



Fire Fighter Dies as a Result of a Cardiac Arrest While Fighting a Brush/Grass Fire - Massachusetts

SUMMARY

On April 11, 1998, a 49-year-old male off-duty career Fire Fighter from the neighboring Fire Department was assisting the local Fire Department that served the area where he lived to suppress a brush/grass fire near his house when he collapsed due to a cardiac arrest. Despite immediate cardiopulmonary resuscitation (CPR) administered by fire fighters, followed by advanced life support (ALS) administered by paramedics and emergency department personnel, the victim died. The death certificate and autopsy reported coronary artery disease as the immediate cause of death.

The following recommendations address preventive measures that have been recommended by other agencies to reduce, among other things, the risk of on-duty heart attacks and cardiac arrests among fire fighters. These recommendations have not been evaluated by NIOSH but represent research presented in the literature, consensus votes of technical committees of the National Fire Protection Association (NFPA), or products of labor/management technical committees within the fire service. This preventive strategy consists of (1) minimizing physical stress on fire fighters; (2) screening to identify and subsequently rehabilitate high-risk individuals; and (3) encouraging increased individual physical capacity (fitness). Issues relevant to this fire department include

- *Fire Fighters should have annual medical evaluations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.*

- *Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by phasing in a mandatory wellness/fitness program for fire fighters.*

INTRODUCTION & METHODS

On April 11, 1998, a 49-year-old male Fire Fighter collapsed while conducting fire suppression activities at a brush fire near his house. Despite CPR and ALS administered by fire fighters on the scene, ambulance EMTs and paramedics, and emergency department personnel, the victim died. NIOSH was notified of this fatality on April 14, 1998, by the United States Fire Administration (USFA). The USFA and the local county retirement board considered this an "on-duty" fatality for memorial and benefit purposes, respectively, due to the victim participating in an active fire suppression operation. On March 2, 1999, NIOSH contacted the Fire Department employing the victim to initiate the investigation. On May 11, 1999, a Safety and Occupational Health Specialist, a Senior Medical Epidemiologist, a Research Epidemiologist, and an Epidemiologist from the

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. 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:

<http://www.cdc.gov/niosh/firehome.html>

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NIOSH Fire Fighter Fatality Investigation Team traveled to Massachusetts to conduct an investigation of the incident.

During the investigation, NIOSH personnel met with the

- Chief of the affected Fire Department (FD)
- Safety and Training Officer of the affected FD
- The Local President of the International Association of Fire Fighters (IAFF)
- Chief of the Responding FD
- Fire Fighters responding to this incident
- City's Retirement Board Administrator

During the site visit NIOSH personnel also reviewed

- FD incident reports and dispatch records
- Emergency medical services—ambulance report
- FD policies and operating procedures
- FD training records
- The FD annual report for 1998

NIOSH personnel also contacted the victim's spouse by telephone.

INVESTIGATIVE RESULTS

Incident Response. On April 11, 1998, at 1410 hours, Dispatch notified the Fire Department having jurisdiction of a brush/grass fire. Engine 1 (Lieutenant and three Fire Fighters) responded. The victim, a career member of a neighboring Fire Department, was the owner of the land involved in the fire. He had been fighting the fire with a garden hose for some time when Engine 1 arrived on the scene at 1416 hours. He was not wearing bunker gear or a self-contained breathing apparatus (SCBA). After investigating the situation, Engine 1 reported the 1-acre brush fire to Dispatch and indicated that they would remain on the scene. The victim assisted the Engine 1 crew members as they pulled 400 feet of

forestry hose into the burning area and began to extinguish the fire. Fire fighters noted the victim appeared anxious, was sweating profusely and had a flushed face. The fire was declared under control at about 1422 hours. As the crew members were overhauling some hot spots, a woman standing nearby yelled "man down."

The victim had fallen face down into the burned area. Fire fighters reported his body shaking as though he were having a seizure. As fire fighters pulled him out of the burned area, they noted the victim having shallow, labored breathing, and they requested an ambulance for a "diabetic reaction." At 1423 hours, Car 8 (ambulance with two emergency medical technicians [EMTs]) responded.

Less than a minute later, fire fighters noted the victim had stopped breathing and he had no pulse. Two-man CPR was initiated using an ambu-bag with oxygen and chest compressions while Dispatch was notified at 1424 hours that this was a cardiac arrest. Paramedic Unit 2 was dispatched. In the responding Fire Department, all fire vehicles carry a semi-automatic defibrillator (SAED). The SAED on Engine 1 was retrieved and attached to the victim's chest to assess his heart rhythm. Over the next 2 minutes, his heart rhythm was assessed four times; after each assessment a cardioversion shock was delivered. Car 8 arrived on the scene at 1426 hours. The victim was reassessed and found to be still unresponsive, with no pulse or respirations, and CPR was continued. Less than 1 minute later Paramedic 2 arrived. The victim was loaded into Car 8 and paramedics intubated the victim, established intravenous (IV) access, and administered IV medications consistent with ALS protocols. Car 8 left the scene en route to the hospital at 1446 hours and arrived at the hospital at 1452 hours. CPR and ALS procedures were performed for a total of 23 minutes on the scene and for 6 minutes during transport to the hospital.



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Medical Findings. The death certificate and autopsy reported coronary artery disease as the immediate cause of death. The victim's medical history identified a few risk factors for coronary artery disease (CAD). The family and coworkers reported he maintained a fair amount of aerobic activity on and off the job without chest pain. His spouse reported that on the morning of the incident he was not complaining of any symptoms suggestive of angina (ischemic heart pain).

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the Fire Department employing the victim was comprised of 123 fire suppression personnel and served a population of 70,000 in a geographic area of 7 square miles. Fire fighters work the following tour of duty at six fire stations: Day 1, 0800-1800; Day 2, 0800-1800; Day 3, 1800-0800; Day 4, 1800-0800; and Days 5, 6, 7, and 8, off duty. Each shift of an engine company is staffed with an officer and three fire fighters; each ladder company, an officer and four fire fighters. In 1998, the Fire Department responded to 5,125 total calls: 2,668 miscellaneous calls; 1,235 false alarms; 320 rescue/EMS; 267 structure fires; 217 other hazardous calls; 130 motor vehicle fires; 111 trash/dumpster fires; 96 grass/brush fires; 52 hazardous materials calls; 25 mutual aid; and 4 other fire calls. The emergency medical service is privately operated from the local hospital.

The day of the incident the victim was off duty. The day prior he had responded to 15 incidents, which included 2 auto accidents, 2 brush fires, 2 smoke scares, 2 mistaken citizen calls, 1 vehicle fire, 1 dumpster fire, 1 elevator lock-in, 1 hazardous condition, 1 system malfunction, 1 medical call, and 1 service call. While performing this work, the victim did not report or show signs of discomfort, pain, or distress.

Training. The Fire Department provides all new fire fighters with the basic 11-week recruit training to become certified to the NFPA Fire Fighter I and II and First Responder levels. All are certified First Responders and are defibrillator-certified. All new fire fighters must become EMT-Basic certified within 1 year of employment. The Fire Department also requires annual completion of CPR, First Responder, and Hazardous Materials training. The victim had 23 years of fire fighting experience and was a certified Fire Officer I.

Preemployment/Preplacement Evaluations. Since 1996, the State of Massachusetts has required all new fire fighter applicants (hired after 1996) to pass a preemployment/preplacement medical evaluation. Components of this State-required evaluation, regardless of age, include

- A comprehensive medical history
- Height, weight, and vital signs
- Physical examination to include the skin, eyes, ears, nose, throat, cardiovascular system, respiratory system, gastrointestinal system, genitourinary system, endocrine and metabolic system, musculoskeletal system, neurological system, and mental status
- Audiometry (hearing test)
- Visual acuity and peripheral vision testing
- Pulmonary function testing

Other optional components may include

- A review of the tetanus immunization status
- A PPD test (test to ascertain exposure to the tuberculosis)
- A review of hepatitis B immunization status
- Five panel drug test
- Urine dipstick
- Chest X-ray
- Electrocardiogram
- Complete blood count (CBC)
- Chemistry panel (20 items)



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These evaluations are performed by a contractor, with results given to the City's Personnel Department. Once this evaluation is complete, a decision regarding medical clearance for fire fighting duties is made by a group of physicians hired by the City. Applicants are also required to complete a physical-capacity test. This is a timed performance evaluation of typical fire fighting duties. Finally, all fire fighters are required to pass a self-contained breathing apparatus (SCBA) performance test (e.g., using an SCBA in a maze) conducted at the State's Fire Training Center. Medical clearance for SCBA use prior to this test is not required.

Periodic Evaluations

No annual/periodic medical evaluations are required by this Fire Department. If employees are injured at work, they must be cleared for "return to work by the examining physician." While the 1996 law requires periodic (every 2 years) physical ability tests for employees hired since 1996, no annual or periodic physical ability tests are required for veterans of the department. Although some stations have exercise (strength and aerobic) equipment, typically purchased by the fire fighters themselves, no voluntary or required fitness/wellness program exists. SCBA performance tests are not conducted.

DISCUSSION

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.¹ Risk factors for its development include family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, obesity/physical inactivity, and diabetes.² The victim had a few of these risk factors, and the autopsy revealed coronary artery disease.

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.³ However, the growth of these

plaques probably occurs in a nonlinear, often abrupt fashion.⁴ Heart attacks typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply.⁵ This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques.

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.⁶⁻⁸ Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.⁹⁻¹² The mental and physical stress of conducting fire suppression activities, and his underlying coronary artery disease, all probably contributed to this victim's cardiac arrest and subsequent sudden cardiac death.

This victim did not report prior episodes of angina (heart pain) during physical activity performed on or off the job. Unfortunately, sudden cardiac death is often the first overt manifestation of ischemic heart disease.¹³

Discrepancies exist in the frequency and content of the State's medical evaluation requirements and those recommended by the NFPA.¹⁴ One example of this discrepancy involves a treadmill stress test conducted as part of the Fire Department's extensive preemployment/preplacement medical evaluations. This preemployment/preplacement treadmill stress test is required for all applicants, regardless of age. The NFPA recommends stress tests for those 35 years old and above with known CAD risk factors, and 40 years old and above for those without CAD risk factors. The NFPA also recommends annual medical evaluations, with periodic medical examinations. Stress tests are included as part of



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these medical examinations. It is assumed that if a treadmill test was performed on this Fire Fighter, his underlying CAD would have been identified and he would have been directed toward further evaluation and treatment.¹⁵

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 and sudden cardiac arrest among fire fighters. These recommendations have not been evaluated by NIOSH but represent research presented in the literature or of 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 annual medical evaluations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

Guidance regarding the content and scheduling of periodic medical examinations for fire fighters can be found in *NFPA 1582: Standard on Medical Requirements for Fire Fighters*,¹⁴ and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs wellness/fitness initiative.¹⁶ The department is not legally required to follow any of these standards. Nonetheless, we recommend the City and Union **negotiate** the content and frequency to be consistent with the above guidelines.

Specifically, according to NFPA 1582, the preemployment/preplacement stress (EKG) tests are

not necessary for applicants under the age of 35. Additionally, preplacement screening radiography (X-rays) of the low back lack clinical value and predictive value, while exposing the candidate to unnecessary radiation and representing an unnecessary expense for the department.¹⁷ On the other hand, annual/periodic medical evaluations should be conducted and should include stress tests for fire fighters with risk factors for CAD beginning at age 35.

In addition to providing guidance on the frequency and content of the medical evaluation, NFPA 1582 provides guidance on medical requirements for persons performing fire fighting tasks. NFPA 1582 should be applied in a **confidential, nondiscriminatory** manner. Appendix D of NFPA 1582 provides guidance for Fire Department Administrators regarding legal considerations in applying the standard.

Applying NFPA 1582 also involves economic issues. These economic concerns go beyond the costs of administering the medical program; they involve the personal and economic costs of dealing with the medical evaluation results. *NFPA 1500: Standard on Fire Department Occupational Safety and Health Program*, addresses these issues in Chapter 8-7.1 and 8-7.2.¹⁸

The success of medical programs hinges on protecting the affected fire fighter. The department must (1) keep the medical records confidential, (2) provide alternate duty positions for fire fighters in rehabilitation programs, and (3) if the fire fighter is not medically qualified to return to active fire fighting duties, provide permanent alternate duty positions or other supportive and/or compensated alternatives.

Recommendation #2: Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by phasing in a mandatory wellness/fitness program for fire fighters.



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NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.¹⁸ In 1997, the International Association of Fire Fighters and the International Association of Fire Chiefs 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 with a video detailing elements of such a program.¹⁶ The Fire Department and the Union should review these materials to identify applicable elements for their department. Other large-city negotiated programs can also be reviewed as potential models.

REFERENCES

1. Fauci AS, Braunwald E, Isselbacher KJ, et al. [1998]. Harrison's principles of internal medicine. 14th ed. New York, NY: McGraw-Hill, pp.222-225.
2. American Heart Association (AHA) [1998]. AHA scientific position, risk factors for coronary artery disease. Dallas, TX.
3. Fauci AS, Braunwald E, Isselbacher KJ, et al. [1998]. Harrison's principles of internal medicine. 14th ed. New York, NY: McGraw-Hill, p.1348.
4. Shah PK [1997]. Plaque disruption and coronary thrombosis: new insight into pathogenesis and prevention. *Clin Cardiol* 20 (11 Suppl2): II-38-44.
5. Fuster V, Badimon JJ, Badimon JH [1992]. The pathogenesis of coronary artery disease and the acute coronary syndromes. *N Eng J Med* 326:242-250.
6. Barnard RJ, Duncan HW [1975]. Heart rate and ECG responses of fire fighters. *J Occup Med* 17:247-250.
7. Manning JE, Griggs TR [1983]. Heart rate in fire fighters using light and heavy breathing equipment: simulated near maximal exertion in response to multiple work load conditions. *J Occup Med* 25:215-218.
8. Lemon PW, Hermiston RT [1977]. The human energy cost of fire fighting. *J Occup Med* 19:558-562.
9. Willich SN, Lewis M, Lowel H, et al. [1993]. Physical exertion as a trigger of acute myocardial infarction. *N Eng J Med* 329:1684-1690.
10. Mittleman MA, Maclure M, Tofler GH, et al. [1993]. Triggering of acute myocardial infarction by heavy physical exertion. *N Eng J Med* 329:1677-1683.
11. Siscovick DS, Weiss NS, Fletcher RH, Lasky T [1984]. The incidence of primary cardiac arrest during vigorous exercise. *N Eng J Med* 311:874-877.
12. Tofler GH, Muller JE, Stone PH, et al. [1992]. Modifiers of timing and possible triggers of acute myocardial infarction in the Thrombolysis in Myocardial Infarction Phase II (TIMI II) Study Group. *J Am Coll Cardiol* 20:1049-1055.
13. Fauci AS, Braunwald E, Isselbacher KJ, et al. [1998]. Harrison's principles of internal medicine. 14th ed. New York, NY: McGraw-Hill, p. 1366.
14. National Fire Protection Association [1997]. NFPA 1582: standard on medical requirements for fire fighters. Quincy, MA: National Fire Protection Association.



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15. Gianrossi R, Detrano R, Mulvihill D, et al. [1989]. Exercise-induced ST depression in the diagnosis of coronary artery disease: a meta-analysis. *Circulation* 57:64-70. occupational safety and health program. Quincy, MA: National Fire Protection Association.

16. International Association of Fire Fighters and the International Association of Fire Chiefs [1997]. The fire service joint labor management wellness/fitness initiative. Washington DC.: International Association of Fire Fighters, Department of Occupational Health and Safety.

17. Gibson ES [1988]. The value of preplacement screening radiography of the low back. In: Deyo RA, ed. *Occupational medicine: state of the art reviews*. Philadelphia: Hanley & Belfus, pp. 91-108.

18. National Fire Protection Association [1997]. NFPA 1500: standard on fire department

INVESTIGATOR INFORMATION

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