



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A summary of a NIOSH fire fighter fatality investigation

July 2002

Revised January 29, 2009 to reflect amended autopsy report, updated support information in the recommendations, and updated references. A footnote was added March 27, 2009.

Fire Fighter Suffers Sudden Death at Fire at his Residence - Florida

SUMMARY

On September 26, 2001, a 32-year-old male fire fighter reported a fire at his own house and initially assisted the responding fire fighters by pulling and holding hose. Half an hour later, he had chest pain and sought help from emergency medical service personnel at the scene. After being evaluated, treated with oxygen (which relieved the pain), and observed, the pain returned and he had a seizure, developed a cardiac arrhythmia (abnormal heart beat), and stopped breathing. Despite cardiopulmonary resuscitation (CPR) and advanced life support, which began immediately and continued on the way to the hospital and in the emergency department, the fire fighter died. An autopsy was performed, but NIOSH received subsequent information from the medical examiner's office stating "Due to the presumed falsified level [of carboxyhemoglobin] the decedent's cause and manner of death come into question." In 2006 a revised death certificate and autopsy investigation report concluded that the cause of death was "Arteriosclerotic cardiovascular disease" with "Probable smoke inhalation and stress associated with house fire" as a contributing cause.

The following recommendations address some general health and safety issues identified during this investigation. This list includes some preventive measures that have been recom-

The National Institute for Occupational Safety and Health (NIOSH), an institute within the Centers for Disease Control and Prevention (CDC), is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. In fiscal year 1998, the Congress appropriated funds to NIOSH to conduct a fire fighter initiative. NIOSH initiated the Fire Fighter Fatality Investigation and Prevention Program to examine deaths of fire fighters in the line of duty so that fire departments, fire fighters, fire service organizations, safety experts and researchers could learn from these incidents. The primary goal of these investigations is for NIOSH to make recommendations to prevent similar occurrences. These NIOSH investigations are intended to reduce or prevent future fire fighter deaths and are completely separate from the rulemaking, enforcement and inspection activities of any other federal or state agency. Under its program, NIOSH investigators interview persons with knowledge of the incident and review available records to develop a description of the conditions and circumstances leading to the deaths in order to provide a context for the agency's recommendations. The NIOSH summary of these conditions and circumstances in its reports is not intended as a legal statement of facts. This summary, as well as the conclusions and recommendations made by NIOSH, should not be used for the purpose of litigation or the adjudication of any claim. To request additional copies of this report (specify the case number shown in the shield above), for other fatality investigation reports, or further information, visit the Program Website at

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mended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These selected recommendations have not been evaluated by NIOSH, but represent published research or consensus votes of technical committees of the National Fire Protection Association (NFPA) or fire service labor/management groups.

- Institute pre-placement and annual medical evaluations. These should incorporate exercise stress testing, depending on the fire fighter's age and coronary artery disease risk factors.
- Fire fighters should be cleared for duty and for respirator use by a physician knowledgeable about the physical demands of fire fighting, the personal protective equipment used by fire fighters, and the various components of NFPA 1582.
- Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.

INTRODUCTION AND METHODS

On September 26, 2001, a 32-year-old male fire fighter died after losing consciousness at the scene of a fire. On October 1, 2001, the United States Fire Administration notified NIOSH of the death. On October 7, 2001, NIOSH first tried to contact the affected Fire Department to initiate the investigation and eventually made contact on October 23, 2001. On May 6, 2002, a NIOSH contract physician traveled to Flor-

ida to conduct an on-site investigation of the incident. On August 2, 2006, NIOSH was informed that the Medical Examiner conducting the autopsy had fabricated autopsy findings in other cases, and that this case was probably compromised.

People interviewed included the:

- Current Fire Chief
- Fire Chief at the time of the incident
- Crew members on duty with the deceased fire fighter
- Deceased fire fighter's spouse
- Human resources director for the deceased fire fighter's oil platform employer
- Medical examiner who performed the autopsy

Documents reviewed included:

- Fire Department policies and operating guidelines
- Fire Department run report and fire incident report
- Fire Department run log for 2001
- Deceased fire fighter's medical records maintained by his private physicians
- Ambulance response report
- Hospital emergency department record
- Medical Examiner's Investigation Report (8/2/06)



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- Death certificate (original and amended on 9/1/06)
- Autopsy report (original and amended on 9/11/06)

INVESTIGATIVE RESULTS

Incident. On September 26, 2001, at 2126 hours, the affected fire fighter reported a fire in the bathroom of his house. He woke up his daughter and they went outside. At 2134 hours, the first engine, driven by the Chief, arrived and parked in back of the house. The affected fire fighter did not have his turnout gear at home, but he pulled hose and held hose for another fire fighter (who had arrived in his own vehicle). After about 15 minutes, the affected fire fighter went around front, and for the next half hour or so, he was seen walking about, leaning against a vehicle and going in and out of the house. (He also talked by cell phone to his wife, who was at the World Trade Center disaster site as part of a disaster medical assistance team.) It was after dark, warm but not hot. Although the fire fighter seemed distraught about the fire, other fire fighters did not observe him to be in physical distress or hear him mention any symptoms.¹

At 2225 hours, he went to the emergency medical service (EMS) ambulance (which routinely responds to structural fire calls) and reported chest pain, which he apparently attributed to smoke exposure. No other symptoms were recorded at this time. His pulse was 113 and his blood pressure was 160/102, but his physical examination was otherwise normal, his electrocardiogram (EKG) showed no significant

abnormalities (normal sinus rhythm, one premature ventricular contraction), and his arterial oxygen saturation was 98% (normal). His pain was largely relieved with oxygen, but it returned after some minutes, more severe than before, and he became diaphoretic (sweating). As he was moved from the bench seat to the stretcher, he had a seizure. He stopped breathing and had no palpable pulse. His EKG first showed ventricular tachycardia (an abnormal heart rhythm) and then, as the defibrillator was being attached, ventricular fibrillation (a different abnormal rhythm). A series of three defibrillator shocks failed to restore his heart beat, CPR and advanced life support were initiated, and as these measures were in progress, the ambulance departed for the hospital at 2245 hours. The fire fighter's heart went into asystole (no heartbeat) at 2249 hours. Advance life support measures at the scene and en route included endotracheal intubation (placing a tube in the airway), intravenous medications, and two more defibrillator shocks when ventricular fibrillation returned for a few minutes (reverting again, at 2305 hours, to asystole). The ambulance arrived at the hospital at 2307 hours. CPR and advanced life support (including intravenous medications and external cardiac pacing) continued in the emergency department, but the fire fighter did not respond. At 2332 hours he was pronounced dead.

¹The investigator interviewed one fire fighter who indicated that the deceased fire fighter had probable smoke exposure. Another fire fighter interviewed reported no smoke exposure.



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Medical Findings. Pertinent findings from the original autopsy report included:

- Cardiomegaly (445 grams) with left and right ventricular hypertrophy
- Mild to severe calcific atherosclerosis of the coronary arteries
- Acute thrombosis of the left anterior descending coronary artery
- No sign of previous myocardial infarction.
- The carboxyhemoglobin concentration (a measure of carbon monoxide exposure) in blood obtained at autopsy was 1.4% (a medically insignificant level).
- There was no soot in the lungs.

In August 2006 the Medical Examiner's office informed NIOSH that the Medical Examiner who conducted the fire fighter's autopsy appeared to have falsified autopsy findings. The Medical Examiner's office felt the findings of this autopsy were compromised because the reported carboxyhemoglobin level of 1.4% "was never justified as being tested from any laboratory."

This calls into question all the other reported findings of this autopsy report. An amended autopsy report and death certificate were issued in September 2006 stating "Arteriosclerotic cardiovascular disease" as the cause of death with "Probable smoke inhalation and stress associated with house fire" as a contributing cause. The latter was not included in the original report.

At the time of his death, the fire fighter had three

jobs: safety officer on an offshore oil platform, emergency medical technician (EMT), and 911 dispatcher. He worked (and lived) on the oil platform for a week, then he had a week off. The other two jobs were part-time during the off week. He had previously worked as a sheriff's deputy and before that as a professional fire fighter. He had been a volunteer fire fighter with his current department for 4 years. He completed Fire Fighter I training and had additional training in apparatus driving/operation, hazardous materials (HAZMAT) operations, wildland fire fighting, and search and rescue. He was the Fire Department's training officer for the last year before his death and held the rank of Captain for the last 6 months.

Except for one episode of self-limited chest pain (for which he did not seek medical attention), he never reported symptoms of coronary artery disease to his family or crew members. He had no known chronic health problems and took no prescription medications. His father had coronary artery bypass surgery at age 56. The fire fighter smoked cigarettes (a pack a day since he was a 14 or 15 years old). Except for home and yard work, he did not engage in regular physical exercise. (EMT work can include episodic strenuous physical activity, but the fire fighter's other jobs did not.) In addition to his apparent emotional stress resulting from the fire at his house, and his concern (unfounded) that he might have caused it, he was under further stress because of a pending legal matter. The deceased fire fighter's last physical examination was in July 2000 for EMT school. At that time, his blood pressure was 140/70 mm Hg (normal). He weighed 226 pounds and was 70 inches tall,



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giving him a body mass index (BMI) of 32 kg/m². (A BMI above 30 kg/m² indicates obesity.¹) A blood cholesterol level in 1987 was 157 mg/dL (normal). He never had an EKG or an exercise stress test.

DESCRIPTION OF THE FIRE DEPARTMENT

The Fire Department consists of 15 volunteer fire fighters. It serves a rural area of 126 square miles with a population of 1,260. There is one fire station. In 2001, the Department responded to 78 calls; these included calls for medical assistance, for which the Department has first responder responsibility until the county EMS arrives.

Training. Fire fighters who were members of the Department when it was established in 1995 have had Fire Fighter I training, but there are no formal training requirements for new members. One current member, who is also a professional fire fighter in another department, provides regular training for the other volunteers. All members are certified in first aid and CPR and trained in the use of an automatic external defibrillator.

Medical Evaluations. The Department has no preplacement or periodic medical evaluations or physical agility tests. Medical clearance is not required for respirator use or for returning to duty after an injury or illness. Members who are unable to perform a full range of duties due to health problems or age, however, are accommodated by limiting their tasks to those they are able to do. The department has

no health promotion programs or exercise/fitness equipment.

DISCUSSION

The Medical Examiner's Office concluded that the carboxyhemoglobin level of 1.4% as reported by former Medical Examiner appears to have been falsified. This calls into question all the other reported findings of the autopsy report including the presence of a coronary artery thrombus (clot), atherosclerotic coronary artery disease, and the lack of soot in the trachea, or even the lack of a pulmonary embolus.

The fire fighter had risk factors for coronary artery disease (male gender, family history, cigarette smoking, lack of regular aerobic physical activity, obesity)² and his clinical scenario is consistent with ischemic heart disease and a heart attack (exertion-related chest pain 5 to 10 minutes prior to his collapse). However, establishing the occurrence of an acute heart attack requires any of the following: characteristic EKG changes, elevated cardiac enzymes, or coronary artery thrombus/plaque rupture. In this fire fighter's case, an EKG several minutes prior to his collapse reportedly showed none of the characteristic heart attack changes. No cardiac enzyme testing was performed, but the enzymes would not be expected to become positive for at least 4 hours post-heart attack. Finally, although a thrombus was reportedly found in the left anterior descending artery, the validity of this information is uncertain.



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Therefore, although atherosclerotic cardiovascular disease with or without a heart attack is the most likely cause of death, other medical conditions need to be considered. These would include a cardiac arrhythmia due to an underlying hypertrophic cardiomyopathy, a pulmonary embolus, or carbon monoxide poisoning either by itself or as a triggering agent for a heart attack or a cardiac arrhythmia.

Fire fighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.³ 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.^{4,6} Epidemiologic studies in the general population and in the fire service have found that heavy physical exertion sometimes immediately precedes and can trigger the onset of acute heart attacks.⁷⁻¹³ The deceased fire fighter had pulled and held hose for about 15 minutes, then he did not engage in strenuous physical for the half hour before he sought help for chest pain. Pulling and handling hose involves moderate to strenuous exertion, more than most home and yard maintenance tasks.^{8,14,15}

RECOMMENDATIONS

The following recommendations address health

and safety issues identified during this investigation. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job cardiac arrest among fire fighters. These selected recommendations have not been evaluated by NIOSH, but they represent published research or consensus votes of Technical Committees of the National Fire Protection Association or fire service labor/management groups.

Recommendation #1: Institute preplacement and annual medical evaluations. These should incorporate exercise stress testing, depending on the fire fighter's age and coronary artery disease risk factors.

The purpose of periodic medical evaluations is to ensure that fire fighters have the 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 1582.¹⁶ 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.

Guidance regarding the content and frequency of periodic medical evaluations and examinations for fire fighters can be found in NFPA 1582 and in the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) Fire Service Joint Labor Management Wellness/Fitness Initiative.¹⁷ The fire department, however, is not legally required



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to follow this standard or this initiative.

This recommendation has financial implications and may be particularly difficult for small, volunteer fire departments to implement. The fire department may have to consider alternative options to overcome the financial obstacle. One option urges current members to get annual medical clearances from their private physicians. Another option is having the annual medical evaluations completed by paramedics and EMTs from the Emergency Medical Service (vital signs, height, weight, visual acuity, and EKG). This information could then be provided to a community physician, perhaps volunteering his or her time, to review the data and provide medical clearance (or further evaluation, if needed). The more extensive portions of the medical evaluations could be performed by a private physician at the fire fighter's expense (personal or through insurance), provided by a physician volunteer, or paid for by the fire department. Sharing the financial responsibility for these evaluations between fire fighters, the Fire Department, and physician volunteers may reduce the negative financial impact on recruiting and retaining needed fire fighters. Additional suggestions for overcoming the financial burden of implementing medical examinations within the volunteer service can be found in the National Volunteer Fire Council (NVFC) and United States Fire Administration's (USFA) Health and Wellness Guide for the Volunteer Fire Service.¹⁸

Recommendation #2: Fire fighters should be cleared for duty and for respirator use by a physician knowledgeable about the physical

demands of fire fighting, the personal protective equipment used by fire fighters, and the various components of NFPA 1582.

The decision regarding medical clearance for fire fighters requires knowledge not only of the fire fighter's medical condition but also of the fire fighter's job duties and NFPA 1582 medical fitness criteria. NFPA 1582 recommends that return-to-duty evaluations (after an injury or illness) be done by the "fire department physician."¹⁶ As part of the return-to-duty evaluation, the fire department physician should review relevant records from the fire fighter's personal physicians and/or discuss with them the fire fighter's illness or injury.

The Occupational Safety and Health administration (OSHA) respiratory protection standard¹⁹ requires employers whose employees are required to use respirators to have a formal respiratory protection program, including periodic medical evaluations. Since Florida does not have an OSHA-approved State plan, public employers, including volunteer fire departments, are not legally subject to OSHA standards.²⁰ Nevertheless, we recommend that the Fire Department voluntarily adhere to the health- and safety-related provisions of the OSHA standard, including periodic medical evaluations. The medical evaluations for respirator use can be done at the same time as fitness-for-duty examinations, and often they do not involve substantial additional evaluation.

Recommendation #3: Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease



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and improve cardiovascular capacity.

Physical inactivity is the most prevalent modifiable risk factor for CAD in the United States. Physical inactivity, or lack of exercise, is an independent risk factor for CAD and it is positively associated with other risk factors including, obesity, dyslipidemia and diabetes.²¹ NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.²² Guidance for how to implement and components of a wellness and fitness program can be found in several documents provided by Fire Service organizations:

- NFPA 1583, Standard on Health-Related Fitness Programs for Fire Fighters;²³
- International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC), Fire Service Joint Labor Management Wellness/Fitness Initiative;¹⁷
- National Volunteer Fire Council (NVFC) / United State Fire Administration (USFA) Health and Wellness Guide for the Volunteer Fire Service.¹⁸

Implementing a Health and Wellness program is a particular challenge for small, volunteer fire departments. Forming effective partnerships (with park districts, fitness clubs, clinics) and capitalizing on the camaraderie of the fire service may help address these issues.

When considering the cost of Health and Wellness programs it is important to keep in mind

the potential cost savings. Worksite health promotion programs have been shown to be cost effective by increasing productivity, reducing absenteeism, reducing the number of work-related injuries, and reducing the number of work-related lost work days.²⁴⁻²⁶ Fire service health promotion programs have been shown to reduce coronary artery disease risk factors and improve fitness levels, with mandatory programs showing the most benefit.²⁷⁻²⁹ A recent study conducted by the Oregon Health and Science University reported a savings of over one million dollars for each of four large fire departments implementing the IAFF/IAFC wellness/fitness program compared to four large fire departments not implementing a program. These savings were primarily due to a reduction of occupational injury/illness claims with additional savings expected from reduced future non-occupational healthcare costs.³⁰

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INVESTIGATOR INFORMATION

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