), how the rates for these clinicians changed over time, and how they compared to the rates for other occupational groups and to all United States workers.

Analysis

The data from DOL were in.xlsx format and the downloaded data were entered into a Microsoft Excel spreadsheet; analyses were done using Microsoft Excel 365.

Although rates based on hours worked is ideal, the available data for this population was at the worker level; therefore, the following formula was used: Rate = (N÷W) × 100,000, where N = the number of fatal work injuries and W = the number of workers.[29]

The relative risk was calculated using the formula: rate for EMS/rate for comparison group.[30,31]

This formula was used for the 95% confidence interval (CI) of the relative risk (RR):

$\mathrm{Ln(RRhat)} +/- z\sqrt{(((n1-x1)/x1)/n1)+(((n2-x2)/x2)/n2)}$,[30]

where n1 was the number of EMS fatalities, x1 was the EMS population, n2 was the number of fatalities in the comparison group, x2 the comparison group population, and z = 1.96 (for the 95% CI). Then the antilog of the lower and upper limits was computed.

Human Subjects

The University of Connecticut IRB Office (Storrs, Connecticut USA) determined that "the proposed activity does not constitute human subjects research as defined by federal regulations for the protection of human subjects in research. As such, IRB exemption or approval review is not required."

Results

Characteristics of Study Subjects

From 2010 through 2020, available data on the annual number of employed paramedicine clinicians showed that the total varied between a low of 172,000 and a high of 261,000 (Avg: 206,000; SD = 28,000). During those years, on average, 33% of the population were women.

Descriptive Data

Specific population demographic data were available only for 2019. In that year, there were 206,000 paramedicine clinicians employed; of them, 33.5% were women, 86.6% were White - non-Hispanic, 10.5% were Black, 0.8% were Asian, and 11.5% were Hispanic or Latino.[32]

Main Results

Data on the number of fatalities and the type of event were available for the years 2003 through 2020. Figure 1 shows that during those years, there was a total of 204 fatal injuries (average of 11 per year). Of the 204 fatalities, 153 (75%) were the result of transportation incidents.

The available DOL data from 2014 through 2020 included characteristics such as event, sex, race, and time of incident. During those years, there were 79 fatalities, for an average of approximately 11 per year. Table 1 shows that of those, 53 (67%) were transportation-related. Thirteen (13) of the victims (16.5%) were women and 62 (78.5%) were White - non-Hispanic. Over one-half of the cases were classified as "multiple traumatic injuries and disorders." The parts of the body most injured were multiple body parts (53%), head (8%), and trunk (6%). Approximately one-third of the cases noted the event time; of those, the most occurred between the hours of 4:00PM and

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	2014	2015	2016	2017	2018	2019	2020	n (%)
Total	10	14	10	12	16	8	9	79 (100.0)
Women		2	3	3		5		13 (16.5)
White, Non-Hispanic	9	11	10	11	13	8		62 (78.5)
Event or Exposure								
Transportation Incidents	6	10	6	10	11	6	4	53 (67.1)
Nature								
Intracranial Injuries		3			2	1		6 (7.6)
Multiple Traumatic Injuries and Disorders	5	8	6	9	8	5		41 (51.9)
Part of Body								
Head		3			2	1		6 (7.6)
Trunk		1	1		3			5 (6.3)
Multiple Body Parts	6	8	6	9	8	5		42 (53.2)
Time								
Noon (12:00PM) to 4:00PM		1						1
4:00PM to 8:00PM		6	4	5	3			18
8:00PM to Midnight (12:00AM)	1			3	1	2		7
Midnight (12:00AM) to Noon (12:00PM)								0

Table 1. Fatal Injuries among Paramedicine Clinicians, with Percentages of Total (2014 to 2020)

Age and Sex	Total Employed	Fatal Cases	Rate	RR	95% CI Low	95% CI High
20 to 24	178,000	2	1.1	6.80	1.52	30.39
25 to 34	406,000	9	2.2	3.45	1.45	8.18
35 to 44	243,000	18	7.4	1.03	0.50	2.14
45 to 54	157,000	12	7.6			
Other/Unknown	99,000	21	21.2	–	–	–
Women	342,278	8	2.3	3.00	1.40	6.30
Men	740,722	51	6.9			
Other/Unknown		3		–	–	–
Total	1,083,000	62	5.7	–	–	–

Table 2. Study Data of Paramedicine Clinicians Employed (2014 to 2018) with N = 1,083,000

8:00PM. No cases were noted as occurring between 12:00AM and 12:00PM.

Employment data and data that identified the age and sex of the victim were available for the years 2014 through 2018. During those years, the number of employed paramedicine clinicians were: 2014 – 232,000; 2015 – 220,000; 2016 – 194,000; 2017 – 223,000; and 2018 – 214,000 for a total of 1,083,000 person-years of workers. The total injury rates per 100,000 workers per year were: 2014 = 4.3; 2015 = 6.4; 2016 = 5.2; 2017 = 5.4; and 2018 = 7.5. Table 2 shows the number of paramedicine clinicians employed, number of fatal cases, and fatality rate per 100,000 workers, by age, sex, and total, with the relative risk (RR) and the 95% confidence interval (CI), from 2014 to 2018, for a total of 1,083,000 person-years. Although one-third of the cases had an unknown or other age, the available data suggested that the rate increased with age. The rate for men was three-times higher than the rate for women (95% CI, 1.4 to 6.3).

Employer

Employer data were available for 2003 through 2018. Of the 187 fatalities during those years, 56 (30%) of the clinicians were employed by local governments. None were state or federal government employees. Most of the remainder likely worked for local businesses (eg, private ambulance services).

Event and Source

The 187 fatalities in the DOL data from 2003 through 2018 included 143 (76%) that were transportation-related, one case that was the result of a fall, and two cases (1%) that were classified as exposure to harmful substances or environments. There were no event types noted for the other 41 cases (22%). Of the 143 transportation cases, 33 (23%) were listed as aircraft incidents and five (3%) were listed as pedestrians.

The 187 fatalities listed the source of injury as vehicles for 163 (87%) cases. The source for one case was listed as chemical, one as

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	Person Years Employed	Fatality Cases	Fatality Rate	Relative Risk	95% CI Low	95% CI High
Paramedicine Clinicians	1,083,000	62	5.72			
Fire Fighters	1,584,920	153	9.65	0.6	0.44	0.80
Police	3,295,860	495	15.02	0.4	0.29	0.50
Health Care Practitioners and Technical Occupations	41,348,150	309	0.75	7.7	5.84	10.07
Registered Nurses	14,149,200	64	0.45	12.7	8.93	17.96
All US Workers	700,707,480	25,244	3.6	1.6	1.24	2.04

Table 3. Study Data for Paramedicine Clinicians Compared to Fire Fighters, Police Officers, Health Care Practitioners and Technical Occupations, Registered Nurses, and All US Workers (2014 to 2018)

machinery, four (2%) listed structures and surfaces, and six cases (3%) listed the source as a person, for a total of 175 (94%) cases that listed a source; 12 of the cases (6%) had no source listed.

Comparison to Other Occupations

Data on the number of personnel and the number of fatalities per year were available by occupation for all United States workers for the years 2014 through 2018. Table 3 shows the relative risk of occupational fatality for paramedicine clinicians compared to fire fighters, police, health care practitioners and technical occupations, registered nurses, and all United States workers. The table shows that the risk for paramedicine clinicians was lower than the risks for fire fighters and police officers, but the rates for paramedicine clinicians were approximately eight-times higher than the rate for health care practitioners and technical occupations (95% CI, 5.84 to 10.07), approximately 13-times higher than the rate for registered nurses (95% CI, 8.93 to 17.96), and 60% higher than the rate for all United States workers (95% CI, 1.24 to 2.04).

Discussion

A 2002 EMS fatalities paper found that this occupational group had an average of 19 fatalities per year[2] and a 2013 paper found 12 fatalities per year,[3] compared to these current findings of 11 per year for 2003 through 2020. Although the trend seems to be improving, the number of fatalities remains high.

From 2014 through 2018, there were 43 transportation-related fatalities (8.6/year). This is down from 14.3/year reported in 2002[2] and 10.2/year reported in 2013.[3] While the trend is promising, there are still almost nine paramedicine clinicians dying every year in the United States from transportation-related injuries.[33] Ambulance crashes are also reported as concerns in other countries.[12,34]

A new National Highway Traffic Safety Administration (NHTSA; Washington, DC USA) goal of zero roadway fatalities[35] is an indicator that a goal of zero paramedicine clinician transportation-related occupational fatalities is both reasonable and appropriate. The risk of transportation fatalities among paramedicine clinicians requires immediate attention. Efforts to reduce risks would benefit from data identifying crashes by volunteers, employer, job title, vehicle type, call type, and area (eg, rural, urban). Crash investigations would also provide data that could be used for risk reduction.

Risk reduction is possible. One of the earliest of the few EMS risk reduction studies found a 50% decrease in ambulance collisions following a multi-modal intervention.[36] The fact that fatal transportation events occur frequently between 4:00PM and 8:00PM suggests an opportunity to re-evaluate ambulance deployment strategies. The utilization of innovative smart traffic solutions, such as IoT-based smart transportation systems and other smart deployment strategies, have proven effective in enhancing road safety.[37] Adopting such smart solutions may help reduce risks for paramedicine clinicians.

This study found that the rate of fatal injuries among male paramedicine clinicians is three-times higher than the rate for female clinicians. This means that: (1) men have a much higher risk of fatal injury; and (2) the risk of fatal injury is not randomly distributed by sex. The available data also indicate that the risk of fatal injuries increases as age increases. This suggests that the risk of fatal injury is not randomly distributed by age. Researchers have found that education level and marriage status may also be associated with differences in risk of occupational fatalities.[38] These findings suggest that any interventions to reduce the risk of occupational fatality for paramedicine clinicians will need to have at least some customization for groups, such as by demographic factors.

The available data are incomplete with many documented cases of occupational fatality among paramedicine clinicians not attributed to paramedicine clinicians; many were likely attributed to other occupations including fire fighters. Further, because of the methods used by CFOI, many occupational fatalities, including the 36 paramedicine clinicians who died of COVID-19,[17] are not included. As a result, the rates for paramedicine clinicians documented in this paper are certainly lower than the actual rates.

Of the cases that were included in one DOL data set, 22% had no event type and six percent did not have a source of injury listed. Overall, very little is known about the specific circumstances and details of occupational fatality among paramedicine clinicians.

Shah noted the great development of EMS systems in the United States from 1960 through 1973.[39] Regrettably, since then, the EMS system in the United States has been grossly underfunded and has fallen far behind the systems in other developed countries.[40] As a result, there are little to no resources available in the United States EMS system to address the crisis of occupational fatalities.

The goals of this research are similar to the goals of the DOL CFOI program: to be "used by safety and health policy analysts and researchers to help prevent fatal work injuries by:

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- Informing workers of life-threatening hazards associated with various jobs;
- Promoting safer work practices through enhanced job safety training;
- Assessing and improving workplace safety standards; and
- Identifying new areas of safety research."[19]

This paper clearly accomplishes the goal of informing workers and will, hopefully, create a foundation for accomplishing the other three goals.

In order to accomplish those other goals, a better data system is urgently needed as a precursor to the development, testing, and implementation of risk reduction interventions. Every case of occupational fatality, as well as serious injury or illness, among paramedicine clinicians should be documented and investigated with the goal of preventing future risks for all paramedicine clinicians. A good model for an improved database is the Defense Medical Epidemiology Database.[41] However, the ultimate goal should be a database that links medical records, personnel files, and operational data at the person level;[42] such a database could document current risks and measure risks by demographic factors (eg, by sex), injury type (eg, violence), and operational factors (eg, call type) in real-time in order to reliably determine post-intervention changes in risks.

Although this study is limited to fatalities among paramedicine clinicians in the United States, it is reasonable to believe that the findings are generalizable to other countries and will hopefully inform risk reduction efforts for paramedicine clinicians world-wide.

There is a dire need for federal, state, and local funds to research, develop, and utilize state-of-the-art solutions in preventing occupational fatalities. The specific recommendation for EMS system funding[40] and for a national EMS research center of excellence[35,43] should be pursued. This paper serves to inform decision makers and paramedicine clinicians of the risks associated with this critically important occupation and provides an urgent call for action.

Limitations

There are almost one million paramedicine clinicians who are full-time, part-time, and volunteer workers in the United States.[4,5] The 261,300 employed paramedicine clinicians included in the DOL database in 2020[44] may not be representative of the entire paramedicine clinician population.

The DOL does not include volunteers in their counts of employed persons by occupation, but CFOI does include volunteers in its counts of fatal injuries (but does not identify them as volunteers); therefore, the rates calculated by counts per population must be interpreted with caution. A 2014 letter from multiple organizations, including the National Association of State EMS Officials (NASEMSO; Falls Church, Virginia USA), to the DOL requested that these issues related to the classification of EMS volunteers and fire fighter paramedics be corrected,[45] but at the time of writing this paper in 2022, they have not been changed.

Although researchers documented that there were at least 36 paramedicine clinician fatalities in 2020 due to COVID-19,[17] and 16 in NYC alone,[1] because CFOI includes only traumatic injuries, they report a total of nine paramedicine clinician fatalities in 2020.

A national report noted that in 2011, more than 50% of paramedicine clinicians were employees (or members) of fire departments.[5] Therefore, it seems probable that fatalities occurring to paramedicine clinicians were categorized as occurring to a fire fighter, even if the paramedicine clinician was a non-fire-fighter, fire department employee, or a fire fighter working in a strictly EMS role (ie, assigned full-time to an ambulance). If so, that will have the effect of decreasing the cases and rates for paramedicine clinicians and increasing the cases and rates for fire fighters. To a more limited degree, the same categorization concerns may be present for some police departments. There is no reason to believe that the DOL would count the same fatality more than once (eg, include the deceased person in both the fire fighter [or police] and the paramedicine clinicians job categories).

It seems possible that a paramedicine clinician working on a hospital-owned ambulance might be classified as a health technician (or other health provider), or one working for a police department might be classified as a police officer. Although it seems reasonable to believe that DOL does capture all occupational fatalities that meet their inclusion criteria, the available data indicate that many fatalities among paramedicine clinicians are not being counted as paramedicine clinicians. These classification complications will become even more pronounced as more and more paramedicine clinicians become involved in non-traditional responsibilities, such as community paramedicine, that may have them working without ambulances. In addition, new ways to capture and classify these data will be needed as more and more paramedicine clinicians work in hospital emergency departments and doctor's offices.

Finally, the classifications used by DOL may not be ideal for this occupational group. For example, it is unclear how there can be 143 fatality cases that were transportation-related but 163 cases where the source of the injury is listed as vehicles. Nor is it known, for example, how many of the transportation deaths were among drivers of the ambulance versus personnel providing care in the patient compartment; such data are critically important for any risk reduction strategies. The lack of more granular data makes it difficult to link the findings to actionable interventions. Given the limitations above, it seems likely that the available data cannot provide the true magnitude of the problem but, since they have been relatively consistently collected across the years, they can be helpful in identifying trends and to show that this topic requires further research.

Conclusions

On average, 11 paramedicine clinicians died every year during the study period, and most of those fatalities were due to transportation events. However, due to the data system limitations, some unknown number of fatalities were not included. The results support the recommendation that the data system for tracking occupational fatalities for paramedicine clinicians must be improved. Collaborations between universities and EMS agencies must work on data gathering, developing and testing risk reduction initiatives, and publishing the results of their endeavors. This research, and the resulting evidence-based interventions, are necessary to meet the ultimate goal of zero occupational fatalities for paramedicine clinicians in the United States and internationally.

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