Feasibility for an EMS Workforce Safety and Health Surveillance System

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16. Abstract
Emergency Medical Services (EMS) personnel treat an estimated 22 million patients a year in the United States. Estimates have placed the EMS workforce at around 900,000 workers, but the precise number is unknown because EMS workers include career and volunteer EMTs, firefighters who have been cross-trained in EMS, commercial ambulance services, third-service public utilities, and others. While the uncertain dimensions of the EMS workforce contribute to the difficulty of conducting adequate surveillance to understand the extent of occupational injury and illness, studies to date have identified EMS workforce occupational injury and fatality rates that greatly exceed the national average for all industries. The goal of this project was to examine the feasibility of creating such a surveillance system. This report is a qualitative study and presents the findings of a consensus process that resulted in an agreement of EMS and data system stakeholders on the utility of existing data systems, and a set of elements and characteristics of the surveillance system. The report also contains a literature review of EMS workforce illness and injury. The EMS Consensus Panel determined that no single data system exists in the United States today that alone can serve as a surveillance data source for EMS workforce illness and injury. The EMS Consensus Panel also concluded that a comprehensive surveillance program should rely upon an integration of data systems to accomplish the goal of conducting EMS workforce illness and injury surveillance.

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A. Background and Purpose

Current research on the problem of occupational injury and illness among EMS workers presents cause for concern, but offers only a limited understanding of the problem. In 2000, the occupational injury rate was highest for EMS workers compared to other industries (Maguire, Smith, Hunting, & Guidotti, 2005). An earlier study found that the occupational fatality rate for EMS workers was more than twice the national average (Maguire, Levick, Hunting, & Smith, 2002).

Compared to information on EMS occupational injury, our depth and scope of knowledge regarding EMS workforce occupational illness is severely lacking. Even in the limited areas where EMS workforce illness is better understood, there is still a large reliance upon analyses of infectious disease reports mandated by law and studies of the respiratory illness that has plagued World Trade Center rescuers.

A limited understanding of the size of the EMS workforce contributes to the difficulty of conducting adequate surveillance of occupational injury and illness among this population. EMS workers function within a number of different types of organizations including career and volunteer fire departments, commercial ambulance services, third service public utilities, rescue squads, and others, thus further obscuring the true dimensions of the EMS workforce. Maguire and Walz (2004) estimated that the total number of EMS workers is around 900,000. Of these, the U.S. Bureau of Labor Statistics estimated that approximately 192,000 paramedics and emergency medical technicians (EMTs) work in full-time paid positions (Bureau of Labor Statistics, 2006). Other data suggests that the size of the EMS workforce may be larger.

The National Highway Traffic Safety Administration (NHTSA) funded an effort titled "Feasibility for an EMS Workforce Safety and Health Surveillance System" to better understand occupational injuries and illnesses among EMS workers. The goal of this project was to assess the feasibility of conducting occupational injury and illness surveillance for the EMS workforce. This report presents the findings of a consensus process involving EMS and data system stakeholders. These findings included agreement on the utility of existing systems for EMS workforce illness and injury surveillance and reaching consensus upon a set of important elements and characteristics of the surveillance system.

B. Methods

For the purposes of this report, surveillance is defined as the "ongoing, systematic collection, analysis, interpretation, and dissemination of data regarding a health-related event for use in … action to reduce morbidity and mortality and to improve health" (Centers for Disease Control and Prevention, 2001).

In consultation with NHTSA, the first phase of this project involved establishing two groups: (1) an EMS Steering Committee composed of knowledgeable experts in occupational injury and illness surveillance and EMS operations; (2) an EMS Consensus Panel drawn from officials of EMS stakeholder organizations in the US, representatives of data collecting or managing entities and university-based experts in emergency medical services and occupational injury.

The first task of the EMS Steering Committee was to reach a consensus on the "ideal characteristics of an EMS workforce illness and injury surveillance system." To reach a consensus on this question, Nominal Group Technique (NGT) was used. NGT facilitates consensus among members of a small group through a series of brief, structured, question-and-answer periods led by a moderator (Delbecq, Van de Ven, & Gustafson, 1975). The process begins with the presentation of a topic or question; group members then consider their responses to the topic or question. Each participant submits one or more responses to the question, in sequential fashion and a moderator immediately records the response on a newsprint pad. After the moderator lists all responses, participants select and rate the best responses to the topic or question. Each question or topic follows this process.

The NGT resulted in a list of 32 characteristics of an EMS workforce illness and injury surveillance system. These characteristics were listed in order of importance based on ratings assigned during the NGT.

Based on the initial EMS Steering Committee meeting, project staff generated two draft reports for dissemination to the EMS Consensus Panel and discussion at the EMS Consensus Panel meeting. First, project staff reviewed existing data systems and rated these systems for suitability as potential components of an EMS workforce Illness and Injury Surveillance System (IISS) based on the EMS Steering Committee findings using the NGT. Second, project staff developed and disseminated a list of draft elements and characteristics of an EMS workforce illness and injury surveillance system to the members of the EMS Consensus Panel.

During a meeting in May 2006, the EMS Consensus Panel members reviewed the two draft reports: (1) the Review of Data Systems and Sources and (2) the Characteristics and Elements of and EMS Workforce Illness and Injury Surveillance System. The panel agreed on the inclusion of specific characteristics and elements, as well as their wording, via direct facilitation. Then, members edited documents and rated elements either as "Essential" or as "Desirable." For each element or characteristic, facilitated discussion ensued until all members of the EMS Consensus Panel agreed on the classification of each item. EMS Consensus Panel members also provided their feedback on the results of the data systems review.

C. Results

1. Reaching Consensus on Surveillance

The EMS Steering Committee assigned higher scores to surveillance approaches that featured (1) integration or linkage with existing data systems; (2) use of denominator data to facilitate rate calculation; (3) specific elements for capturing contributing factors and EMS events underway when illness or injury occurred; (4) "user friendliness" of resulting data products, (5) utility for evaluation of prevention efforts, and (6) inclusion of provisions for evaluation of the surveillance system.

2. Review of Data Systems and Sources

Of the 14 data systems/sources reviewed, the Committee classified 7 systems as being of low suitability and classified the remaining 7 systems as being of medium suitability. No data system received a rating of high suitability.

Consistent themes emerge from an examination of the ratings. Most that were deemed as being of low suitability were limited in their scope of surveillance (e.g., Hazardous Substances Emergency Events Surveillance) or spectrum of the EMS workforce for which they provided surveillance coverage (e.g., IAFF Death and Injury Survey; National EMS Memorial Database). Those that received a medium rating were characterized by accessibility of data for an important component of EMS workforce illness or injury (e.g., Fatality Analysis Reporting System) or current or future potential for providing information on broad sectors of the EMS workforce (e.g., NEISS-Work; Workers Compensation Files) or were census-sample based systems (e.g., Census of Fatal Occupational Injuries).

Finally, few if any of the reviewed data systems provide an opportunity for collection of occupational injury and illness risk behavior (e.g., adherence to body substance isolation procedures), though FARS does collect information on occupant restraint use and Workers' Compensation records, if made available for the purpose, do contain information of this type.

3. Characteristics and Elements of an EMS Workforce Illness and Injury Surveillance System

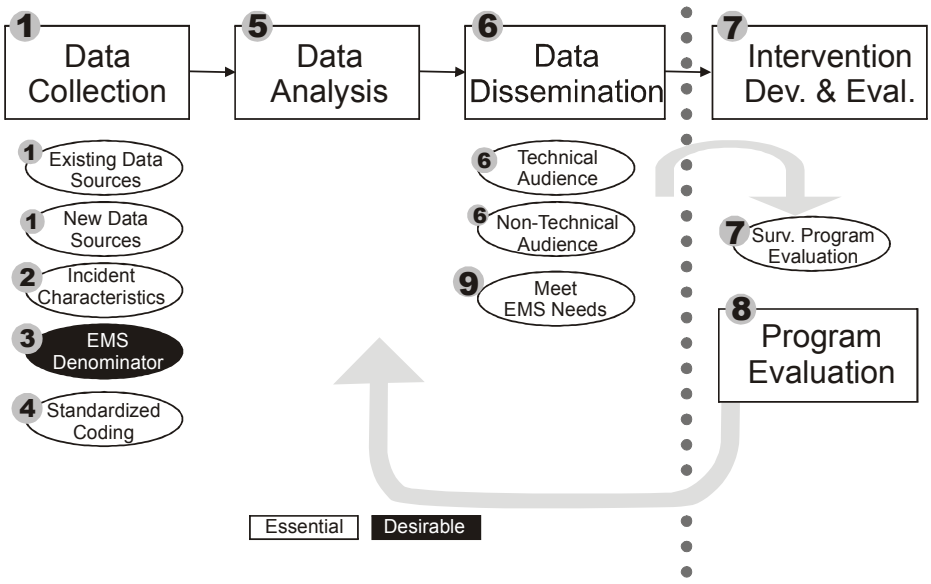
The EMS Consensus Panel agreed that the most effective approach to surveillance of EMS workforce illness and injury was to draw upon several existing systems. To reflect this approach, the EMS Consensus Panel adopted the language "Surveillance Program" to replace "Surveillance System." Of the top 10 priority characteristics/elements defined during the NGT, all but one was deemed as "essential." The panel deliberations suggest that "capturing denominator data" was deemed desirable rather than essential in an effort to limit barriers to progress in EMS workforce illness and injury surveillance, as the size of the EMS workforce is speculative.

EMS Consensus Panel Ratings of Characteristics and Elements of an EMS Workforce Illness and Injury Surveillance Program

Characteristic/Element	Consensus Rating
1. An EMS workforce injury and illness surveillance program will capture information from a variety of available data sources or create new data sources.	Essential
2. An EMS workforce injury and illness surveillance program will capture information regarding the injury or illness event (including the specific EMS activity) at the time of the injury or illness.	Essential
3. An EMS workforce injury and illness surveillance program will capture denominator data.	Desirable
4. An EMS workforce injury and illness surveillance program will use standardized coding schemes.	Essential
5. An EMS workforce injury and illness surveillance program will facilitate systematic analysis.	Essential
6. An EMS workforce injury and illness surveillance system will generate technical and non-technical output that is user friendly.	Essential
7. An EMS workforce injury and illness surveillance program will include ongoing planning and evaluation.	Essential
8. An EMS workforce injury and illness surveillance program will provide outputs useful for evaluation of preventive measures.	Essential
9. An EMS workforce injury and illness surveillance program will be responsive to the needs of the EMS community at the local, State, and national levels.	Essential

4. A Conceptual Model for EMS Workforce Illness and Injury Surveillance

Based on the work performed in reaching a consensus on surveillance and prioritizing surveillance characteristics, the EMS Consensus Panel presented and reviewed a conceptual model. The model describes the pathway of data collection, analysis and dissemination of results, the use of data in developing preventive interventions and program evaluation, and finally, the surveillance program evaluation (see Figure 1).



A Process/Component Model for the EMS Workforce Illness and Injury Surveillance Program

The EMS Workforce Illness and Injury Surveillance Program (EMSWIISP) approach is based upon the accumulation of EMS workforce morbidity and mortality information from existing or newly developed or identified data sources (Component 1) which under best circumstances will also contain information on incident characteristics (Component 2). Denominator data (Component 3), if available would allow calculation of morbidity and mortality rates. Standardized coding schemes (Component 4) would govern data analysis (Component 5). Data dissemination (Component 6) would logically follow with the information being provided in technical and non-technical formats to satisfy the needs of different stakeholders, policy and decision-makers and the public. Based on the information developed through a program based on this conceptual model it would be possible and desirable to developed safety and health interventions (Component 7) and to conduct program evaluation (Component 8). The arrows indicate a feedback-driven, ongoing process of analysis, dissemination, intervention and evaluation, meeting the needs of the EMS Workforce (Component 9). Finally, the model portrays a vision of EMS stakeholders, data owners and managers, scientists and healthcare workers, policy- and decision-makers and the public at large, working cooperatively to improve occupational health characteristics of the EMS workforce.

D. Conclusions

- The EMS Consensus Panel concluded that no single data system exists in the United States today that alone can serve as an effective surveillance data source for EMS workforce illness and injury.

- The EMS Consensus Panel also noted that some existing systems (e.g. CFOI, FARS, and NEISS-Work) already contribute to, or show potential in, increasing our understanding of EMS workforce illness and injury.

- Additionally, the EMS Consensus Panel concluded that a comprehensive surveillance program should rely upon an integration of data systems.

- The EMS Consensus Panel suggested that those who manage data systems should consider sharing systems, and data owners and other data providers should be encouraged to explore new approaches to data aggregation to address EMS issues.

- The EMS Consensus Panel also agreed that EMS stakeholders should work together with data holders/owners to encourage analysis and dissemination of information on EMS workforce illness and injury.

- The EMS Consensus Panel stressed that a national EMS workforce injury and illness surveillance program should be established, spanning surveillance to prevention because, ultimately, the goal of the program is to improve the health and safety of EMS workers.

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I. Introduction

Emergency Medical Services (EMS) personnel treat an estimated 22 million patients a year in the United States (Maguire & Walz, 2004). The precise dimensions of the EMS workforce have been estimated but are not known with certainty. Maguire & Walz (2004) estimated the total number of EMS workers at around 900,000. Of these, the U.S. Bureau of Labor Statistics estimated in 2004 that approximately 192,000 paramedics and emergency medical technicians (EMTs) work in full-time paid positions (Bureau of Labor Statistics, 2006). However, other data suggests that the size of the EMS workforce may be larger. For example, the National Association of Emergency Medical Technicians notes that many of the Nation's 1,000,000+ firefighters may be cross-trained in EMS; this is in addition to 600,000 EMTs and 142,000 paramedics (National Association of Emergency Medical Technicians, 2006). Further, EMS workers function within a number of different types of organizations including career and volunteer fire departments, commercial ambulance services, third-service public utilities, rescue squads, and others, thus further obscuring the true dimensions of the EMS workforce. The uncertain dimensions of the EMS workforce also contribute to the difficulty of conducting adequate surveillance to understand the extent of occupational injury and illness.

What research has shown regarding EMS workforce occupational injury is unsettling. A pioneering study by Maguire et al. (2005) indicates that occupational injury rates compared to Department of Labor records were higher for EMS workers in 2000 than for any other industry. In an earlier study, the same author found that the occupational fatality rate for EMS workers was more than twice the national average (Maguire et al., 2002).

Compared to information on EMS occupational injury, our depth and scope of knowledge regarding EMS workforce occupational illness is severely lacking. Even in the limited areas where EMS workforce illness is better understood, there is still a large reliance upon analyses of infectious disease reports mandated by law and studies of the respiratory illness that has plagued World Trade Center rescuers.

The National Highway Traffic Safety Administration funded an effort titled "Feasibility for an EMS Workforce Safety and Health Surveillance System." The goal of this project was to assess the feasibility of conducting occupational injury and illness surveillance for the EMS workforce. This effort began with adopting a definition of injury and illness surveillance based upon the Centers for Disease and Control's definition for public health surveillance, which draws upon the work of Teutsch and Thacker (1995), Buehler (1998), and Thacker (2000). For the purposes of this report, we will define surveillance as the "ongoing, systematic collection, analysis, interpretation, and dissemination of data regarding a health-related event for use in….action to reduce morbidity and mortality and to improve health" (Centers for Disease Control and Prevention, 2001).

This report presents the qualitative findings of a consensus process resulting in EMS and data system stakeholder agreement on the utility of existing data systems for an EMS workforce illness and injury surveillance, a set of elements and characteristics of the surveillance system and a set of conclusions and recommendations. It further describes the work of the EMS Steering Committee and EMS Consensus Panel and presents cumulative findings. This report also reviews the existing literature to determine the extent of research on occupational injuries and illness among EMS personnel.

II. Literature Review

A. Introduction

Injury and illness are two work-related risks among EMS workers. A pioneering study by Maguire, Smith, Hunting, and Guidotti (2005) using Department of Labor records indicates that occupational injury rates were higher in EMS workers in 2000 than for workers in any other industry. In an earlier study, the same authors found that the occupational fatality rate for EMS workers was more than twice the national average (Maguire, Levick, Hunting, & Smith, 2002). Though the magnitude of the problem of occupational injury among this workforce appears to be substantial, a complete review of current research does not exist. EMS workforce occupational illness is somewhat better understood, at least to the extent that transmission of infectious disease via needlestick and other blood exposures has been under study for 20 to 25 years. This paper reports our systematic review of the existing literature to determine the circumstances, characteristics, and extent of occupational injury and illness among the EMS workforce.

B. Firefighter Fatalities

Before beginning the review of EMS workforce illness and injury, we will briefly review firefighter illness and injury. Firefighters perform EMS functions in many parts of the country, especially in urban areas. Standardized reporting systems were mandated by the Federal Fire Prevention and Control Act of 1974 (P.L. 93-498) which authorized the National Fire Data Center in the United States Fire Administration (USFA) to gather and analyze information on fires and fire department operations, including injury and later illness. In addition, reports on patterns of firefighter injury have grown in detail and sophistication since their launch in 1986 (USFA, 2006); Finally, the National Fire Protection Association (NFPA) has been conducting annual analyses of these data since 1977 (NFPA, 2006). As a result, the information collected and analyzed regarding firefighters is relevant to the present topic. However, by their design, much of the information from these systems focuses upon fire-fighting activities, and information on EMS-related illness and injury is limited.

In a special 2005 report, the NFPA released an analysis of U.S. firefighter fatalities due to sudden cardiac death (Fahy, 2005). Of 1,006 total fatalities for the 10-year period, 440 (44%) were attributed to sudden cardiac death and 47 (11%) occurred during the performance of EMS activities. The most recent NFPA analysis (Fahy, 2006) analyzed 87 total firefighter deaths, 47 (54%) of which were due to sudden cardiac death. It was not possible from this report to determine how many were related to EMS activities.

Fangchao et al. (2005) examined mortality in a cohort of Florida firefighters, noting increased risk of mortality for males from breast, bladder, and thyroid cancers, and increased risk of cardiovascular disease mortality in female firefighters. Based upon an analysis of nine years of data from the National Health Interview Survey, Lee, Fleming, Gomez–Marin, and LeBlanc (2004) reported that firefighters age 30 to 39 face a significantly greater risk of hospitalization relative to other employed men in the same age group. Haas, Wartenberg, Gochfeld, and Robson (2003) reviewed 17 studies that reported calculated standardized mortality ratios (SMRs) for firefighters. These authors examined time-dependent mortality effects for all causes, and, specifically, coronary artery disease (CAD), cancer and respiratory deaths. In contrast to other studies, their time-series study failed to identify any increased mortality with increasing tenure

for all-cause mortality or any specific cause. Further, the authors identified many causes of death for which firefighters' SMRs were less than one, indicating decreased mortality for those causes.

Mechem, Dickinson, Shofer, and Jaslow (2002) conducted a retrospective review of occupational injury records from a large city fire department. Four percent of the 1,100 injury records involved assault by a patient. Firefighters were the subject of the injury report in about one-fifth of these records. While the contribution of assault to overall injury levels is rather low, this study nevertheless highlights an additional area for concern. Becker, Zaloshnja, Levick, Li, and Miller (2003) examined firefighters' risk for fire apparatus crash injuries and fatalities. Unrestrained firefighters were especially at risk for fatality if involved in a crash. The centralized data sets used for this study did allow the author to distinguish fire-truck-related crash fatalities from those of ambulance occupants, but it was not possible to determine if the fire truck deaths were associated with EMS or fire suppression activities.

C. Nonfatal Illness, Injury, and Infectious Disease Exposure of Firefighters

Deblina, Datta, Armstrong, Roome, and Alter (2003) examined blood samples from three first responder populations in the United States for presence of antibody to hepatitis C (anti-HCV; HCV). Prevalence ranged from 1.3 percent to 3.6 percent, which is consistent with appropriate reference groups in the U.S. population. HCV infection among first responders was not statistically associated with skin exposures to blood, but rather was statistically linked to nonoccupational risk factors. One other recent study supports these findings (Boal, Hales, & Ross, 2005).

In a 2005 report based on a stratified national sample, the NFPA released an analysis of on-duty firefighter injuries (Karter & Molis, 2005). Of 78,750 estimated injuries, 7,735 (9.8%) strains, sprains, and muscle pain events occurred during non-fire emergencies (Karter & Molis, 2004). Though details of the circumstances of the non-fire emergencies are not available from the report, the authors reported an estimated 10,550 exposures to infectious disease, or about 0.7 exposures/1,000 EMS run by fire departments in 2004.

D. Coronary Artery Disease and Cardiovascular Health of Firefighters

Campbell, Ritter, Lee, Garcia, and Rosenberg (1998) assessed a group of 65 firefighters in a number of fitness categories. Anywhere from 45 percent to 68 percent of the participants failed to meet benchmarks. Clark, Rene, Theurer, and Marshall (2002) applied "standard" and World Health Organization (WHO) body mass index (BMI) categorization methods to a group of 218 active-duty firefighters in six departments in North Central Texas undergoing duty fitness evaluations. According to standard methods, nearly 60 percent of individuals were rated with high or medium BMIs. Using the WHO classification, almost 81 percent of the subjects were classified as overweight, obese, or morbidly obese. Further, statistically significant inverse correlations were found between BMI and systolic and diastolic blood pressure, maximal oxygen consumption (VO_{2max}), resting oxygen consumption (METS) and total cholesterol. These findings not only contribute to the understanding of overall cardiovascular fitness in firefighters but also that BMI may be an important tool to identify firefighters in need of health and fitness remediation activities.

Kales, Soteriades, Christoudias, and Christiani (2003) published the results of a case-control study of firefighter on-duty deaths from coronary heart disease (CHD). They determined

that most deaths occurred between noon and midnight. Compared to non-emergency duties, fire suppression, training, and alarm responses were significantly associated with risk for CHD death. Furthermore, comparing firefighters who died from CHD to other firefighters, those having died from CHD tended to be current smokers and diagnosed with high blood pressure and/or coronary artery disease.

Other studies are consistent with Kales et al.'s (2003) findings. Womack et al. (2004) examined the data from annual physical exams of 75 firefighters, finding that 23 were positive for metabolic syndrome. This incidence is well above that predicted for American males by NCEP III (30.7% vs. 24%). Parker et al. (2005) analyzed coronary artery disease (CAD) risk factor data for 41 firefighters and determined that the prevalence of metabolic syndrome increased significantly as aerobic fitness declined. Though a small sample, these findings are entirely consistent with Jurca et al.'s (2004) findings for a sample of almost 9,000 men enrolled in the Aerobic Center Longitudinal Study and is also consistent with Lakka et al.'s (2003) study of Finnish men enrolled in a heart disease risk factor study. In an unrelated effort, Byczek et al. (2004) found that in a sample of 200 firefighters, the prevalence of obesity, elevated total cholesterol, and elevated blood pressure exceeded Healthy People 2010 (U. S. Department of Health and Human Services, 2000) targets. In addition, the prevalence of obesity, low high-density lipoprotein (HDL), high low-density lipoprotein (LDL), and high total cholesterol levels among these firefighters was higher relative to the general population. In a more extensive analysis, Tonya et al. (2004) examined a 10-year time series of CAD risk factors for firefighters in Southern California, finding that as a group the total number of risk factors significantly increased over the ten-year period. Webster et al. (2005) findings of ischemic change in moderate-risk firefighters during maximum exertion in a graded exercise test are alarming and entirely consistent with the CAD risk factor findings summarized above. Meyer, Hutchison, Martin, Womack, and Crouse (2001) found statistically significant concordance between self-reported physical activity and cardiovascular risk factors.

Though specific studies of cardiovascular risk have not been studied in single-role EMS providers, given the participation of fire department in EMS activities, it is entirely reasonable to believe that the findings for firefighters also reflect at least some proportion of the EMS workforce.

E. EMS Workforce Illness and Injury

1. Overview

This next section highlights a series of papers that have addressed EMS workforce illness and injury from a general perspective. Interest in this area has generated an unrelated series of studies from the early 1990s to the present. Schwartz, Benson, and Jacobs (1992) reported the results of a stratified random sample survey of emergency medical technicians (EMTs) of all levels in New England and calculated prevalence of reported disorders. Stress, whether from one event or cumulative over time, back and extremity injuries and assault were amongst the highest reported incidences. A survey to EMS training officers in 1990 revealed high rates of disabling injuries requiring hospitalization for injuries to hands, the head, feet and the eyes (Tortella & Lavery, 1994). A retrospective chart review of fire department injury, incident and exposure reports revealed that sprains (23%), strains (20%), and exposure to blood and body fluids (15%) were the most commonly reported events over a one-year period (Gershon, Conrad, Murphy,

Vlahov, & Kelen, 1995). An in-depth study of records of Irish ambulance personnel identified musculoskeletal disorders (neck and joint injuries), hypertension, peripheral vascular disease, and "mental problems" (primarily alcohol-related) as the leading causes of early retirement on medical grounds for the period 1988-1992 (Rodgers 1998).

A new era of interest in EMS workforce occupational illness and injury was ushered in by a groundbreaking study of occupational fatalities by Maguire and colleagues in 2002. Using data from the Bureau of Labor Statistics' Census of Fatal Occupational Injuries, the National EMS Memorial Database, and NHTSA's Fatality Analysis Reporting System (FARS), this group determined that EMS workers' occupational fatality rate of 12.5 per 100,000 substantially exceeded the national average of 5.0 per 100,000, and was comparable to the rates for police (14.2 per 100,000) and firefighters (16.5 per 100,000). In order of magnitude, the leading causes of occupational fatality were ground transportation, air ambulance crash, cardiovascular causes, and assault/homicide.

This team conducted a retrospective review of approximately four years of injury records of EMS providers employed by two urban agencies (Maguire et al., 2005). The study revealed injury rates for EMS workers were higher than rates reported by the U.S. Department of Labor for any industry in 2000. "Sprains, strains, and tears" was identified as the leading category of injury and the back was the body part most often injured. Of the 489 cases, 277 (57%) resulted in lost workdays, resulting in a rate of 19.6 (95% CI 17.3–21.9) per 100 full-time workers. In comparison, the relative risks for EMS workers were 1.5 (95% CI 1.35–1.72) compared with firefighters, 5.8 (95% CI 5.12–6.49) compared with health services personnel, and 7.0 (95% CI 6.22–7.87) compared with the national average. The leading source of injury was "healthcare patients" and the leading injury event was "overexertion-lifting only."

Contemporaneously, 27.4 percent of paramedics and 16.1 percent of EMT-Basics responding to the Longitudinal Emergency Medical Technician Attribute and Demographic Study (LEADS) reported having experienced a "back problem" (Brown Jr., Dickison, Misselbeck, & Levine, 2002). This was the second leading complaint for both groups, only exceeded by "Had a sleeping problem."

The subsequent sections of this chapter review the most common reported causes of EMS workforce illness and injury.

F. Emergency Vehicle Crash Injury and Fatalities

Ambulance crashes have received some attention in EMS media and other trade media (Elling 1989; Spivak 1998; Burns, 1999; LaDuke, 1999) but few peer-reviewed analytical accounts exist. Pirrallo and Swor (1994) examined ambulance crashes in four years of FARS data, and provided an overview of the earlier literature, including a series of sporadic government reports. Auerbach, Morris Jr., Phillips Jr., Redlinger, and Vaughn (1987) analyzed a very small sample of ambulance crashes in Tennessee. Notably, despite their known effectiveness in reducing injury and death, only about half of vehicle drivers and front-seat occupants were wearing occupant restraints; over half of the patients lying prone on a stretcher were restrained, while only 15 percent of bench seat patients were wearing restraints, and almost all rear-compartment occupants sitting in the "jump seat" were wearing restraints. Biggers, Zachariah, and Pepe (1996) conducted a retrospective study of one year of ambulance crash data from the Houston, Texas, fire department. An important finding from this study was that a driver

history of prior EMS vehicle crash is a key risk factor for future crashes. Kahn, Pirrallo, and Kuhn (2001) analyzed 1987-1997 FARS data, finding that unrestrained rear occupants were most at risk for fatal and/or incapacitating injuries. Just over four percent (4.1%) of respondents to a New England survey of EMTs reported that they had been involved in ambulance collisions (Schwartz et al., 1993). Field data monitoring restraint use suggests that there is frequent sub-optimal usage of the standard restraint systems fitted in ambulances for both crew and patients (Cook Jr., Meador, & Buckingham, 1991; Larmon, LeGassick, & Schriger, 1993). Gershon et al.'s (1995) review of EMS worker injuries focused mostly on injury type rather than injury cause, though motor vehicle collisions were noted as a source of the most serious EMS worker injuries.

Becker et al. (2003) addressed the role of emergency vehicle (ambulances, police cars, and fire trucks) occupant seating position, restraint use, and vehicle response status in injuries and fatalities. Multi-way frequency and ordinal logistic regression analyses were performed on two large national databases, NHTSA's FARS and the General Estimates System (GES). Several logistic regression models were estimated. One model estimated the relative risk ratios for different levels of injury severity to occupants traveling in ambulances. Restrained ambulance occupants involved in a crash were significantly less likely to be killed or seriously injured than unrestrained occupants. Ambulance rear occupants were significantly more likely to be killed than were frontseat occupants. Ambulance occupants traveling non-emergency were more likely than occupants traveling emergency to be killed or severely injured. Unrestrained ambulance occupants, occupants riding in the patient compartment and especially unrestrained occupants riding in the patient compartment were at substantially increased risk of injury and death when involved in a crash.

A second model incorporated police cars and fire trucks. In the combined ambulance-fire truck-police car model, the likelihood of an occupant fatality for those involved in a crash was higher for routine responses. Relative to police cars and fire trucks, ambulances experienced the highest percentage of fatal crashes where occupants die and the highest percentage of crashes where occupants are injured. Lack of restraint use and/or responding with "lights and siren" characterized the vast majority of fatalities among fire truck occupants. A third model incorporating non-special use van and passenger car applicants replicated the second model. The findings suggest that ambulance crewmembers riding in the back and firefighters in any seating position should be restrained whenever feasible. Family members accompanying ambulance patients should ride in the front seat of the ambulance.

The cumulative findings regarding traffic crash morbidity and mortality in the EMS workforce are consistent with the limited data on restraint use by providers in the rear compartment. Both Larmon et al.'s (1993) provider survey data and Cook Jr. et al.'s (1991) self-reported provider run analyses suggest that pre-hospital providers believe that traditional restraint systems negatively effect patient care.

G. Violence and Assault

The study of violence in a pre-hospital occupational injury context is rather new. A 1999 review did not identify any pre-hospital studies in this area prior to 1993 (Lucas, 1999). One of the earliest accounts of EMS workforce exposure to violence is a review of EMS run sheets in North Carolina (Tintinalli, 1993). Approximately 1 percent of a small sample of EMS run

records indicated violence. The situations included cases involving weapons on the scene (clearly indicative of intentional injury), but also included patients who were recorded as having been aggressive secondary to hypoglycemia. No on-duty injuries to EMS personnel were reported as a consequence of these emergency responses. In a prospective observational field study, 5 percent of EMS runs were classified as involving physical and/or verbal aggression (Mock, Eustis, Slovis, Wrenn, & Wright, 1998). A further 14 percent of EMS runs occurred in response to a violent event. The authors estimated a frequency for providers of exposure to one violent episode every four 12-hour shifts, or every 19 runs. Another prospective study examined 4,102 consecutive EMS calls over a one-month period in a southern Californian metropolitan area (Grange & Corbett, 2002). Some type of violence was identified in 8.5 percent of the calls. Of 349 calls, 184 (52.7%) involved violence directed against the crews while the remainder (47.3%) involved violence directed against others. The calculated prevalence of violence against crewmembers was 4.5 percent. Verbal aggression only characterized 20.7 percent of the calls, 48.9 percent involved physical aggression only and the remainder (30.4%) involved both verbal and physical aggression.

A serious picture of occupational injury exposure emerges from a survey fielded in 1996 to a convenience sample of almost 500 pre-hospital care providers in a southern California metropolitan area (Corbett, Grange, & Thomas, 1998). The group of approximately 500 respondents was largely male (93%) and white (80%) with a median of 10 years' experience on the job. Having been asked if they were "ever assaulted in the field," 61 percent reported one or more assaults and 25 percent reported injury from assault. Furthermore, 37 percent of those injured required medical attention. In a separate study, with regard to potential exposure to weapons, 51 percent of Boston and 76 percent of Los Angeles paramedics, reported finding weapons during searches of patients (Thomsen, Sayah, Eckstein, & Hutson, 2000). In addition, 27 percent of these respondents reported having found more than five weapons in their careers.

Mechem et al. (2002) reviewed three years of an occupational injury database of an urban fire department. Four percent of the 1,100 records involved an assault; well within the range of other reports and consistent with the 3.1 percent figure (160/5,170) which can be calculated for emergency medical technicians and paramedics from the 2004 BLS SOII data in Appendix 5 of this report. Assaults of paramedics and firefighters accounted for 79.5 percent and 20.5 percent of incidents, respectively. The authors reported that medical attention was sought in 81.8 percent of the incidents and that work time was lost in 31.8 percent of the incidents. With regard to intentionality, 59.1 percent of the incidents were judged as intentional, 38.6 percent as unintentional, and 2.3 percent could not be classified. These authors concluded that assault-related injuries to EMS personnel were uncommon.

EMS workforce exposure to threats and violence is not unique to the United States (Suserud, Blomquist, & Johansson, 2002). In a survey of Swedish ambulance personnel, 80.3 percent of respondents reported that they had experienced threats and/or violence.

Finally, a recently published study sought to identify demographic and scene characteristics of patients that had been restrained in the pre-hospital setting as a step in developing prevention strategies for assault of EMS workers (Cheney, Gossett, Fullerton–Gleason, Weiss, & Sklar, 2006). Late night calls, female patients, patients reported as violent, those in custody or injured in custody, and paramedics' perceived need for chemical restraint were associated with assaults on EMS personnel.

H. Infectious Disease

1. Needlestick Injury

The first study of pre-hospital needlestick injury dates back to 1988. Employees of the St. Louis Emergency Medical Services reported 44 injuries over a 38-month period (Hochreiter & Barton, 1988). New employees, defined as those with less than one year's employment, accounted for 43 percent of the injuries. In addition, the incidence rate for paramedics exceeded that for EMTs. Three hundred Florida paramedics responding to a systematic random sample survey resulted in 69 (23%) paramedics reporting 110 needlesticks (Klontz, Gunn, & Caldwell, 1991). Over one-third of the reported injuries resulted from recapping needles. A series of studies in different jurisdictions produced largely similar findings (See Table 1).

A comprehensive review of firefighter and EMT needlestick injury and hepatitis B and C (HBV and HCV) seroprevalence has been recently published (Boal et al., 2005). Table 1 is adapted from Boal et al. (2005). Overall, the incidence of needlestick injury is in decline. The regulatory context of this decline is discussed later in this report.

Table 1. Needlestick injury incidence as calculated by Boal et al. (2005)

City, County, or State	Locale and Time Period	Needlesticks per 1,000 Employee-Years	Employee Group	Reported By
City	St. Louis, 1982-1985	181	Paramedics	(Hochreiter & Barton, 1988)
State	Florida, 1987	367	Paramedics	(Klontz, Gunn et al., 1991)
City	Portland, 1988-1989	104	Firefighter-EMTs	(Reed, Grellman et al., 1993)
Cities	New York City, Chicago, Baltimore	200	All EMS Providers	(Marcus, Srivastava et al., 1995)
City	Atlanta, 1991	95	Emergency Medical Personnel	(Woodruff, Moyer et al., 1993)
City	Baltimore, 1992	56	All EMS Providers	(Gershon, Conrad et al., 1995)
County	Fulton County, 1992-1993	11	Firefighters	(Averhoff, Moyer et al., 2002)
County	Dade County, 1993-1994	180	Paramedics	(Carrillo, Fleming et al., 1996)
City	Tucson, 1998-2000	16.8	Firefighters & Paramedics (nonretracting stylets in use)	(Peate, 2001)
City	Tucson, 1998-2000	4.2	Firefighters & Paramedics (retracting stylets in use)	(Peate, 2001)

2. Hepatitis B Virus (HBV)

Two early reports revealed alarming levels of HBV seroprevalence. In an early study of EMS workers in Boston, one or more markers indicative of exposure to HBV were found in 18 percent of the personnel tested (Kunches, Jacobs, Craven, & Werner, 1983). Further, an EMS worker with 10 years of experience was 2.2 times more likely to be seropositive than a six-month employee. Results reported several years later for firefighters assigned to the Houston Fire Department revealed total combined HBV/HBC seroprevalence of 13 percent (Pepe, Hollinger, Troisi, & Heiberg, 1986). The seroprevalence of personnel with 7 years of experience or more reached levels of 15 percent while that of workers with less than 2 years of experience was 2.8 percent. Further, seroprevalence for hepatitis A was determined to be 16 percent. In another study, HBV seroprevalence of a small group of Midwestern paramedics was 7.1 percent (Fligner et al., 1989). In 1991, the U.S. Department of Labor's Occupational Safety and Health Administration issued the Bloodborne Pathogen (29 CFR 1910.1030), requiring vaccination of potentially exposed workers. HBV serosurveys have become scare in the literature since that time.

3. Hepatitis C Virus (HCV)

Hepatitis C (formerly "Non-A, Non-B")was identified as a specific virus strain in the late 1980s (U.S. Department of Health and Human Services, 2001). As the recognition of the threat of HCV grew, so did a series of studies of HCV seroprevalence. Table 2, adapted from Boal et al. (2005), summarizes these findings.

4. HIV/AIDS

In their extensive review, Boal et al. (2005) were unable to find any published serosurveys of HIV/ AIDS among firefighters and EMS personnel. Based on CDC surveillance data, of 57 documented occupational transmissions of HIV/AIDS, none have occurred among EMTs or EMT-Paramedics. However, of 139 possible occupational transmissions of HIV/AIDS, 12 have occurred in EMTs or EMT-Paramedics (Centers for Disease Control and Prevention 2003).

Table 2. HCV seroprevalence as reported for the EMS workforce

City/ State	Locale and Year of Data Collection	Prevalence of HCV Antibody (%)	Employee Group	Reported By:
City	Atlanta, GA, 1991	2.1	EMTs and Firefighters	(Woodruff et al., 1993; Centers for Disease Control and Prevention, 2000a)
State	Maryland, <1994	2.2	Career Firefighters and Paramedics	(Spitters et al., 1995; Pardoe, 1996);
State	Ohio, 1992	0.9	EMS Workers	(Werman & Gwinn, 1997)
State	Connecticut, 1992	1.3	Firefighters and other public safety personnel	(Roome et al., 1993; Centers for Disease Control and Prevention, 2000)
City	Tucson, AZ, 1998	1.5	Firefighters and Paramedics	(Peate, 2001)
City	Philadelphia, PA 1999	3.0	Firefighters	(Centers for Disease Control and Prevention, 2000a)
City	Miami, FL, 2000	2.1	Firefighters, Paramedics and EMTs	(Centers for Disease Control and Prevention, 2000a; Dailey et al., 2001)
City	Pittsburgh, PA, 2000	3.2	Paramedics	(Centers for Disease Control and Prevention, 2000a)
City	Detroit, MI <2001	2.8	EMS Personnel	(Upfal et al., 2001)
State	Oregon, <2002	1.2	Firefighters and EMTs	(Rischitelli et al., 2002)

I. Stress and Mental Health

The media is replete with accounts of the "stress" experienced by emergency providers. This section provides an overview of studies of mental health morbidity of the EMS workforce.

1. Job Stress and Burnout

High work-stress burnout can be formally described as consisting of three components: (1) Emotional exhaustion which may lead to negative, cynical attitudes towards their patients; (2) Deindividuation and depersonalization of patients; and (3) A tendency to evaluate themselves

negatively when assessing their work with patients (Maslach & Jackson, 1981). In a 1986 study, paramedics in a major midwestern city showed high levels of job dissatisfaction, organizational stress and negative attitudes, but not somatic symptoms, as compared to a sample of general hospital personnel (Hammer, Mathews, Lyons, & Johnson, 1986). A follow-up study, several years later in the same jurisdiction, did not identify any statistically significant differences in scores between the two samples (Cydulka et al., 1989). A national convenience sample of EMTs completed the Medical Personnel Stress Survey-Abbreviated (Hammer, Jones, Lyons, Sixsmith, & Afficiando, 1985), fielded by Cydulka and colleagues (Cydulka, Kubincanek, Emerman, & Shade, 1997). This study revealed high levels of stress, manifested primarily somatically, secondarily as organizational distress and job dissatisfaction, and last as negative patient attitudes. This finding is unique as most of the studies reviewed in this study identified psychological stress to be primary manifestations of stress and somatic symptoms to be secondary manifestations.

A study of career EMTs in Baltimore County, Maryland, revealed statistically significant relationships between work group cohesion and supervisor behavior, and reports of work-related stress, and linked high levels of work-related stress to increased levels of psychological stress (Revicki & Gershon, 1996). Full-time EMTs in a large, urban EMS department in the southern United States were studied to assess the possible links between stress, job satisfaction, and psychological distress and to also obtain preliminary information about which coping strategies might be associated with stronger feelings of stress and burnout (Boudreaux, Mandry, & Brantley, 1997). Greater job dissatisfaction, higher rates of depression, anxiety, and hostility were found to be present in EMTs who experienced more job-related stressors. With regard to coping strategies, EMTs who were quick to blame stressful situations on themselves or who assumed too much personal responsibility reported higher levels of distress and burnout. Based on the Occupational Stress Indicator (Cooper & Williams, 1991), EMS workers in a large city in the North of England reported significantly more pressure from "factors intrinsic to the job," "career and achievement," and "organizational structure and climate" compared to normative findings from populations of other types of workers (Young & Cooper, 1997). Furthermore, based on stepwise regression analysis, pressure from organization structure and climate was the most important predictor of job dissatisfaction.

Several studies used multivariate analytical techniques to study stress in the EMS workforce. A work stress instrument was fielded to members of the Devon, England, Ambulance Service (James & Wright, 1991). Factor analysis identified 13 factors accounting for 62 percent of instrument variance. The top four factors accounting for almost two-thirds of that variance (39.8%) were: Factor 1 (Organizational/Managerial Aspects) accounting for 20.8 percent of total variance; Factor 2 (New, Unfamiliar and Difficult Duties, Uncertainty) accounting for 6.2 percent of total variance; Factor 3 (Work Overload) accounting for 4.9 percent of total variance; and Factor 4 (Interpersonal Relations) accounting for 4.0 percent of total variance. Firefighter-Paramedics and Firefighter-EMTs in Washington States were assessed with an instrument to identify sources of job related stress (Beaton & Murphy, 1993). The top four factors accounting for two-thirds of that variance (42.3%) were Factor 1 (Sleep Disturbance) accounting for 26.4 percent of total variance; Factor 2 (Job Skill Concerns) accounting for 6.5 percent of total variance; Factor 3 (Past Critical Incidents) accounting for 5.2 percent of total variance; and Factor 4 (Management Conflicts) accounting for 4.2 percent of total variance. Firefighter-EMTs and Firefighter-Paramedics in two large northwestern U.S. cities were asked to rate and rank the

stressfulness of 33 actual and/or potential duty-related incident stressors (Beaton, Murphy, Johnson, Pike, & Corneil, 1998). Principal components analysis of incident stressors yielded five components accounting for 63 percent of the incident stressor variance: (1) Component 1 (Catastrophic Injury to Self or Co-worker) accounted for 40 percent of the instrument variance; (2) Component 2 (Gruesome Victim Incidents) accounted for 10 percent of the instrument variance; (3) Component 3 (Render Aid to Seriously Injured, Vulnerable Victim) accounted for 5 percent of the instrument variance; (4) Component 4 (Minor Injury to Self) accounted for 4 percent of the instrument variance; and (5) Component 5 (Death and Dying Exposure) accounted for 4 percent of the instrument variance.

2. Post-Traumatic Stress Disorder (PTSD)

It is well established that EMS providers are a group at risk for developing sequelae from exposure to traumatic stressors (Weiss, Ronfeldt, Marmar, & Metzler, 1995). In fact, EMS personnel are frequently and routinely exposed to several, and periodically exposed to all, of the dimensions described by Green and colleagues that make events traumatic (Green, 1993).

Added by the American Psychiatric Association to its DSM-III (Diagnostic and Statistical Manual of Mental Disorders, American Psychiatric Association, 1980) in the post-Vietnam War era (Friedman, 2006), PTSD has been diagnosed in hospital workers, police and the EMS workforce (Duckworth, 1986). The symptoms of PTSD include traumatic nightmares, psychotic reenactments known as PTSD flashbacks, dissociation and psychogenic amnesia, and hyper-vigilance. Individuals may display one or more or any combination of symptoms (Friedman, 2006). Interestingly, though worker compensation for PTSD was originally defined as resulting from a single catastrophic event, recent case law has now allowed employee compensation for PTSD that develops over "general exposure" to traumatic events within emergency services employment (Lindahl, 2004).

Weiss and others (1995) studied predictors of symptomatic distress of EMS workers involved in the 1989 Interstate 880 collapse during the San Francisco earthquake and a matched replicate of regional coworkers. This study definitively established for this group of workers were positively related to the degree of exposure to the incident, that an EMS worker's level of "adjustment" was inversely predictive of the severity of symptoms, and that dissociative phenomena at the time of trauma were linked with symptom severity. In an unrelated study comparing experienced West Coast paramedics and paramedic students, 20 percent of the former and 22 percent of the latter were judged to be suffering psychological trauma (Grevin, 1996).

Corneil and colleagues (1999) reported rates of PTSD in a group of urban U.S. and Canadian firefighters that were 15 to 18 times the prevalence rate found for a group of Canadian men (Stein, Walker, Hagen, & Forde, 1997). Further, Corneil's rates are comparable to those of wounded Vietnam veterans and 4 to 6 times those reported for U.S. crime victims (Kilpatrick & Resnick, 1993). In a study of Scottish regional ambulance personnel, nearly one-third reported high levels of general psychopathology, burnout, and posttraumatic stress symptoms (Alexander & Klein, 2001). Quite recently, an assessment of ambulance personnel in a county in Sweden revealed that 15.2 percent of current employees scored highly on the Impact of Events Scale(Horowitz, Wilner, & Alvarez, 1979), a standard tool used to assess stress reactions and the likelihood of PTSD (Jonsson, Segesten, & Mattsson, 2003)

a. The World Trade Center (WTC), September 11, 2001

Three-hundred forty-three members of the Fire Department of New York died as a result of the WTC collapse on September 11, 2001 (Centers for Disease Control and Prevention, 2002). Twelve EMS workers also were reported to have died as a result of the WTC collapse (National EMS Memorial Service, 2001). Over 5,000 rescuers were treated for illness and injury at five on-site Disaster Medical Assistance Team facilities and area emergency departments from September 11 to October 11, 2001 (Berríos-Torres et al., 2003). Overall, musculoskeletal conditions (19%), respiratory complaints (16%), and eye disorders (13%) were the leading causes of visits. During the 11 months after the WTC collapse, 1,277 stress-related incidents were recorded by FDNY, 17 times the number of incidents for the 11 months prior to September 11, 2001. Further, as of August 28, 2002, a total of 250 FDNY rescue workers remained on leave with service-connected, stress-related problems (Centers for Disease Control and Prevention, 2002). The long-term psychological impacts are not known. Psychological consequences of events of this magnitude can span years or even decades (Landrigan, 2001).

One relatively unique disorder developing as a result of the collapse has become known as "World Trade Center Cough" (Prezant et al., 2002). The syndrome is characterized as a persistent cough that developed after exposure to the WTC and is accompanied by respiratory symptoms severe enough to require medical leave for at least four weeks. During the six months after 9/11, 332 firefighters and one EMS worker were diagnosed with this syndrome (Centers for Disease Control and Prevention, 2002). The dust/smoke aerosol characterizing the WTC site was analyzed and found to be a complex mixture of building debris and construction products (Lioy et al., 2002). Fibrous materials made of mineral wool, fiberglass, asbestos, wood, paper, and cotton were found along with soot, paint, and unburned or partially burned jet fuel. The alkaline nature of the particulate matter (pH 10), which was caught in the eyes, nose, and throat, was probably responsible for the cough (Chen & Thurston, 2002). Most recently, Herbert et al. (2006) published their comprehensive follow-up of WTC responders. Their alarming findings include the following: (1) Almost 70 percent of WTC responders complained of a new or worsened respiratory symptom that developed or worsened during their exposure at the WTC site; (2) 61 percent of previously asymptomatic responders developed respiratory symptoms while working at the WTC site; (3) One-third of the responders pulmonary function tests were abnormal at time of follow-up (much higher than expected); (4) Severe respiratory conditions including pneumonia were significantly more common in the six months after 9/11 than the six months prior to the rescue response.

Though a complete review of WTC-related rescuer morbidity and mortality exceeds the scope of this report, this section will review what is known regarding illness and injury among EMS workers serving at the WTC site. Table 3 is based on data reported by Berríos-Torres et al. (2003) on illness and injury visits for EMS workers. Musculoskeletal, respiratory, neurologic, and eye-related complaints predominated. The distribution of injury and illness was largely consistent with those of the group of rescue workers as a whole. Given that visits of those classified as EMS workers constituted 138 of 5,222 total visits, the percentages reported should be interpreted with some caution. For example, of the 22 neurologic complaints reported by EMS workers, 21 of these visits were characterized as visits for "headache" (Berríos-Torres et al., 2003), whereas headache constituted only 9.3 percent of complaints of all rescue workers while constituting just over 15 percent of total EMS visits.

Table 3. Summary of EMS worker illness and injury at the WTC site

Injury and Illness Category	Frequency	Percent Total
Musculoskeletal	38	27.3
Respiratory	27	19.4
Eye	18	12.9
Skin	11	7.9
Neurologic	22	15.8
GI/GU	7	5
Psychological Stress	5	3.5
Cardiovascular	6	4.3
Environmental	1	<1
Endocrine	1	<1
Other Medical	3	2.1
Total	138	100

J. Miscellaneous Reports

Two early studies of hearing loss produced alarming results. In the first study, the auditory acuity of a group of paramedics with up to 15 years experience (hence siren exposure) was examined and compared to normal value age-related hearing loss (Johnson, Hammond, & Sherman, 1980). These authors reported that the personnel showed hearing loss of approximately one standard deviation in higher and lower frequency ranges. The authors also noted that hearing deficits in the left ear exceeded those of the right ear. Further, ambulance cable noise levels during siren use averaged 96 dBA to102.4 dBA, exceeding the Occupational Safety and Health Administration (OSHA)standard in use at the time(OSHA, 1974). In a somewhat later study, the authors estimated total number of hours of siren exposure for each of 192 male firefighters and, comparing those data with the results of hearing tests, concluded that (1) degree of hearing loss was positively correlated to duration of siren exposure; (2) the identified hearing loss could not be attributed to non-job-related exposure; and (3) the rate of hearing loss was 150 percent of that expected in age-matched, non-exposed men (Pepe, Jerger, Miller, & Jerger, 1985). Almost 20 years later, this area was re-investigated in a group of Louisville EMTs and Paramedics (Price & Goldsmith, 1998). Based on comparisons between pre-employment baseline audiograms and follow-up audiograms as part of this study, the authors failed to find a significant correlation between the number of months between audiograms and pre-post age-adjusted hearing loss. Left-ear hearing was reported to be somewhat more diminished than right-ear hearing, but still within overall normal limits. Overall, the authors concluded that for the group studied, there appeared not to be an excessive loss of hearing acuity. The authors noted that the careers of the individuals tested partially or entirely spanned the era of General Services Administration (KKK-1822) ambulance specifications requiring front-grill mount, rather than cab-roof mount, of siren speakers.

Finally, a brief report published in 2000 summarized heath risks to first responders, including EMTs, to exposures associated with illicit methamphetamine laboratories (Centers for Disease Control and Prevention, 2000b). Though the numbers were quite small (17 total EMT cases), respiratory, eye, and skin irritation were the leading reported injuries.

K. Conclusions

While some aspect of EMS workforce occupational illness and injury have been relatively well studied (e.g., ambulance crash), the literature review demonstrated that studies are limited in other areas. Further, as one would expect, with the exception of a handful of pioneering efforts, the existing literature has been built around information from systems developed for purposes other than studying EMS workforce illness and injury. Some areas, such as cardiovascular fitness of EMS workers, are almost wholly unexplored.

It would appear from this review of firefighter cardiovascular fitness that much needs to be done to improve the overall health of many firefighters in the United States. Pioneering efforts such as the 10 North American (9 in the United States and 1 in Canada) fire departments participating in the International Association of Fire Fighters Joint Labor-Management Wellness-Fitness Initiative are important steps in addressing this issue (The International Association of Fire Fighters, 2006).

As stated earlier in this report, many members of the fire service perform EMS duties and as such, the findings on cardiovascular fitness may reflect upon the health status of the EMS workforce. One study directly addresses this issue (Gerace & George, 1996). These authors identified predictors of weight increase in a group including firefighters and paramedics and observed levels of weight increase (e.g., 26% gained 15 lbs. or more) that are associated with negative impacts on blood glucose, lipids, and blood pressure (National Institutes of Health Consensus Development Panel, 1985). Furthermore, it has been known at least since the era of the publication of findings from the Framingham Heart Study that increases in weight are associated with an increased risk of cardiovascular disease (Hubert, Feinleib, McNamara, & Castelli, 1983).

EMS work often involves heavy lifting. Given the nature of EMS work, it is not surprising that musculoskeletal injuries are the leading cause of reported morbidity.

Patient-lifting is part of EMS work and one current health trend in the United States suggests that this lifting may become more hazardous. During the past 20 years there has been a dramatic increase in obesity in the United States (Centers for Disease Control and Prevention, 2006). The implications of this trend for EMS are twofold: (1) heavier patients are often more difficult to lift safely; and (2) a growing trend of obesity in the United States implies suggests the possibility of a greater number of relatively immobile patients requiring EMS assistance.

The studies reviewed herein as well as others (e.g., Pirrallo & Swor, 1994; Kahn et al., 2001), indicate that under crash conditions, the ambulance rear compartment is more hazardous to occupants than the driver's compartment. Over three-quarters (78.5%) of respondents to the National Registry of EMTs' LEADS EMS Driving Safety and Health Risk Survey reported that their EMS organization maintained a written policy regarding wearing seat belts (Margolis, 2006). Further, 63.6 percent of respondents reported that their EMS organization enforced the policy somewhat strictly or very strictly and 64.4 percent reported that they always wear their seat belts as a front-seat passenger.

According to the LEADS survey results, the EMS workforce is lagging behind in seat belt use relative to the reported level of seat belt use for 2005, which is 82 percent (National Highway Traffic Safety Administration, 2006). Pirrallo, Levine, & Dickison (2005) determined that regardless of gender, age, or race, EMTs wore their seat belts less often compared to U.S.

adults. Studies on rear-compartment seat belt use (Cook Jr. et al., 1991; Larmon et al., 1993), indicated that EMS providers believe that such use hinders patient care, and based upon what is know about rear-compartment crash injury and fatality risk, then seat belt use rates in the rear compartment are low. The National Institute for Occupational Safety and Health is currently studying rear-compartment restraint systems (National Institute for Occupational Safety and Health, 2004), but implementation of any newly developed restraint technologies will undoubtedly take some time. A strategy is necessary until the next generation of ambulance restraints is brought from prototype to assembly line to widespread implementation. EMS providers must be retrained in methods to simultaneously address their patient's needs and their own safety. Indeed, protecting one's self while at work is an important primary injury prevention knowledge and skill area for EMS providers (Garrison et al., 1996).

Violence and assault are a safety and health concern for the EMS workforce. Over half (50.8%) of respondents to the LEADS survey reported that they had been slapped, kicked, or punched. More alarmingly, 5.3 percent and 3.7 percent, respectively, reported that they had been involved in a job-related stabbing or shooting attempt (Margolis, 2006). The studies reviewed herein indicate that some of the violence experienced by the EMS workforce seems to be intentional. In addition, a study of one year of EMS runs in California revealed that 17 percent of EMS runs to homes for adults 65 or younger were associated with interpersonal violence (Weiss, Ernst, Phillips, & Hill, 2001).

The 1983 CDC *Guidelines for Isolation Precautions in Hospitals* contained a section titled "Blood and Body Fluid Precautions" that laid the groundwork for recommendations contained in the 1989 *Recommendations for Prevention of HIV Transmission in Health-Care Settings* (Centers for Disease Control and Prevention, 1989). The 1991 Bloodborne Pathogens Standard (29 CFR 1910.1030) codified the existing CDC recommendations and further protected the healthcare workforce by mandating employer-paid vaccinations. The Needlestick Safety and Prevention Act of 2000 clarified the intent of the 1991 OSHA standard by specifying engineering approaches to preventing needlestick injury and explicitly added hepatitis C (HCV) as an infectious disease covered under the standard.

With regard to HCV, studies of blood samples from first responders in Atlanta, Georgia, and Connecticut did not reveal seroprevalence levels that were different from appropriate referent groups in the U.S. population (Datta et al., 2003). In addition, an earlier study had identified non-occupational, behavioral risk factors for HCV infection in a study of public safety workers in Detroit (Upfal et al., 2001). Nevertheless, there is some unavoidable uncertainty with regard to HCV seroprevalence in the EMS workforce. Boal et al. (2005) in their review of the literature note that HCV transmission is principally through injection and other illicit drug use. Pre-employment and thereafter periodic drug-screening is common in fire-based EMS systems (Bureau of Labor Statistics, 2006). This combination of factors sets the stage for the "Healthy Worker Effect," as described by Boal et al. (2005), whereby HCV seroprevalence in the EMS workforce should be lower than the general population because drug users are not likely to be hired or to remain in the workforce. However, studies have demonstrated HCV seroprevalence levels in the EMS workforce that are comparable to those of the general population in the United States This leaves three possible scenarios: (1) the seroprevalences truly are the same; (2) EMS workforce members actually have higher seroprevalences than the general population, but needlestick injury under-reporting (Tandberg, Stewart, & Doezema, 1991) and participation bias make them appear similar; or (3) baseline HCV prevalence is actually lower in the EMS

workforce because of the healthy worker effect, but occupational seroconversions raise the prevalence to that of the general population (Boal et al., 2005).

With regard to HIV/AIDS, there is little information on occupational seroconversions in the EMS workforce. According to the best available information, the average risk for HIV transmission after a percutaneous exposure to HIV-infected blood has been estimated to be approximately 0.3 percent (95% confidence interval [CI] = 0.2%--0.5%) (Bell, 1997) and after a mucous membrane exposure, approximately 0.09 percent (CI = 0.006%--0.5%) (Centers for Disease Control and Prevention, 2001). The CDC has issued a series of recommendations for Post-Exposure Prophylaxis (PEP) after documented exposure to HIV/AIDS. Studies have determined that PEP can limit HIV seroconversions by anywhere from 67 percent to 81 percent (Connor et al., 1994; Cardo et al., 1997). The most recent update to these recommendations has expanded the potential antiretroviral drugs agents to five classes of drugs (Centers for Disease Control and Prevention, 2005).

As seems to be the case with musculoskeletal injuries, psychological stress, and even PTSD seem to be occupational hazards of the EMS workforce. Of course, Critical Incident Stress debriefing, developed in the early 1980s (Mitchell, 1983), has become a common practice in EMS (Bledsoe, 2003). Controversy has arisen regarding the effectiveness of CISD in reducing psychological sequelae associated with exposure to critical incident stress. A series of review papers and meta-analyses have led to conflicting conclusions. One of the earliest meta-analyses revealed a large effect size (Cohen's d = .86) indicating that CISD is an effective crisis intervention (Everly & Boyle, 1999). Alternatively, a number of studies questioning the effectiveness of CISD have been reviewed by (Bledsoe, 2003). Jeff Mitchell and colleagues have published clarifying reviews supporting the effectiveness of CISD (Everly & Mitchell, 2000; Mitchell, 2003). Most recently, Jacobs and colleagues have concluded that CISD is an effective method of reducing risk of PTSD-related symptoms in EMS personnel, but may not be effective for the primary victims of the trauma, i.e., the patients who have been treated by the providers (Jacobs, Horne-Moyer, & Jones, 2004). The discussions in this area continue to the present.

III. Common Themes

Thus, the existing literature has validated conventional wisdom that musculoskeletal injuries, especially those related to lifting, remain an EMS workforce injury concern. Of course, the elapse of time for data maturation will be necessary before it is possibly to evaluate current and recent past technological advances that may mitigate these types of injuries. Ambulance crash injuries and fatalities seem to be one area where focused prevention efforts and/or new engineering approaches may be effective in reducing morbidity and mortality. This literature review supports the conclusion that EMS workers are at risk for exposure to threats, violence and violence-induced injury. Perhaps, enhanced training and renewed prevention emphasis might mitigate this potential and real occupational hazard. Finally, the potential for stress disorders due to exposure to single catastrophic incidents or exposure to many incidents of differing magnitude over time is well established. Though areas of concern remain, the history of reductions in needlestick and infectious disease to the EMS workforce demonstrate how effective prevention efforts can reduce morbidity and likely mortality.

In summary, the following common elements emerge from this literature review:

- Cardiovascular fitness is a concern for the EMS workforce.
- Occupationally induced musculoskeletal injuries are an inherent hazard of the EMS profession.
- Ambulance-crash related injuries remain a hazard for the EMS profession, especially patient-compartment injuries and fatalities.
- The infectious disease hazard to the EMS workforce has diminished in recent years.
- EMS workers are prone to exposure to violence, threats, and violence-related injury.
- Psychological trauma is a hazard in EMS work.

IV. Methods

A. Establishing the EMS Steering Committee and EMS Consensus Panel

In consultation with NHTSA, the first phase of this project involved establishing an EMS Steering Committee (Appendix I) composed of experts in occupational injury and illness surveillance, and in EMS operations in the United States.

Also in consultation with NHTSA, an EMS Consensus Panel (Appendix 2) was established including EMS stakeholder organization officials, data collecting or managing entities experts, as well as university experts in EMS and occupational injury.

B. Reaching Consensus on Surveillance

For this project, to facilitate consensus among members of a small group, the EMS Steering Committee used the Nominal Group Technique (Delbecq et al., 1975), a series of brief, structured, question-and-answer periods led by a moderator. This process began with the presentation of a topic or question and then group members considered their responses. Each participant submitted one or more responses to the question, in sequence, and the moderator recorded them. Then the participants rated the best responses to each topic or question. The Committee followed this process for each question or topic.

The nominal group session followed a strict question-and-answer cycle. The question of interest, "What are the ideal characteristics of an EMS workforce illness and injury surveillance system?" was presented to the EMS Steering Committee Panel members. After reflection, panel members stated their response to the question in sequential fashion. Each panel member had the opportunity to respond to the question and the moderator recorded and numbered each response on newsprint. A round of "questions for clarification only" followed. Panel members could ask clarifying questions regarding the responses on the newsprint, with the author of the item answering the questions.

After the completion of the round for clarification, panel members reflected upon the items on the newsprint and selected what they believed to be the five best responses. Panel members recorded their responses on five index cards—one response per card. When it was apparent that all panel members completed their quiet review of the items, the moderator

instructed panel members to rank the five responses to identify the single most appropriate response. To do this, the moderator explained the rating scale used in this evaluation and asked attendees to rate the items they selected using a five-point rating scale with "5" being the most favorable or appropriate response, and recording their ratings in the bottom right corner of the index cards. Panel members then selected the most favorable response among the four remaining cards and rated it as "4." The participants repeated the procedure until panel members rated all of their top five responses.

Next, the cards were collected and tallied, and total scores were generated for each item. This was done in real-time, which allowed participants to further reflect upon the items and perhaps to be influenced by the results of the "scoring." After a review of the total scores, the moderator asked participants to repeat the process of selecting five items and then ranking the items as described above. Items receiving a "zero" score in the second round were omitted.

C. Development of Draft Products for Consideration

1. Review of Data Systems and Sources

Using the EMS Steering Committee findings, project staff reviewed existing data systems and rated these systems for suitability as potential components of an EMS workforce Illness and Injury Surveillance System (IISS).

Houser, Jackson, Bartis, and Peterson (2004) conducted an analysis of surveillance data for emergency responders. Where appropriate, this report draws upon the work of Houser et al. (2004). Data systems mentioned by Houser et al. (2004), as well as other data systems, were reviewed for suitability for inclusion in an EMS workforce IISS. Along with other draft products subsequently described, EMS Consensus Panel members received the data systems review.

2. Characteristics and Elements of an EMS Workforce Illness and Injury Surveillance System (IISS)

Based upon the deliberations of the EMS Steering Committee, the EMS Steering Committee developed and distributed a list of draft elements and characteristics of an EMS workforce IISS to the members of the EMS Consensus Panel.

D. Reaching Consensus

During a meeting in May 2006, the EMS Consensus Panel members reviewed the draft elements and agreed on inclusion of specific characteristics and elements. They edited documents until they were all in agreement with the phrasing. Then, the EMS Consensus Panel rated these elements as either "Essential" or "Desirable." For each element or characteristic, facilitated discussion ensued until all members of the EMS Consensus Panel agreed on the classification of each item. Consensus panel members also provided feedback on the results of the data systems review.

V. Results

A. Reaching Consensus on Surveillance

Table 4 summarizes the results of the NGT process. The EMS Steering Committee assigned higher scores to approaches that featured (1) integration or linkage with existing data systems; (2) use of denominator data to facilitate rate calculation; (3) specific elements for capturing contributing factors and EMS events underway when illness or injury occurred; (4) "user friendliness" of resulting data products; (5) utility for evaluation of prevention efforts; and (6) inclusion of provisions for evaluation of the surveillance system.

Table 4. Nominal Group Process Results: Question: What are the ideal characteristics of an EMS workforce injury and illness surveillance system?

Concept	Additional Description	First Voted Total Score	Final Voted Total Score
Accumulate usable information		48	49
Ability to capture/obtain (multiple) denominator data	- EMS specific - In order to calculate rates need standard denominator data along with EMS data - Not sufficient to have just one denominator data Ex. Hours worked by age, gender, job title	47	47
Uses/integrates with existing systems / linkage		31	32
Outputs useful for prevention evaluation / impact evaluation / measures illness/injury impact		22	31
Valid and reliable		40	30
Stakeholder Buy-in		12	21
Capture circumstances of contributing factors and EMS events		16	20
Flexible: responds to changing needs			17
Enables cross-sectional analysis, longitudinal analysis, case studies (data elements + follow-up)		6	17
User friendly		20	16
Ability to communicate information downstream (changed from "data")	- Disseminating data to public - Make data useful	13	16
Plan for funding of		10	16

Concept	Additional Description	First Voted Total Score	Final Voted Total Score
evaluation of system + research that uses data			
Ability to support linking of (show) cause and effect		5	10
Ability to follow up with victim		10	10
Injury specifics, BR type of injury		11	8
National in scope		16	7
Trend analysis		9	7
Can be integrated with policy	- Incorporated into laws, service policies or workplace procedures; address this systematically - Reporting incorporated with EMS system operations	4	7
Useful to guide prevention activities		7	7
Risk analysis		5	6
Financially viable		6	6
Near-miss reporting		6	6
Loss analysis / ability to "cost" injuries		10	5
Capture suicides (including attempts)		5	5
Capture known/suspected individual and environmental risk factors	- Worker health and fitness status - Hours worked prior to incident - Adaptable system to work/test hypothesis	5	5
Coding schemes standardized	- Using a coding scheme already created - Coding "crosswalk"	5	5
Comprehensiveness		18	4
EMS activity at time of event		6	4
Measure (level of) disability + (level of) severity		3	3
"Timely," usable reports		14	2
Captures events occurring en route to work and home		2	2
Output accessibility		10	1

B. Review of Data Systems and Sources

This section presents the results of the review of existing data systems. The description of each data system is followed by a summary table of advantages and disadvantages with regard to EMS workforce IISS. Consistent with the ideal characteristics as determined by the nominal group process, a rating of "High," "Medium," or "Low" has been assigned for overall suitability for use in this context.

1. Census of Fatal Occupational Injuries

The Census of Fatal Occupational Injuries (CFOI),[1] maintained by the Bureau of Labor Statistics, has historically provided counts of fatal firefighter injuries. Information such as type of event, type of vehicle/equipment, and demographic characteristic of workers is available. Medical events such as myocardial infarction and nontraumatic on-duty illnesses are excluded from the census counts unless an injury contributed to the death. Beginning with the 2003 reporting year, occupation codes have been added which will allow identification of non-firefighter EMS workers. A query system that can produce profile tables of EMS workers is available online. More detailed tables for a specific characteristic, such as type of event, may be available on a request-by-request basis.

CFOI guarantees data sources strict confidentiality and consequently, cell counts that would be part of detailed cross-tabulations by variables of interest such as event/exposure and activity are censored (Table 5). A table derived from CFOI data is in Appendix 3.

Table 5. Census of Fatal Occupational Injuries Advantages and Disadvantages

Advantages	Disadvantages
• Recent years' analyses specifically code non-firefighter EMS workers • Census counts (all-inclusive) • Includes government and private sector workers • Data are available for various events, demographic variables, type of equipment/vehicle involved • Some ability to query online	• Stringent confidentiality protections hamper detailed cross-tabulations of data • Some information not readily accessible
Overall Suitability Rating	**Medium**

[1] U.S. Department of Labor. Census of Fatal Occupational Injuries: Definitions. Last modified: October 16, 2001. Retrieved from www.bls.gov/iif/oshcfdef.htm. Accessed April 22, 2006.

2. Fatality Analysis Reporting System

The National Highway Traffic Safety Administration maintains the Fatality Analysis Reporting System,[2] a census of all motor vehicle crash fatalities in the United States. Fatality information derived from FARS includes motor vehicle traffic crashes that result in the death of an occupant of a vehicle or nonmotorist within 30 days of the crash. The database is queriable on-line and data is available for off-line analysis. FARS allows identification of vehicle type, "emergency use," restraint use, contributing factors, fatality demographics, geographic information, injury severity, and a number of other factors (Table 6).

Table 6. Fatality Analysis Reporting System Advantages and Disadvantages

Advantages	Disadvantages
• Allow identification of crash fatalities by vehicle type • Allows analysis of crash circumstances and emergency device use • Public use files are available and also queriable online	• Not always possible to distinguish crew from patients • By design and purpose, limited to traffic and pedestrian crash fatalities
Overall Suitability Rating	**Medium**

3. Hazardous Substances Emergency Events Surveillance

The Hazardous Substances Emergency Events Surveillance[3] (HSEES), maintained by the Agency for Toxic Substances and Disease Registry, captures information about any incident involving the release or threatened release of at least one hazardous substance. Fifteen States participate in HSEES. Information is included in the database on all injuries occurring at these events, including injuries to emergency responders. Responder injuries are analyzed and presented by type of responder, nature and severity of injury, and type of protective equipment worn. Annual reports are available from 1995 to 2003 (Table 7).

Table 7. Hazardous Substances Emergency Events Surveillance Advantages and Disadvantages

Advantages	Disadvantages
• Captures information on hazardous materials events involving first responders • Some ability to distinguish career and volunteer providers • Some ability to distinguish EMS providers • Public use data file is available from 1995-2003	• Current data are unavailable
Overall Suitability Rating	**Low**

[2] www-fars.nhtsa.dot.gov/main.cfm
[3] www.atsdr.cdc.gov/HS/HSEES

4. IAFF Death and Injury Survey

The International Association of Fire Fighters' (IAFF)[4] *Death and Injury Survey* is an annual report based on a survey of a population-stratified random sample of career-only and career and/or volunteer fire departments. Houser et al. (2004) reported that in a typical year, the sampled departments employ around 100,000 firefighters. Information collected includes line-of-duty deaths and injuries, incidence and type of infectious disease exposure, and occupational injury and illness retirements. Injuries are analyzed and presented by type of duty and nature of injury (Table 8).

Table 8. IAFF Death and Injury Survey Advantages and Disadvantages

Advantages	Disadvantages
• Includes injury and infectious disease exposure • Includes causes of occupational injury and illness retirements • Includes type of duty breakdown	• By its nature, population sampled consists of career firefighters only • Findings reported as percentage of all injuries (no raw counts or industry estimates) • Proprietarily owned
Overall Suitability Rating	**Low**

5. National Electronic Injury Surveillance System

The U.S. Consumer Product Safety Commission[5] (CPSC) administers the National Electronic Injury Surveillance System[6] (NEISS), a national stratified probability sample of U.S. hospitals with 24-hour emergency departments, to capture product-related injuries and illnesses that are non-work-related. In addition, CPSC collaborates with the Centers for Disease Control and Prevention to collect data for two adjunct programs: the National Institute for Occupational Safety and Health (NIOSH) work-related injuries/illnesses program (NEISS-Work) and the NEISS All-Injury Program (NEISS-AIP).[7] Appendix 4 contains a variable list for the NEISS-Work Program.

The NEISS-Work data includes all cases of work-related injuries and illnesses that present to emergency departments. Marsh, Derk, and Jackson (2006) have recently published an analysis of data from this system. NEISS-Work captures approximately 50,000 cases annually from a subset of 67 of the 101 hospitals within the CPSC NEISS sample. This is the only NEISS data that collects occupational information, allowing for identification of EMS providers. Variables coded include age, sex, body part, diagnosis, event, and source. Occupation and industry are currently captured as narrative fields only. Comment fields, providing additional injury/illness description, are also available.

A feature of NEISS data is the ability for other Federal agencies to contract with CPSC for follow-back investigations conducted through telephone interviews. These investigations

[4] International Association of Fire Fighters, 1750 New York Ave. NW., Washington, DC 20006 (www.iaff.org/).
[5] www.cpsc.gov
[6] www.cpsc.gov/library/neiss.html.
[7] Personal Communication, Dr. Larry Jackson, NIOSH.

focus on specific types of cases (e.g., EMS personnel) captured in a NEISS database. The survey instruments used in follow-back investigations are designed by the sponsoring agency and may contain both quantitative and qualitative information.

Table 9. National Electronic Injury Surveillance System Advantages and Disadvantages

Advantages	Disadvantages
• Captures information on emergency department visits for work-related injuries and illnesses • Captures both paid and volunteer EMS personnel • Includes standardized coding for occupational injuries and illnesses • Statistical probability sample allows extrapolation to national counts • Information available to federal agencies and organizations	• Occupational variables are not currently available in public access files • Does not capture cases treated in a setting other than an ED
Overall Suitability Rating	**Medium**

6. National EMS Memorial Service Database

The purpose of the National EMS Memorial Service (NEMSMS) is to honor those EMS personnel who have died in the line of duty and to recognize the ultimate sacrifice they have made for their fellow man. The first NEMSMS was held in 1992. It is now held annually during National EMS Week. Houser et al. (2004) report that the NEMSMS[8] maintains a database of line-of duty deaths, broken down by cause of death and containing some narrative information about the circumstances surrounding the death. NEMSMS relies upon members of the public to nominate for inclusion in its database (Table 10).

Table 10. National EMS Memorial Service Database Advantages and Disadvantages

Advantages	Disadvantages
• Potential to capture events not elsewhere recorded • Information is readily accessible	• Participation is voluntary • Limited information per case
Overall Suitability Rating	**Low**

7. NFPA Firefighter Fatality Reports

National Fire Protection Association (NFPA) [9] produces an annual report on firefighter fatalities. The NFPA firefighter fatality reports include the results of analyses of the complete set

[8] National EMS Memorial Service, P.O. Box 279, Oilville, VA 23129 (http://nemsms.org/).
[9] National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269 (www.nfpa.org/ Home /index.asp).

of on-duty deaths by nature of injury, cause of injury, type of duty, and demographics (Table 11). The NFPA count is a census, or complete count, of annual firefighter deaths.

Table 11. NFPA Firefighter Fatality Reports Advantages and Disadvantages

Advantages	Disadvantages
• Census sample (complete count) • Includes career and volunteer providers • Includes type of duty breakdown • Widely available at modest cost	• By its nature, population sampled consists of firefighters only • Limited causal data on non-fireground injuries • Limited illness information
Overall Suitability Rating	**Medium**

8. NFPA Firefighter Injury Reports

NFPA also produces an annual report of firefighter injuries based on a survey of a population-stratified random sample of municipal (city and county) fire departments. NFPA estimates the total number of firefighter line-of-duty injuries in the Nation, analyzed by type of duty and nature of injury for all injuries as well as by cause of injury for fireground injuries and includes both career and volunteer firefighters (Table 12).

Table 12. NFPA Firefighter Injury Reports Advantages and Disadvantages

Advantages	Disadvantages
• Allows extrapolation to national population • Includes career and volunteer providers • Includes type of duty breakdown • Widely available at modest cost	• By its nature, population sampled consists of firefighters only • Limited causal data on non-fireground injuries • Limited illness information
Overall Suitability Rating	**Medium**

9. NIOSH Fatality Investigation Reports

The National Institute for Occupational Safety and Health Fatality Assessment and Control Evaluation (FACE) program[10] is a research program designed to identify and study fatal occupational injuries. The goal of the FACE program is to prevent occupational fatalities across the Nation by identifying and investigating high-risk work situations for injury, and then formulating and disseminating prevention strategies to those who can intervene in the workplace. The FACE program provides detailed investigations into the causes and circumstances of selected occupational fatalities including those of EMS workers. The reports also offer recommendations on preparedness, management, training, and other factors that might have prevented the casualties (Table 13). On-site investigations are an integral component of FACE, are essential for observing sites where fatalities have occurred, and for gathering facts and data from company officials, witnesses, and co-workers. Investigators collect facts and data on what was happening just before, at the time of, and right after the fatal injury.

Table 13. NIOSH Fatality Investigation Reports Advantages and Disadvantages

Advantages	Disadvantages
• Results of in-depth investigations • Typically includes information on prevention and risk management • Widely available at no cost	• By its nature, very limited number of EMS cases investigated • Volunteer providers not included • Limited illness information
Overall Suitability Rating	**Low**

10. National Occupational Mortality Surveillance System

The National Occupational Mortality Surveillance System[11], maintained by NIOSH, contains information on the cause of death and normal occupation and industry of the deceased for a significant fraction of all deaths, not just those that are work-related. Occupation and Industry is coded according to the 1980 Bureau of the Census Classification System. Though frequencies and proportional mortality ratios for specific occupations can be computed, Houser et al. (2004) note that the data do not include genetic and behavioral risk factors such as smoking, many of which are likely more significant than occupational risk factors (Table 14).

[10] www.cdc.gov/niosh/face/
[11] http://wonder.cdc.gov/noms.html

Table 14. National Occupational Mortality Surveillance System Advantages and Disadvantages

Advantages	Disadvantages
• Captures information on substantial proportion of all deaths • Includes coding for occupation and industry • Allows for calculation of proportional mortality ratios • Queriable on-line without access restriction	• 1980 codes do not allow for identification of EMS providers other than firefighters or law enforcement • Last complete year available is 1999 • Data only collected by a few States at present
Overall Suitability Rating	**Low**

11. National Surveillance System for Health Care Workers

The National Surveillance System for Health Care Workers (NaSH), maintained by the National Center for Infectious Diseases, collects information on exposures and infections among health-care workers, including hospital-based EMTs. Houser et al. (2004) reported that for infectious disease exposures, the data includes information about the mechanism of exposure (Table 15). NaSH monitors immunization and tuberculin-skin testing programs and exposure events to blood and body fluids, vaccine-preventable diseases and tuberculosis. NaSH also evaluates the level of underreporting of percutaneous injuries and denominators for incidence rate calculations. Participation in NaSH is voluntary.

Table 15. National Surveillance System for Health Care Workers Advantages and Disadvantages

Advantages	Disadvantages
• Monitors trends in occupational exposures and infections	• Participation is voluntary • Private sector workers only • Volunteer providers not included • Information not readily accessible
Overall Suitability Rating	**Low**

12. Survey of Occupational Injuries and Illnesses

The Survey of Occupational Injuries and Illnesses (SOII), maintained by the Bureau of Labor Statistics, provides national counts and incidence rates for nonfatal occupational injuries and illnesses by private sector industry. Detailed case (nature of injury, part of body, event and exposure, time of incident) and demographic (age, sex, occupation) data are available for cases involving days away from work. Houser et al. (2004) report that data for public-sector employees is available only for the 25 States with OSHA-approved safety programs (Occupational Safety and Health Administration, 2006). Beginning with the 2003 reporting year, codes have been added which will allow identification of non-firefighter EMS workers. A query system that can produce profile tables of nonfatal injuries and illnesses to EMS workers is available online. More

detailed tables of a specific characteristic, such as type of event or nature of injury, may be available by special request. A table derived from SOII data can be found in Appendix 5.

BLS guarantees employers strict confidentiality and consequently, many of the cell counts that would be part of detailed cross-tabulations by variables of interest are censored. State-level data for the public sector are not aggregated to the national level and this further hampers analysis by variables of interest. The result of minimum cell count requirements to protect confidentiality is that a portion of the data is not publicly available (Table 16).

Table 16. Survey of Occupational Injuries and Illnesses Advantages and Disadvantages

Advantages	Disadvantages
• Recent years' analyses specifically code non-firefighter EMS workers • Statistical probability sample allows extrapolation to national counts for private sector industries • Some on-line query capability for case and demographic characteristics for cases with days away from work.	• Stringent confidentiality protections hamper detailed cross-tabulations • Lack of aggregation to the national level for public sector data restricts availability of information for EMS workers
Overall Suitability Rating	**Low**

13. USFA Firefighter Fatality Reports

The United States Fire Administration[12] (USFA), produces an annual report based on the complete set of firefighter on-duty deaths. Fatalities are analyzed and presented by nature of injury and cause of injury, and type of duty, fireground activity, and demographics. In recent years, USFA fatality reports have been providing increasing levels of detail by distinguishing medical calls from other "non-fireground" activities. The USFA report contains narrative information describing the circumstances of every fatality (Table 17).

Table 17. USFA Firefighter Fatality Reports Advantages and Disadvantages

Advantages	Disadvantages

• Census sample (complete count)
• Includes career and volunteer providers
  • Includes type of duty breakdown and increased detail on medical responses
  • Contains narrative for each case
  • Widely available at no cost
	• By its nature, population sampled consists of firefighters only
	• Limited illness information

Overall Suitability Rating	**Medium**

[12] www.usfa.fema.gov/

14. Workers Compensation Files

At the State level, workers compensation files are a decentralized set of State-level data files. The National Council on Compensation Insurance[13] is an organization that is funded by insurance carriers and is charged with gathering data on the number, severity, length of disability, type of disability, and cost of work-related injuries (broken down by medical, indemnity, and expenses) from each State. Based on the industry and the types of employees in that industry, the NCCI assigns a "job class code" for each class of employee. The insurers use the job class codes and the cost of injuries by job class code to charge employers a premium for each type of employee. The insurer can modify (up or down) the rate for a given employer based on its "experience" per class of employee. The insurers track all work related injuries by employer, by job class code, by severity, length of disability, type of disability, and cost of the claim, and provide this information to the NCCI. Based on the information provided by the insurance carriers, the NCCI sets a standard insurance premium rate per job class code (x times each hundred dollars of payroll in that job class code). Thus, it would appear that NCCI files, if made available, would contain a wealth of information on occupational injuries of the EMS workforce. Furthermore, in many States, injured volunteer providers are entered into the State level workers compensation files. Though only 32 of the 50 States participate in the NCCI program, the data elements collected are uniform across existing members.

The NCCI job class-coding scheme is complex. NCCI does not assign one job class code to all EMS workers, but assigns a different number to EMS worker by each industry. For example, EMS workers employed by a municipality are given a different number from EMS workers employed by a private ambulance service, or a private corporation. Moreover, firefighters employed by a municipality are given a different number from firefighters employed by a private corporation. Thus, for EMS workers injuries, all in the same State, working for different industries (i.e. municipalities, forestry, mining, private ambulance companies, etc.), each type of industry would have a different job class code for its type of EMS worker (Table 18). Queries of the data can be contracted; fees vary depending on the complexity of the query.

Table 18. Workers Compensation Files Advantages and Disadvantages

Advantages	Disadvantages
• Identification of EMS workforce occupational injury and illness costs is possible for over one-half of the States in the United States • Queries of the data can be arranged through purchase	• Several large States do not participate, reducing any potential representation of the data • Proprietary data base, public use files are not available
Overall Suitability Rating	**Medium**

C. Summary of Review Findings

Table 19 below summarizes the initial assessment of suitability of the data sources identified by this effort as potentially useful for surveillance of EMS workforce illness and injury.

[13] www.ncci.com

Table 19. Data Suitability Assessment

Data Source/System	Suitability Rating
Hazardous Substances Emergency Events Surveillance	Low
IAFF Death and Injury Survey	Low
National EMS Memorial Service Database	Low
NIOSH Fatality Investigation Reports	Low
National Occupational Mortality Surveillance System	Low
National Surveillance System for Health Care Workers	Low
Survey of Occupational Injuries and Illnesses	Low
Census of Fatal Occupational Injuries	Medium
Fatality Analysis Reporting System	Medium
NFPA Firefighter Fatality Reports	Medium
NFPA Firefighter Injury Reports	Medium
NEISS-Work	Medium
Workers Compensation Files	Medium
USFA Fire Fatality Reports	Medium

Of the 14 data systems and sources reviewed, the EMS Steering Committee and EMS Consensus Panel classified 7 systems as being of low suitability and classified the remaining 7 systems as being of medium suitability. No data system received a rating of high suitability.

Consistent themes emerge from an examination of the ratings. Most systems that were deemed as being of low suitability were limited in their scope of surveillance (e.g., Hazardous Substances Emergency Events Surveillance) or spectrum of the EMS workforce for which they provided surveillance coverage (e.g., IAFF Death and Injury Survey; National EMS Memorial Database). Those systems that received a medium rating were characterized by accessibility of data for an important component of EMS workforce illness or injury (e.g., Fatality Analysis Reporting System) or current or future potential for providing information on broad sectors of the EMS workforce (e.g., NEISS-Work; Workers Compensation Files) or were census-sample-based systems (e.g., Census of Fatal Occupational Injuries).

Finally, few if any of the reviewed data systems provide an opportunity for collection of occupational injury and illness risk behavior (e.g., adherence to body substance isolation procedures). Exceptions are FARS, which does collect information on occupant restraint use and worker's compensation records, which if made available for the purpose, contains information of this type.

D. Characteristics and Elements of an EMS Workforce Illness and Injury Surveillance System

The major work product of the EMS Consensus Panel meeting held in May 2006 was agreement upon the elements and characteristics displayed in Table 20. As it grew increasingly clear that the most feasible approach to surveillance of EMS workforce illness and injury was to work with a collection of existing systems, rather than create a new surveillance system, the

EMS Consensus Panel adopted the language "Surveillance Program," to replace "Surveillance System." The precise wording of each of the characteristics or elements (hereafter element) in Table 20 was agreed upon by all present and recorded in real-time throughout the deliberations. The sequential numbering of the elements broadly maps to those reported in Table 4 of this report. Where logical, items in Table 4 were combined and/or duplicates were removed. Consensus was reached upon the steps of an action plan for each element in Table 20 and once again recorded in real time throughout the deliberations. Finally, for each item, discussions were held until the group reached consensus on a rating of "Essential" or "Desirable" for each element.

Table 20. Characteristics and Elements of an EMS Workforce Illness and Injury Surveillance Program

1. An EMS workforce injury and illness surveillance program will capture information from a variety of available data sources or create new data sources. **Action Plan:** • Verify accessibility and potential linkage between the different data sets. • Review samples of raw data. • Rank the utility and accuracy of the data. • Create a data dictionary (codebook).	Essential
2. An EMS workforce injury and illness surveillance program will capture information regarding the injury or illness event (including the specific EMS activity) at the time of the injury or illness. **Action Plan:** • Identify information to be collected. • Evaluate pre-existing data sources (e.g., BLS occupational injury illness classification system (event source, secondary source, body part, nature of injury) as well as other systems to identify systems that are already collecting the desired data elements. • Add/modify/edit the pre-existing data sources to the data elements to be collected.	Essential
3. An EMS workforce injury and illness surveillance program will capture denominator data. **Action Plan:** • Define denominator information required for the surveillance program. • Determine sources of denominator sources. • Obtain denominator data and use.	Desirable
4. An EMS workforce injury and illness surveillance program will use standardized coding schemes. **Action Plan:** • Identify applicable coding structures of previously existing systems. • Select the most appropriate coding scheme for each element. • Create a standardized coding scheme where an appropriate pre-existing coding scheme does not exist.	Essential

5. An EMS workforce injury and illness surveillance program will facilitate systematic analysis. **Action Plan:** • Identify the types of analysis that are possible given the data sources that comprise the program. • Conduct preliminary analyses. • Reevaluate the feasibility of using existing data sources for the different types of analyses. • Create a listing of available types of analyses.	Essential
6. An EMS workforce injury and illness surveillance system will generate technical and non-technical output that is user friendly. **Action Plan:** • Identify stakeholders, partners and their information needs. • Develop a health communication plan (a plan for dissemination of information). • Evaluate the dissemination of information products--are they serving the needs of the target audiences?	Essential
7. An EMS workforce injury and illness surveillance program will include ongoing planning and evaluation. **Action Plan:** • Evaluate the program according to CDC surveillance system guidelines. • Modify surveillance program activities as is practical.	Essential
8. An EMS workforce injury and illness surveillance program will provide outputs useful for evaluation of preventive measures. **Action Plan:** • Define a target audience to evaluate and use the data. • Define targeted information needed. • Collect information. • Disseminate. • Identify who can develop/improve/implement prevention measures.	Essential
9. An EMS workforce injury and illness surveillance program will be responsive to the needs of the EMS community at the local, State, and national levels. **Action Plan:** • Identify stakeholders, partners and other involved parties. • Conducts a needs assessment. • Evaluate program performance and design relative to needs. • Repeat process at feasible intervals.	Essential

E. A Conceptual Model for EMS Workforce Illness and Injury Surveillance[14]

The EMS Consensus Panel presented and reviewed a conceptual model for an EMS Workforce Illness and Injury Surveillance Program (EMSWIISP). Each of the rectangles (e.g., Data Collection, Data Analysis) represents major activities or processes which are proposed to occur as part of the EMS Workforce Illness and Injury Surveillance Program. The text ovals reflect the essential elements or characteristics of EMSWIISP as determined by the EMS Consensus Panel. The circled numbers relate the EMSWIISP elements or characteristics (Table 20) to the conceptual model in Figure 1. The model shows the pathway of data collection, analysis and dissemination of results to lead to countermeasure development and evaluation, as well as surveillance program evaluation.

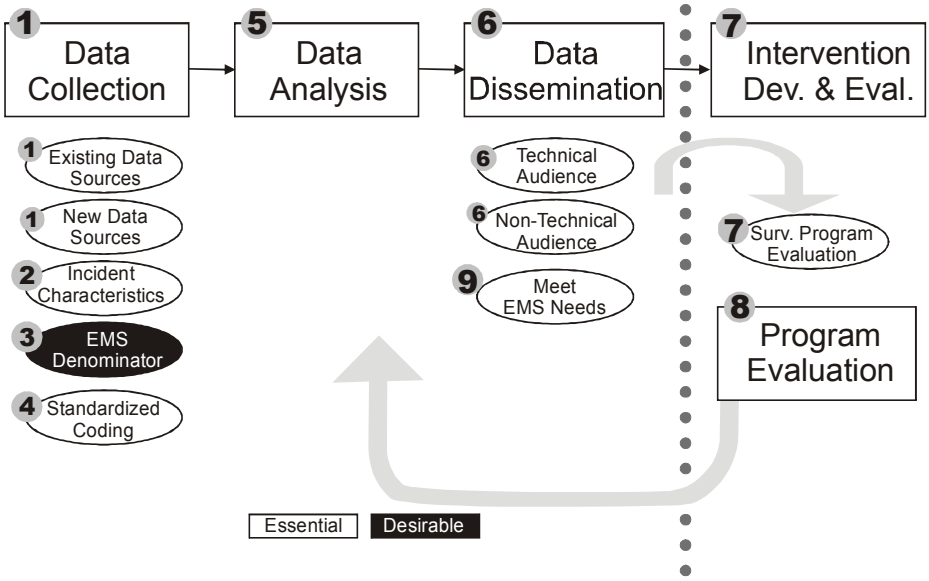

Figure 1. A Process/Component Model for the EMS Workforce Illness and Injury Surveillance Program.

The EMSWIISP approach is based upon the accumulation of EMS workforce morbidity and mortality information from several data sources (Component 1) which may also contain information on incident characteristics (Component 2). Denominator data (Component 3), would allow calculation of morbidity and mortality rates. Standardized Coding schemes (Component 4) would govern Data Analysis (Component 5). Data Dissemination (Component 6) would logically follow with the information being provided in technical and non-technical formats to satisfy the needs of different stakeholders, policy and decision-makers and the public. Data from this program would be used to develop safety and health interventions (Component 7) and to conduct program evaluation (Component 8). The arrows indicate a feedback-driven, ongoing process of analysis, dissemination, intervention and evaluation, Meeting the Needs of the EMS Workforce (Component 9). Finally, the model portrays a vision of EMS stakeholders, data owners and managers, scientists and healthcare workers, policy- and decision-makers and the public at large, working cooperatively to improve the occupational safety and health of the EMS workforce.

[14] This model was originally developed and presented at the Consensus Meeting by Dr. L. Jackson of NIOSH.

F. Conclusions

The data systems review contained in this report supports the conclusion that no single data system exists in the United States today that alone can serve as an effective surveillance data source for EMS workforce illness and injury. Existing data systems lack a broad scope of injury or illness, specificity of target population, or ability to identify EMS workers or accessibility of usable information. However, this finding is in no way defamatory, because all of these existing data systems were designed for some other purpose. Furthermore, some of the existing systems (e.g. CFOI, FARS or NEISS-Work) already contribute greatly to this task and/or show potential for increasing our understanding of EMS workforce illness and injury.

Thus, the EMS Consensus Panel determined that a national EMS workforce illness and injury surveillance program could provide data to support a range of functions spanning surveillance to prevention. At present, the EMS Consensus Panel concluded that it seems most reasonable that such a program should build upon the integration of existing data systems, and should be augmented by data elements that provide further insight into the nature of EMS workforce occupational illness and injury. The EMS Consensus Panel established that the ultimate goal of a national EMS workforce illness and injury surveillance program must be to improve the health and safety of EMS workers.

The EMS Consensus Panel suggested that those who manage data systems should consider data sharing and exploring new approaches to data aggregation with an aim of increasing the utility of existing data. Finally, the Panel concluded that EMS stakeholders should work together with data owners, managers, and analysts to promote analysis and dissemination of information that increases understanding of EMS workforce illness and injury.

VI. References

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Appendix 1:
Feasibility of an EMS Workforce Illness and Injury Surveillance System

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Appendix 2:
Feasibility of an EMS Workforce Illness and Injury Surveillance System

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Appendix 3:
EMS Injury Fatality Data Excerpted From the BLS Census Of Fatal Occupational Injuries[15]

Fatal occupational injuries by selected industry, all United States, all ownerships, 2004

Characteristic	All Industries	Ambulance Services (code 62191)
Total:	5,703	27
Employee status:		
Wage and salary workers	4,537	27
Self-employed	1,166	--
Gender:		
Men	5,292	19
Women	411	8
Age:		
Under 16 years	12	--
16 to 17 years	25	--
18 to 19 years	102	--
20 to 24 years	415	--
25 to 34 years	988	9
35 to 44 years	1,325	7
45 to 54 years	1,370	7
55 to 64 years	899	--
65 years and over	563	--
Race or ethnic origin[1]:		
White, non-Hispanic	4,030	23
Black, non-Hispanic	542	--
Hispanic or Latino	883	--
American Indian, Aleut, Eskimo	26	--
Asian	165	--
Pacific Islander	12	--
Multiple races	4	--
Other or not reported	41	--
Event or exposure:		
Contact with objects and equipment	1,004	--
Struck by object	596	--
Struck by falling object	370	--
Caught in or compressed by equipment or objects	270	--
Caught in running equipment or machinery	142	--
Falls	815	--
Fall to lower level	732	--
Fall from ladder	133	--
Fall from roof	178	--
Fall from scaffold, staging	89	--
Exposure to harmful substances or environments	459	--
Contact with electric current	253	--
Exposure to caustic, noxious, or allergenic substances	114	--
Oxygen deficiency (including drowning)	63	--
Transportation incidents	2,460	25

[15] Courtesy of Dr. Janice Windau, BLS.

Characteristic	All Industries	Ambulance Services (code 62191)
Highway incidents	1,374	4
Collision between vehicles, mobile equipment	687	3
Non-collision incidents	316	--
Non-highway incident, except rail, air, water	335	--
Overturned	181	--
Worker struck by vehicle, mobile equipment	377	3
Aircraft incidents	230	18
Fires and explosions	159	--
Assaults and violent acts	795	--
Homicides	551	--
Self inflicted injuries	200	--
Other or not reported	11	--
See footnotes at end of table.		
Primary source[2]:		
Vehicles	2,550	25
Highway vehicles	1,816	6
Automobiles	371	--
Trucks	1,221	--
Plant and industrial powered vehicles, tractors	309	--
Forklifts	92	--
Tractors	198	--
Structures and surfaces	874	--
Floors, walkways, ground surfaces	779	--
Machinery	474	--
Agriculture and garden machinery	63	--
Construction, logging, and mining machinery	201	--
Material handling machinery	122	--
Parts and materials	391	--
Machine, tool, and electric parts	146	--
Persons, plants, animals, and minerals	294	--
Persons -other than injured worker	38	--
Robber	9	--
Co-worker, former co-worker	7	--
Trees, logs	131	--
Chemicals and chemical products	126	--
Tools, instruments, and equipment	139	--
Containers	79	--
Other	776	--
Bullets and pellets	527	--
Fire, flame, smoke	90	--
Secondary source[3]:		
Vehicles	984	3
Highway vehicles	838	3
Plant and industrial powered vehicles, tractors	76	--
Structures and surfaces	914	10
Floors, walkways, ground surfaces	279	10
Structures	384	--
Machinery	280	--
Parts and materials	275	--
Machine, tool, and electric parts	144	--
Persons, plants, animals, and minerals	766	4
Persons -other than injured worker	522	--
Robber	229	--
Co-worker, former co-worker	56	--
Trees, logs	198	--
Chemicals and chemical products	98	--

Characteristic	All Industries	Ambulance Services (code 62191)
Tools, instruments, and equipment	235	--
Containers	99	--
Other	225	--
Liquids (including water)	82	--
No secondary source	1,827	9
See footnotes at end of table.		
Nature:		
Intracranial injuries	1,093	4
Other traumatic injuries	1,570	--
Internal injuries	663	--
Asphyxiations, suffocations	335	--
Drownings	159	--
Electrocutions	250	--
Poisonings, toxic effects	157	--
Open wounds	663	--
Gunshot wounds	530	--
Burns (heat, chemical, etc.)	153	--
Multiple traumatic injuries	1,987	20
Intracranial injuries and injuries to internal organs	634	5
Part of body:		
Head	1,337	5
Trunk	966	--
Chest	446	--
Back	49	--
Neck	128	--
Lower extremities	64	--
Upper extremities	12	--
Body systems	896	--
Multiple	2,274	21
Worker activity:		
Vehicular and transportation operations	2,483	24
Using or operating tools, machinery	479	--
Constructing, repairing, cleaning	1,247	--
Protective service activities	136	--
Materials handling operations	285	--
Physical activities	400	--
Other activities	492	--
Tending a retail establishment	242	--
Not reported	181	--
Location:		
Private residence	542	--
Farm	485	--
Mine, quarry	60	--
Industrial place and premises	1,297	--
Place for recreation or sports	85	--
Street and highway	1,870	5
Public building	632	--
Residential institutions	20	--
Other or not reported	712	15
See footnotes at end of table.		

Characteristic	All Industries	Ambulance Services (code 62191)
Occupation:		
Management occupations	629	--
Business and financial operations occupations	27	--
Computer and mathematical occupations	7	--
Architecture and Engineering occupations	68	--
Life, physical, and social science occupations	25	--
Community and social services occupations	44	--
Legal occupations	3	--
Education, training, and library occupations	27	--
Arts, design, entertainment, sports, and media occupations	51	--
Healthcare practitioners and technical occupations	72	18
Healthcare support occupations	11	--
Protective service occupations	271	--
Food preparation and serving related occupations	52	--
Building and grounds cleaning and maintenance occupations	277	--
Personal care and service occupations	55	--
Sales and related occupations	352	--
Office and administrative support occupations	91	--
Farming, fishing, and forestry occupations	281	--
Construction and extraction occupations	1,129	--
Installation, maintenance, and repair occupations	382	--
Production occupations	288	--
Transportation and material moving occupations	1,490	9
Military specific occupations	64	--

[1]Persons identified as Hispanic or Latino may be of any race. The race categories shown exclude data for Hispanics and Latinos.
[2]The primary source of injury identifies the object, substance, or exposure that directly produced or inflicted the injury. For most transportation incidents, the primary source identifies the vehicle in which the deceased was an occupant. For most falls, the primary source identifies the surface or object contacted.
[3]The secondary source of injury, if any, identifies the object, substance, or person that generated the source of injury or that contributed to the event or exposure. For vehicle collisions, the deceased's vehicle is the primary source and the other object (truck, road divider, etc.) is the secondary source. For most homicides, the "bullet" is the primary source and the "perpetrator" is the secondary source. For most falls, the secondary source identifies the equipment or surface from which the worker fell.
NOTE: Dashes indicate no data or data that do not meet publication criteria. Totals for major categories may include subcategories not shown separately.
Data for 2004 are preliminary.
SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Census of Fatal Occupational Injuries, August 13, 2006

Appendix 4:
National Electronic Injury Surveillance System – Work Program (NEISS-Work)

variable Name	Description
AGE	Age of patient, yrs
N_AGEGRP	Age categories, 5 yr range
BODYPART	Body part affected
BUSNAME	Name of company employing victim (narrative)
BUSTYPE	Kind of business in which victim is employed (narrative)
CASEID	Hospital/NEISS case ID number
CITYEMP	City where employed
COMMENT	Description of injury/illness circumstances
COMMENT2	Continuation of injury description
DIAG	Injury diagnosis
DISP	Hospital disposition of case
N_EVENT	BLS/OIICS injury event code
F_A	Fire/motor vehicle involvement
HOSPITAL	Hospital ID number
LOC	Incident locale
NEK	CPSC record number (unique ID)
NIO_WT	NIOSH weight assigned by CPSC
NIOSTUDY	NIOSH telephone interview study descriptor
OCCTYPE	Victim's job title (narrative)
RACE	Race of patient
RACEOTH	Other race or ethnicity
SEX	Sex of patient
N_SOURCE	BLS/OIICS source of injury code
N_SOUR2N	BLS/OIICS secondary source of injury code
SPTY	Special study identifier (e.g., NIOSH work or NCIPC firearms)
STATE	State where employed (country if not USA)
STRATUM	Hospital-size stratum (Assigned by CPSC per sample design)
TKNO	CPSC telephone interview tracking number
TRDATE	Date of ED treatment
N_TRYRMO	Treatment year and month
N_VARNUM	Hospital ID for variance calculations

Disposition (DISP)	
1	Treated & released
2	Treated & transferred to another hospital
4	Treated & admitted for hospitalization
5	Held for observation (not used until 7/2000)
8	Fatality (removed from dataset)
9	Unknown

Fire/motor vehicle involvement (F_A)	
0	No fire/MV involvement or not recorded
1	Fire &/or smoke inhalation, Fire Department attended
2	Fire/smoke inhalation, Fire Department did not attend
3	Fire/smoke inhalation, Fire Department attendance not stated
4	Motor vehicle involvement

Location (LOC)	
0	Not recorded
1	Home
2	Farm/ranch
4	Street or highway
5	Other public property
6	Manufactured (mobile) home
7	Industrial place
8	School
9	Place of recreation or sports

Sex (SEX)	
0	Unknown
1	Male
2	Female

Race (N_RACE, recoded RACE and RACEOTH)	
0	Not stated
1	White (Non-Hispanic)
2	Black (Non-Hispanic)
4	Am Indian/Alaska Native
5	Asian/Pacific Islander
6	Hispanic

Event (N_EVENT)[1]	
0***	Contact with objects & equipment
1***	Falls
2***	Bodily reaction & exertion
3***	Exposure to harmful substances or environments
4***	Transportation accidents
5***	Fires & explosions
6***	Assaults & violent acts
9***	Other events or exposures (excluding 9999)
9999	Nonclassifiable

[1] For complete, detailed 4-digit codes, see www.bls.gov/iif/oshsec3.htm#section34

Source and Secondary Source (N_SOURCE and N_SOUR2N)[2]	
0***	Chemicals and chemical products
1***	Containers
2***	Furniture and fixtures
3***	Machinery
4***	Parts and materials
5***	Person, plants, animals, & minerals
6***	Structures and surfaces
7***	Tools, instruments, and equipment
8***	Vehicles
9***	Other sources (excluding 9999)
9999	Nonclassifiable

[2] For complete, detailed 4-digit codes, see www.bls.gov/iif/oshsec3.htm#section33.

Body part (BODYPART)	
00	Internal (used with aspiration & ingestion)
30	Shoulder (including clavicle or collarbone)
31	Upper trunk (not including shoulders)[1]
32	Elbow
33	Lower arm (not including elbow or wrist)
34	Wrist
35	Knee
36	Lower leg (not including knee or ankle)
37	Ankle
38	Pubic region
75	Head
76	Face (including eyelid, eye area, & nose)
77	Eyeball
79	Lower trunk
80	Upper arm
81	Upper leg
82	Hand
83	Foot
84	25-25% of body
85	All parts of body (more than 50% of body)
87	Not stated
88	Mouth (including lips, tongue, & teeth)
89	Neck (including cervical vertebrae)
92	Finger
93	Toe
94	Ear

Hospital stratum (STRATUM)[3]	
C	Children's
S	Small
M	Medium
L	Large
V	Very large

[3] Stratum are determined by a hospital's total annual ED visits.

Diagnosis (DIAG)	
41	Ingested foreign object
42	Aspirated foreign object
46	Burn: electrical
47	Burn: Not specified
48	Burn: Scald (from hot liquids or steam)
49	Burn: Chemical (caustics, etc.)
50	Amputation
51	Burn: thermal (from flames or hot surfaces)
52	Concussions
53	Contusions, abrasions
54	Crushing
55	Dislocation
56	Foreign body
57	Fracture
58	Hematoma
59	Laceration
60	Dental injury
61	Nerve damage
62	Internal organ injury
63	Puncture
64	Sprain or strain
65	Anoxia
66	Hemorrhage
67	Electric shock
68	Poisoning
69	Submersion (including drowning)
70	Not stated
71	Other
72	Avulsion
73	Burns: radiation (e.g., cell damage by UV, etc.)
74	Dermatitis, conjunctivitis

Appendix 5:
EMS Injury and Illness Data Excerpted From the BLS Survey of Occupational Illness and Injury[16]

Number of nonfatal occupational injuries and illnesses involving days away from work[1] by selected worker and case characteristics and occupation, All United States, private industry, 2004

Characteristic	All occupations	Emergency medical technicians and paramedics (code 29-2041)
Total:	1,259,320	5,170
Sex:		
Men	829,300	2,790
Women	425,470	2,380
Age:		
Under 14	--	--
14 to 15	200	--
16 to 19	38,230	80
20 to 24	141,730	960
25 to 34	303,880	2,010
35 to 44	331,610	1,200
45 to 54	272,250	720
55 to 64	128,810	130
65 and over	23,950	--
Length of service with employer:		
Less than 3 months	162,410	320
3 months to 11 months	258,500	1,060
1 year to 5 years	446,820	2,710
More than 5 years	383,050	1,080
Race or ethnic origin:		
White	591,570	3,460
Black or African American	103,820	70
Hispanic or Latino	164,390	200
Asian	16,040	--
Native Hawaiian or other Pacific Islander	4,650	--
American Indian or Alaska Native	5,140	--
Hispanic and other	530	--
Multi-race	1,260	--
Not reported	371,920	1,410

[16] Courtesy of Dr. Janice Windau, BLS.

Characteristic	All occupations	Emergency medical technicians and paramedics (code 29-2041)
Number of days away from work:		
Cases involving 1 day	180,500	960
Cases involving 2 days	144,480	900
Cases involving 3-5 days	231,350	1,160
Cases involving 6-10 days	159,250	710
Cases involving 11-20 days	143,560	390
Cases involving 21-30 days	85,620	270
Cases involving 31 or more days	314,570	780
Median days away from work [5]	7	4
See footnotes at end of table.		
Industry sector:		
Goods producing industries[2]	408,400	--
Natural resources and mining[2,3]	29,100	--
Agriculture, Forestry, Fishing and Hunting[2]	19,750	--
Mining[3]	9,350	--
Construction	153,200	--
Manufacturing	226,090	--
Service providing industries	850,930	5,170
Trade, Transportation and Utilities[4]	387,650	130
Wholesale Trade	81,140	--
Retail Trade	178,760	--
Transportation and Warehousing[4]	120,010	130
Utilities	7,740	--
Information	21,150	--
Financial activities	34,930	--
Finance and Insurance	12,920	--
Real Estate and Rental and Leasing	22,010	--
Professional and business services	90,500	--
Professional, Scientific, and Technical Services	20,370	--
Management of Companies and Enterprises	10,260	--
Administrative and Support and Waste Management and Remediation Services	59,870	--
Education and health services	189,980	5,030
Educational Services	10,070	--
Health Care and Social Assistance	179,910	5,030
Leisure and hospitality	95,380	--
Arts, Entertainment, and Recreation	17,750	--
Accommodation and Food Services	77,620	--
Other services	31,350	--
Other Services, except Public Administration	31,350	--
Public Administration	--	--

Characteristic	All occupations	Emergency medical technicians and paramedics (code 29-2041)
Nature of injury, illness:		
Sprains, strains	525,390	3,410
Fractures	94,040	80
Cuts, lacerations, punctures	114,140	40
Bruises, contusions	114,680	330
Heat burns	18,510	--
Chemical burns	7,360	--
Amputations	8,160	--
Carpal tunnel syndrome	18,710	--
Tendonitis	6,930	20
Multiple injuries	50,350	100
With fractures	9,960	--
With sprains	19,720	60
Soreness, Pain	104,560	690
Back pain	37,930	260
All other	196,480	490
See footnotes at end of table.		
Part of body affected:		
Head	81,530	60
Eye	36,680	--
Neck	21,130	130
Trunk	447,140	3,140
Back	282,240	2,410
Shoulder	82,220	540
Upper extremities	290,460	720
Finger	107,860	140
Hand, except finger	50,190	130
Wrist	58,510	280
Lower extremities	269,490	600
Knee	99,720	280
Foot, toe	57,940	60
Body systems	14,300	170
Multiple	126,530	350
All other	8,750	--
Source of injury, illness:		
Chemicals, chemical products	17,880	20
Containers	161,370	90
Furniture, fixtures	44,790	140
Machinery	82,160	40
Parts and materials	127,790	--
Worker motion or position	182,820	530
Floor, ground surfaces	234,010	460
Hand tools	58,410	--
Vehicles	111,270	740
Health care patient	57,230	1,860
All other	181,590	1,250

Characteristic	All occupations	Emergency medical technicians and paramedics (code 29-2041)
Event or exposure:		
Contact with object, equipment	335,160	430
Struck by object	170,080	140
Struck against object	83,330	150
Caught in object, equipment, material	55,510	130
Fall to lower level	79,800	170
Fall on same level	167,010	260
Slips, trips	37,500	230
Overexertion	316,670	2,750
Overexertion in lifting	173,400	1,720
Repetitive motion	48,710	--
Exposed to harmful substance	52,830	170
Transportation accidents	62,860	580
Fires, explosions	2,420	--
Assault, violent act	24,880	160
by person	17,670	100
by other	7,220	50
All other	131,480	400
See footnotes at end of table.		
Day of Week:		
Sunday	70,630	380
Monday	231,260	790
Tuesday	228,760	1,000
Wednesday	218,330	790
Thursday	220,400	670
Friday	196,780	980
Saturday	93,160	570
Time of Day:		
12:01 AM - 4:00 AM	41,600	280
4:01 AM - 8:00 AM	119,610	430
8:01 AM - 12:00 PM	374,760	1,010
12:01 PM - 4:00 PM	286,410	1,140
4:01 PM - 8:00 PM	136,400	810
8:01 PM - 12:00 AM	74,640	540
Not reported	225,910	960
Hours Worked:		
Occurred before shift began	6,740	--
Less than 1 hour	101,550	310
1 - 2 hours	121,830	570
2 - 4 hours	275,580	800
4 - 6 hours	203,830	970
6 - 8 hours	186,580	600
8 - 10 hours	92,210	490
10 - 12 hours	23,490	320
12 - 16 hours	7,820	90
More than 16 hours	470	--
Not reported	239,230	980

[1] Days away from work include those that result in days away from work with or without job transfer or restriction.
[2] Excludes farms with fewer than 11 employees.
[3] Data for mining (Sector 21 in the *North American Industry Classification System* -- United States, 2002) include establishments not governed by the Mine Safety and Health Administration (MSHA) rules and reporting, such as those in oil and gas extraction and related support activities. Data for mining operators in coal, metal, and nonmetal mining are provided to BLS by the Mine Safety and Health Administration, U.S. Department of Labor. Independent mining contractors are excluded from the coal, metal, and nonmetal mining industries. These data do not reflect the changes the Occupational Safety and Health Administration made to its recordkeeping requirements effective January 1, 2002; therefore estimates for these industries are not comparable to estimates in other industries.
[4] Data for employers in railroad transportation are provided to BLS by the Federal Railroad Administration, U.S. Department of Transportation.
[5] Median days away from work is the measure used to summarize the varying lengths of absences from work among the cases with days away from work. Half the cases involved more days and half involved less days than a specified median. Median days away from work are represented in actual values.
NOTE: Because of rounding and data exclusion of nonclassifiable responses, data may not sum to the totals. Dashes indicate data that do not meet publication guidelines. The scientifically selected probability sample used was one of many possible samples, each of which could have produced different estimates. A measure of sampling variability for each estimate is available upon request.
SOURCE: Bureau of Labor Statistics, U.S. Department of Labor, August 13, 2006

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