



## **Driver/Operator Dies at his Station After Responding to Three Emergency Incidents – Massachusetts**

### **SUMMARY**

On October 13, 2000, a 63-year-old male Driver/Operator (D/O) responded to three emergency incidents. The second incident was a motor vehicle crash involving a tractor-trailer; the victim, wearing full bunker gear, assisted in spreading 50 bags of absorbent to prevent the leaking fuel from entering the sewer system. After being on the scene for over 2 hours, the victim mentioned to crew members that he was experiencing shoulder pain. Later that evening, the victim was found in his bunk unresponsive, not breathing, and pulseless. Despite cardiopulmonary resuscitation (CPR) and advanced life support (ALS) administered by the fire fighters, ambulance emergency medical technicians (EMTs) and paramedics, and by hospital personnel in the emergency department (ED), the Driver/Operator died. The death certificate, completed by the emergency department physician, listed cerebral event as the immediate cause of death, due to cerebral hypoperfusion and coronary artery disease. No blood tests were done and no autopsy was performed.

Other agencies have proposed a three-pronged strategy for reducing the risk of on-duty sudden death and sudden cardiac death among fire fighters. This strategy consists of (1) reducing physical stress on fire fighters (2) screening to identify and subsequently rehabilitate high risk individuals and (3) encouraging increased individual physical capacity. Issues relevant to this Fire Department include

- ***Fire Fighters should have mandatory annual medical evaluations and periodic physical examinations to determine their medical ability to perform duties without***

***presenting significant risk to the safety and health of themselves or others.***

- ***Exercise stress tests should be incorporated into the Fire Department's medical evaluation program.***
- ***Fire fighters should be cleared for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582.***
- ***A mandatory wellness/fitness program for fire fighters should be phased in to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.***

Additional recommendations include

- ***Autopsies should be performed on all on-duty fire fighters whose death may be cardiovascular-related.***
- ***Adequate fire fighter staffing should be provided to ensure safe operating conditions.***

The Fire Fighter Fatality Investigation and Prevention Program is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. The program does not seek to determine fault or place blame on fire departments or individual fire fighters. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at [www.cdc.gov/niosh/firehome.html](http://www.cdc.gov/niosh/firehome.html) or call toll free 1-800-35-NIOSH



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**INTRODUCTION AND METHODS**

On October 13, 2000, a 63-year-old male Driver/Operator died after responding to three incidents. On February 7, 2001, NIOSH contacted the affected Fire Department (FD) to initiate the investigation. On February 14, 2001, a Safety and Occupational Health Specialist and a physician from the NIOSH Fire Fighter Fatality Investigation Team traveled to Massachusetts to conduct an on-site investigation of the incident.

During the investigation, NIOSH personnel interviewed either in person or by telephone the

- Fire Chief
- Victim's wife
- Local Union President
- Crew members on duty with the victim

During the site visit, NIOSH personnel reviewed

- FD policies and operating guidelines
- FD training records
- FD annual report for 1999
- Victim's personnel file at the FD
- FD physical examination protocols
- Private physician records
- Ambulance response reports
- Hospital records
- Death Certificate

**INVESTIGATIVE RESULTS**

*Incident.* On October 13, 2000, the victim reported for work at Ladder 2 at 0700 hours. The victim, serving as Driver/Operator of Ladder 2, performed equipment checks and station maintenance prior to the first incident. At 0840 hours, Engine 1, Ladder 2, and Chief 2 were dispatched to a smoke detector activation in a high school. Upon investigation, no fire was found, the alarm was reset, and companies returned to their stations.

At 1012 hours, Engine 1, Engine 2, Engine 3, Ladder 2, Ladder 3, Chief 2, Chief 2A, and Chief 3 were dispatched to a motor vehicle accident (MVA) involving a trash truck and a tractor-trailer. Two injured persons from the trash truck were transported to the hospital, and the tractor-trailer was leaking diesel fuel and antifreeze. Crew members, including the victim (wearing full bunker gear), spread 50 bags of absorbent to prevent the leaking diesel fuel from entering the sewer system. Crew members tried to plug the leaking fuel tank but then transferred 150 gallons of the diesel fuel (utilizing a hand pump) into other vehicles at the scene. After being on the scene for more than 2 hours, the victim mentioned to crew members that he was experiencing shoulder pain. He was sweating profusely. He took his bunker coat off and continued working. The victim reported no other symptoms to his peers, and all companies returned to quarters at 1303 hours.

At 1400 hours, Engine 1, Engine 2, Engine 3, Ladder 1, Ladder 2, and Chief 2 were dispatched to a fire in a clothes dryer at a self-service laundry. The fire, caused by lint build-up, was quickly extinguished with a CO<sub>2</sub> extinguisher. Ladder 2 was released at 1437 hours and returned to quarters (across the street).

After completing a post-incident check of Ladder 2, the victim went upstairs to the bunkroom to read. At approximately 1636 hours, a fire fighter checked on the victim and noticed that he looked pale and was lying on his back in bed with his book across his chest. The fire fighter called for the Lieutenant to help check the victim. The Lieutenant and the Fire Fighter found the victim to be unresponsive, not breathing, and pulseless, and requested crew members to call an ambulance. CPR was begun immediately, an oral airway was placed, and assisted ventilations provided by an ambu-bag. A semi-automatic external defibrillator (SAED) monitored the victim's heart rhythm and found the victim's heart rhythm to be asystole (no heart beat). Within 5



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minutes, a basic life support (BLS) ambulance arrived and assisted with CPR. The advanced life support (ALS) ambulance arrived on the scene at 1641 hours, and the victim was loaded onto a backboard and taken downstairs to the ambulance. The victim was reevaluated and found to be unresponsive, not breathing, and pulseless. CPR was continued and ALS measures were begun (intubation, intravenous access, and resuscitation medications). The ambulance departed the scene at 1648 hours and arrived at the hospital emergency department (ED) at 1654 hours. Despite CPR and ALS administered by the fire fighters, ambulance service emergency medical technicians (EMTs) and paramedics, and hospital personnel in the ED, the D/O was pronounced dead at 1705 hours.

*Medical Findings.* The death certificate, completed by the ED physician, listed a “cerebral event” as the immediate cause of death, due to cerebral hypoperfusion and coronary artery disease. No blood tests were done, and no autopsy was performed.

Medical history indicated that the victim had four coronary artery disease (CAD) risk factors: age greater than 45 years, male gender, family history, and high cholesterol (borderline). Medical records noted very few occupational injuries or missed work days due to illness over his 31-year career. He had an extensive work-up for cardiovascular disease in December 1995 following a possible transient ischemic attack (TIA) manifested by visual field changes. This work-up included a neurological examination, electrocardiography, magnetic resonance imaging (MRI), and magnetic resonance angiography (MRA) of the carotid arteries and brain. The results were essentially negative, showing only mild narrowing of internal carotid arteries at the origin. His last visit to his family physician, in 1999, revealed an elevated serum cholesterol level (221 mg/dl), first identified in 1990. The victim was not prescribed

any cholesterol-lowering medication or any other medications at the time of his death. Prior to his death, the victim did not relate any symptoms suggestive of ischemic heart pain (angina) to his wife, but, as noted above, mentioned shoulder pain to his crew members during the MVA incident. An exercise stress test (EST) to screen for CAD was never performed on this victim.

#### **DESCRIPTION OF THE FIRE DEPARTMENT**

At the time of the NIOSH investigation, the Fire Department consisted of 153 uniformed career personnel and served a population of 78,000 permanent residents and approximately 12,000 immigrants (documented and undocumented) and students, in a geographic area of 4.2 square miles. There are five fire stations. Engine and Ladder Companies are staffed with a Lieutenant and two Fire Fighters. Fire fighters work on one of four 24-hour shifts, from 0700-0700 hours, with the next 72 hours off duty.

In 2000, the Department responded to 10,240 calls: 163 structure fires, 74 rubbish fires, 36 explosions/delayed ignition calls, 51 vehicle fires, 15 wildland fires, 7 other fires, 524 hazardous condition calls, 4,127 emergency medical treatment calls, 706 motor vehicle accident calls, 45 other rescue calls, 115 hazardous materials calls, 886 service calls, 578 cooking calls (food left on stove, grease fire, smoke in kitchen from overheated food), 329 mutual aid calls, 407 good intent calls, 1,976 other false calls (includes malicious, alarm functioning, and alarm malfunctions), and 201 other calls. Ladder 2 responded to 1,619 calls in 2000 (16% of the Fire Department total responses and averaging 4.4 responses per day).

*Training.* The Fire Department requires all new fire fighters to pass a State-required preemployment



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evaluation (specific components listed below). Once hired, the fire fighter must complete the 55-day recruit training at the Massachusetts State Fire Academy. If the new hire cannot enter the Academy when first hired, the Fire Fighter is given 3 to 5 weeks of in-house training and then sent to the Academy. Once recruit training is completed, the Fire Fighter is assigned to a shift. Subsequent training is conducted on the shift. There is a no minimum State requirement for fire fighter certification or for annual fire fighter recertification, although there are State recertification requirements for Hazardous Materials (Hazmat), CPR, emergency medical technician (EMT), and First Responder. The victim was certified as a Fire Fighter and a Driver/Operator and had 31 years of fire fighting experience.

*Preemployment/Preplacement Evaluations.* The Department requires a preemployment/preplacement medical evaluation for all new hires, regardless of age. Components of this evaluation for all applicants include the following:

- Medical history
- Physical examination
- Vital signs
- Pulmonary function tests (PFT)
- Drug screen: hair
- Audiogram
- Vision test: visual acuity and peripheral vision
- Physical agility test

These evaluations are performed by a contractor, who makes a determination regarding medical clearance for fire fighting duties and forwards this decision to the City's personnel director.

*Periodic Evaluations.* Periodic medical evaluations are to be required, beginning in May 2001, for all fire fighters hired after 1996. The evaluation will occur every 2 years. The content of the medical evaluation for these special groups is the same as the preemployment. No annual

clearance for fire fighting duties or SCBA use is required.

If an employee is injured at work or ill, the FD requires the employee's private physician to provide clearance for returning to work. Although all fire stations have exercise (strength and aerobic) equipment, primarily purchased by the Fire Department, the Department does not have a mandatory fitness program. Wellness programs (smoking cessation, weight control, high blood pressure, diabetes, and cholesterol) are offered by the City.

## **DISCUSSION**

The cause of death was listed as a "cerebral event, due to cerebral hypoperfusion and coronary artery disease." In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.<sup>1</sup> CAD most often causes cardiac ischemia, which results from an imbalance between the heart's demand for oxygen and the delivery of oxygen to the myocardium.<sup>2</sup> Angina is the most common presenting symptom of myocardial ischemia and underlying CAD, but in many persons, the first evidence of CAD may be myocardial infarction or sudden death.<sup>3</sup> Risk factors for the development of CAD include increasing age, male gender, family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, obesity/physical inactivity, and diabetes.<sup>4</sup> The victim had four of these risk factors (advancing age, male gender, family history, and high cholesterol).

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.<sup>5</sup> However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.<sup>6</sup> Heart attacks typically occur with the sudden development of complete blockage

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(occlusion) in one or more coronary arteries that have not developed a collateral blood supply.<sup>7</sup> This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. However, a serial EKG, cardiac enzyme test, and autopsy would determine if a thrombus is present, which would cause an MI. None of these were performed.

Blood clots, or thrombus formation, in coronary arteries are initiated by disruption of atherosclerotic plaques. Certain characteristics of the plaques (size, composition of the cap and core, presence of a local inflammatory process) predispose the plaque to disruption.<sup>7</sup> Disruption then occurs from biomechanical and hemodynamic forces, such as increased blood pressure, increased heart rate, increased catecholamines, and shear forces, which occur during heavy exercise.<sup>8,9</sup>

Fire fighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.<sup>10</sup> Fire fighting activities are strenuous and often require fire fighters to work at near maximal heart rates for long periods. The increase in heart rate has been shown to begin with responding to the initial alarm and persist through the course of fire suppression activities.<sup>11-13</sup> Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.<sup>14-17</sup> The victim had assisted in spreading 50 bags of absorbent at the MVA earlier in the day while wearing full turnout gear (weighing approximately 30 pounds). This is considered a heavy level of physical exertion.<sup>18</sup>

The Department requires a preemployment/preplacement medical examination for all new hires but does not currently require periodic medical evaluations for all fire fighters. NFPA recommends a yearly physical evaluation to include a medical history, height, weight, blood pressure, and visual

acuity test.<sup>19</sup> NFPA also recommends a more thorough examination, to include vision testing, audiometry, pulmonary function testing, a complete blood count, urinalysis, and biochemical (blood) test battery, be conducted on a periodic basis according to the age of the fire fighter (less than 30: every 3 years; 30-39: every 2 years; over 40 years: every year).

To reduce the risk of heart attacks and sudden cardiac arrest among fire fighters, the National Fire Protection Association (NFPA) has developed guidelines entitled “Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians,” otherwise known as NFPA 1582.<sup>19</sup> They recommend, in addition to screening for risk factors for CAD, an exercise stress EKG, otherwise known as an exercise stress test (EST). The EST is used to screen individuals for CAD. Unfortunately, it has problems with both false negatives (inadequate sensitivity) and false positives (inadequate specificity), particularly for asymptomatic individuals (individuals without symptoms suggestive of angina), young men, and women.<sup>20,21</sup> This has led other expert groups to **not** recommend EST for asymptomatic individuals without risk factors for CAD.<sup>22-23</sup>

When these asymptomatic individuals **have** risk factors for CAD, however, recommendations vary by organization. The American College of Cardiology/American Heart Association (ACC/AHA) identifies four groups for EST although they note that the “usefulness/efficacy is less well established by evidence/opinion.”<sup>22</sup>

Group 1: Persons with multiple risk factors. They define five risk factors for CAD: hypercholesterolemia (total cholesterol greater than 240 mg/dL), hypertension (systolic greater than 140 mm Hg or diastolic greater than 90 mm Hg), smoking, diabetes, and family history of



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premature CAD (cardiac event in first-degree relative less than 60 years old).

Group 2: Men over the age of 40 and women over the age of 50 (especially if sedentary) who plan to start vigorous exercise.

Group 3: Men over the age of 40 and women over the age of 50 who are at high risk for CAD due to other diseases (e.g., chronic renal failure).

Group 4: Men over the age of 40 and women over the age of 50 who are involved in occupations in which impairment might impact public safety.

The U.S. Preventive Services Task Force (USPSTF) does not recommend EST for asymptomatic individuals, even those with risk factors for CAD; rather, they recommend the diagnosis and treatment of modifiable risk factors (hypertension, high cholesterol, smoking, and diabetes).<sup>23</sup> The USPSTF indicates that evidence is insufficient to recommend screening middle age and older men or women in the general population; however, “screening individuals in certain occupations (pilots, truck drivers, etc.) can be recommended on other grounds, including the possible benefits to public safety.”<sup>23</sup>

Since the victim was over the age of 40 and had hypercholesterolemia, according to NFPA 1582 an EST would have been reasonable to perform. An EST might have identified his CAD, thereby leading to further evaluation and treatment, and possibly the prevention of this death.

**RECOMMENDATIONS AND DISCUSSION**

The following recommendations address health and safety generally. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks among fire fighters. These recommendations

have not been evaluated by NIOSH, but represent published research or consensus votes of Technical Committees of the National Fire Protection Association or labor/management groups within the fire service. In addition, they are presented in a logical programmatic order, and are not listed in a priority manner.

***Recommendation #1: Fire Fighters should have mandatory annual medical evaluations and periodic physical examinations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.***

The content and frequency of this evaluation should be negotiated between the Fire Department and the local union. Guidance can be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians,<sup>19</sup> and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) Wellness/Fitness Initiative.<sup>24</sup>

***Recommendation #2: Exercise stress tests should be incorporated into the Fire Department’s medical evaluation program.***

NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians, and the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) Wellness/Fitness Initiative both recommend at least biannual EST for fire fighters.<sup>19,24</sup> They recommend that these tests begin at age 35 for those with CAD risk factors and at age 40 for those without CAD risk factors. The EST could be conducted by the fire fighter’s personal physician (at City or Fire Department expense) or the City physician. If the fire fighter’s personal physician conducts the test, the results must be communicated to the City physician, who is

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responsible for decisions regarding medical clearance for fire fighting duties.

***Recommendation #3: Fire Fighters should be cleared for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582.***

Physicians providing input regarding medical clearance for fire fighting duties should be knowledgeable about the physical demands of fire fighting and familiar with the consensus guidelines published by NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians. To ensure that physicians responsible for clearance decisions are aware of these guidelines, we recommend that the Fire Department physician provide them with a copy of NFPA 1582. The final decision regarding medical clearance for return to work lies with the Fire Department physician with input from many sources including the employee's private physician.

***Recommendation #4: A mandatory wellness/fitness program should be phased in for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.***

NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.<sup>25</sup> In 1997, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) joined in a comprehensive Fire Service Joint Labor Management Wellness/Fitness Initiative to improve fire fighter quality of life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service

program. They produced a manual and a video detailing elements of such a program.<sup>24</sup> Wellness programs have been shown to be cost effective, typically by reducing the number of work-related injuries and lost work days.<sup>26,27</sup> A similar cost savings has been reported by the Wellness program at the Phoenix Fire Department, where a 12-year commitment has resulted in a significant reduction in their disability pension costs.<sup>28</sup>

Additional recommendations include

***Recommendation #5: Autopsies should be performed on all on-duty fire fighters whose death may be cardiovascular-related.***

In 1995, the United States Fire Administration (USFA) published the *Firefighter Autopsy Protocol*.<sup>29</sup> This publication hopes to provide “a more thorough documentation of the causes of firefighter deaths for three purposes:

- (1) to advance the analysis of the causes of firefighter deaths to aid in the development of improved firefighter health and safety equipment, procedures, and standards;
- (2) to help determine eligibility for death benefits under the Federal government's Public Safety Officer Benefits Program, as well as state and local programs; and
- (3) to address an increasing interest in the study of deaths that could be related to occupational illnesses among firefighters, both active and retired.”

***Recommendation #6: Adequate fire fighter staffing should be provided to ensure safe operating conditions.***

NFPA 1500 recommends that “members operating in hazardous areas at emergency incidents shall operate in teams of two or more.”<sup>25</sup> Understaffing causes those members on the scene to work harder

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and for longer periods of time. Engine and ladder companies should be staffed with four personnel at a minimum.

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**INVESTIGATOR INFORMATION**

This investigation was conducted by and the report written by Tommy N. Baldwin, MS, Safety and Occupational Health Specialist, and Daniel Rhodes, MD, MPH, Visiting Scientist

Mr. Baldwin is with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component, located in Cincinnati, Ohio. Dr. Rhodes is a NIOSH guest researcher.