



Line-of-duty deaths among U.S. firefighters: An analysis of fatality investigations

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ABSTRACT

More than 100 firefighters die in the line-of-duty in the U.S. each year and over 80,000 are injured. This study examined all firefighter fatality investigations ($N = 189$) completed by the National Institute for Occupational Safety and Health (NIOSH) for fatalities occurring between 2004 and 2009. These investigations produced a total of 1167 recommendations for corrective actions. Thirty-five high frequency recommendations were derived from the total set: six related to medical fatalities and 29 to injury-related fatalities. These high frequency recommendations were mapped onto the major operational components of firefighting using a fishbone or cause-effect diagram. Over 70% of the 30 non-external recommendations were categorized within the personnel and incident command components of the fishbone diagram. Root cause techniques suggested four higher order causes: under-resourcing, inadequate preparation for/anticipation of adverse events during operations, incomplete adoption of incident command procedures, and sub-optimal personnel readiness. These findings are discussed with respect to the core culture of firefighting.

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1. Introduction

The United States depends on about 1.1 million career and volunteer firefighters to protect its citizens and property from losses caused by fire. Firefighting is considered to be one of the most stressful and dangerous occupations. Each year more than 100 firefighters die in the line of duty and over 80,000 are injured (Karter and Molis, 2009; United States Fire Administration, 2009). The fatality rate for firefighters is three times worse than for the general working population (International Association of Firefighters, 2001). Advances in technology, personal protective equipment, engineering controls, environmental management, medical care, and safety legislation produced substantial reductions in fatalities during the 1970s and 1980s; however, these numbers have not improved during the past 25 years and have been trending upward for the past decade.

Without question, firefighting is high hazard work, but it is unique beyond this. In most high hazard work situations, the goal is hazard avoidance. In contrast, for firefighting, the principal work activity is hazard engagement, which is usually further complicated by extreme time pressure. The customary safety strategy in

many high hazard work situations is to implement multiple safety measures, or what is sometimes referred to as: “defenses in depth” (Rasmussen, 1997; Reason, 1997). That is, several layers of precautions are put in place to protect the workers and the integrity of the overall system, even when components fail or errors occur. There is little protective redundancy in firefighting, and risks to personnel must continually be assessed and reassessed as the fire situation develops and changes, often with little predictability or advanced warning. Most efforts to protect firefighters fall into two general categories: preparative measures and operational measures. Preparative measures encompass actions that prepare the firefighters to do their work in as safe a manner as possible. This would include personnel selection and placement, training, professional socialization, as well as the provision of personal protective equipment (PPE) and other safety devices. Operational measures focus on maintaining an adequate margin of safety during actual firefighting activities. This would include adherence to various standard operating procedures (SOPs), continued monitoring of risk-benefit ratios, communications, staffing, and other command and control activities.

As part of the effort to reduce firefighter line-of-duty fatalities, the United States Fire Administration (USFA) collects and evaluates information regarding line-of-duty (LOD) firefighter fatalities and publishes the data in the annual firefighter fatality reports (e.g., United States Fire Administration, 2009). In 1998, Congress appropriated funding to the National Institute for Occupational Safety and Health (NIOSH) to conduct independent, onsite investigations of firefighter line-of-duty (LOD) deaths (National Institute for Occupational Safety and Health, 2009). The investigations con-

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ducted as part of the NIOSH Firefighter Fatality Investigation and Prevention Program (FFFIPP) are voluntary and not all fatalities are investigated. Cases are selected for investigation using a decision algorithm (National Institute for Occupational Safety and Health, 2009), with the primary goal not to find fault or assign blame, but rather to learn from these events and to formulate recommendations directed at preventing future firefighter injuries and deaths.

Once notified of a LOD fatality, usually by the USFA or the fire department, NIOSH starts its investigation by contacting the fire department and conducting a thorough review of all applicable documents (e.g., department policies and procedures, dispatch records, victim's training records, coroner/medical examiner's reports, death certificates, police reports, photographs, and video). NIOSH investigators also interview fire department personnel and firefighters who were on the scene at the time of the incident. Additional expert assistance might be sought for incident reconstruction or fire growth modeling. The entire series of events during the incident is then summarized in a report, which includes recommendations to prevent future deaths and injuries under similar circumstances. Recommendations are made based on established best practices, National Fire Protection Association (NFPA) standards, information from the United States Fire Administration (USFA), and the public health and fire service literatures related to each case. Each report typically addresses multiple contributing factors and contains a number of different recommendations. Reports for all completed investigations are available on the NIOSH website. Since the program's inception, NIOSH has completed over 470 fatality investigations.

There have been several prior efforts to compile and analyze various portions of this accumulated database. Hodous and colleagues (Hodous et al., 2004) reviewed firefighter fatalities from 1998 to 2001 and synthesized NIOSH recommendations for cases involving structural firefighting activities. These researchers identified eight frequently occurring recommendations that highlighted three general areas of concern: (1) use and enforcement of standard operating procedures (SOPs) related to structural firefighting techniques and strategies; (2) adequate staffing and adherence to contemporary incident command practices, and (3) increased attention to communications and personnel accountability and rescue. Peterson and colleagues (Peterson et al., 2006) examined recommendations from the first five years of fatality investigations (1999–2003). Their analysis identified 31 “key” recommendations, 22 involving traumatic injury fatalities and 9 involving cardiovascular fatalities. These were further reduced to 17 sentinel recommendations involving training, standard operating procedures, safety practices, and the safety environment of fire departments. More recently, Ridenour and associates (Ridenour et al., 2008) reviewed all investigations completed between 1998 and 2005. This analysis highlighted ten categories of recommendations, two focusing on medical cases and the other eight focusing on traumatic injuries.

The clear majority of medically-related fatalities involve cardiovascular events and these have produced two predominant recommendations: the need for improvements in medical screening, and the need for wider adoption of fitness/wellness programming for firefighters. These are both preparative measures designed to identify and address cardiovascular risk in operational personnel. Trauma cases, on the other hand, have yielded a much more diverse array of recommendations and a less clear picture of high priority needs. These recommendations address both preparative and operational measures, and cover a broad territory that includes command and control functions, operations and tactics, and equipment and resources.

2. Purpose

The present study continues this line of inquiry but expands it in several ways. The first objective was to determine the extent to which the incidents investigated by NIOSH are representative of all firefighter LOD fatalities. NIOSH investigations are voluntary on the part of the fallen firefighter's organization and NIOSH does not have sufficient resources to investigate all fatalities. This issue has potentially important implications for the generalizability of any key recommendations extracted from the accumulated database of reports. The second objective was to better describe the procedures used to derive key or sentinel recommendations. In the analyses described above, only limited procedural details were provided on how the high frequency recommendations were actually determined. For example, it would be useful to know how frequent the high frequency recommendations were, not only in absolute terms but also relative to other recommendations. Since most investigations contain several recommendations, it would be useful to know how similar recommendations were handled within and across investigations. The third objective involved the issue of causation. The recommendations contained in these reports speak primarily to the “what” – that is, what needs to be done, not done, done better, or done differently in the future to reduce risk. These recommendations almost always draw upon contemporary knowledge and accepted best practices in the firefighting and emergency response professional communities. Logically, it should be possible to link high frequency recommendations to causal factors or clusters of causal factors. Therefore, we were interested in determining whether insights into important causal factors could be extracted from these reports. Identification of such factors is a requisite step in the development of effective prevention strategies (Higgins et al., 2001). With these objectives forming the organizing framework, the present research sought to examine NIOSH investigations for the years 2004–2009. This time period was chosen to complement the previous analyses and to provide a current perspective.

3. Method

This study reviewed all FFFIPP investigation reports for fatalities occurring between 2004 and 2009 and released by NIOSH on or before August 15, 2010. Reports were accessed from the NIOSH website (www.cdc.gov/niosh/fire). Spreadsheet software (Microsoft Office Excel 2007) and relational database software (Microsoft Office Access 2007) were used to compile the relevant information for each completed investigation. The spreadsheet was configured so that the case file number was linked to the full report available on the NIOSH website.

Using NIOSH categories, medical-related incidents were subcategorized as cardiac or non-cardiac. Trauma-related incidents were subcategorized as: motor vehicle, structure fire, training, water, wild-land fire, or other traumatic incidents. Some incidents involved a combination of factors and thus were categorized into more than one category. Acute non-traumatic medical events resulting in the firefighter's death were classified as medical fatalities. Motor vehicle fatalities were defined as those due to a crash involving a driver or occupant of a moving vehicle while travelling on fire service-related duties, or as an on-duty pedestrian struck by a motor vehicle. Structure fire fatalities were defined as those traumatic incidents that occurred on the scene of a structure fire. Training related fatalities were those fatalities which occurred while the firefighter was involved in any firefighting related training activities. All drowning incidents were categorized as water related, and traumatic fatalities that occurred at the scene of a wild fire incident were regarded as wild-land fire-related incidents. The

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