



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

July 13, 2004

Fire Fighter Suffers Sudden Cardiac Death in Parking Lot of Fire Station - Tennessee

SUMMARY

On July 21, 2003, a 50-year-old male career Fire Fighter had an unwitnessed collapse in the parking lot. After being down for approximately 10 to 15 minutes, he was found lying in the parking lot with agonal respirations and no pulse. Cardiopulmonary resuscitation (CPR) was begun and an ambulance was requested. After approximately one-hour of CPR and advanced life support (ALS), administered on the scene, in the ambulance and at the hospital, the fire fighter was pronounced dead. The death certificate, completed by the Physician, listed "myocardial infarction" as the immediate cause of death. No autopsy was performed.

The following recommendations address some general health and safety issues. 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 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 (NFPA) or fire service labor/management groups.

- *Conduct periodic medical evaluations to determine the fire fighter's medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.*
- *Fire fighters with two or more risk factors for Coronary Artery Disease (CAD) should have an exercise stress test (EST).*
- *Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting.*

- *Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.*

Although unrelated to this fatality, the Fire Department should consider these additional general recommendations:

- *Perform an annual physical performance (physical ability) evaluation.*
- *Perform an autopsy on all on-duty fire fighter fatalities.*
- *Provide fire fighters with medical evaluations and clearance to wear SCBA.*
- *Discontinue routine use of x-rays of the lumbar spine.*
- *Designate an employee to administer the pre-placement and annual medical evaluations and their outcomes.*

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

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Fatality Assessment and Control Evaluation Investigative Report #F2003-39

Fire Fighter Suffers Sudden Cardiac Death in Parking Lot of Fire Station - Tennessee

INTRODUCTION AND METHODS

On July 21, 2003, a 50-year-old male career Fire Fighter collapsed in the parking lot after smoking. Despite CPR and ALS administered by fellow fire fighters, Emergency Medical Technicians/Paramedics (EMT/EMT-P), the ambulance crew, and in the emergency department (ED), the victim died. On July 25, 2003, NIOSH - Cincinnati contacted the affected Fire Department to initiate the investigation. On December 15, 2003, an Occupational Nurse Practitioner from the NIOSH Fire Fighter Fatality Investigation Team traveled to Tennessee to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed the following:

- Fire Chief
- Crew members
- Victim's wife

During the site visit NIOSH personnel reviewed:

- Emergency medical service (ambulance) incident report
- Hospital ED report
- Death certificate
- Past medical records of the deceased
- Fire Department policies and operating guidelines
- Fire Department training records

INVESTIGATIVE RESULTS

Incident. On July 21, 2003, at approximately 0700 hours, a 50-year-old male career fire fighter (the deceased) began his 24-hour shift at the fire station. One alarm call was received at 1155 hours and was disregarded in route. No other emergency calls were received that day, and the rest of the day was spent conducting maintenance of the station (light exertion). At about 1900 hours, the deceased informed two crewmembers he was going out to smoke a cigarette in the Station's parking lot. He was last seen by a crewmember at approximately 1945 hours. At 2000

hours, one of the crewmembers came outside and found the deceased lying on his back, unresponsive, with agonal breathing and no pulse. The crewmember ran inside the station, grabbed the automatic external defibrillator (AED) off of the fire apparatus and yelled for another crewmember to call 911. After calling 911 at 2007 hours, the other crewmember blew the air horn on the apparatus to alert other crewmembers, then went to assist the collapsed fire fighter.

The first crewmember returned to find the collapsed fire fighter pulseless, with no spontaneous breathing. He began CPR and attached AED pads on the fire fighter's chest. The AED analyzed the heart rhythm and delivered one shock, then advised CPR. At this time the second crewmember arrived to assist with CPR. He witnessed the AED analyze and administer four to five additional shocks without visible results.

The ambulance arrived at 2017 hours, and re-evaluation by the ambulance paramedic found the fire fighter to be unresponsive, pulseless, and without spontaneous breathing. The paramedic of the ambulance crew attempted intubation three times and was unsuccessful, so a "Combitube" was placed and confirmed with bilateral breath sounds. (The Combitube is an airway device designed for emergency situations which allows assisted ventilations without accidental placement in the esophagus.) An intravenous line (IV) was placed into the fire fighter's vein and ALS medications were administered. He was then placed on a cardiac monitor by the ambulance crew and found to be in ventricular fibrillation (a heart rhythm incompatible with life). ALS procedures (including shocks) and medications were continued as well as CPR. The patient was placed on an ambulance stretcher at which time a bleeding laceration was noticed on the back of his head. After being placed on the stretcher, the fire fighter was again noted to have a heart rhythm of Ventricular Fibrillation for which another shock was administered, unfortunately putting the patient



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into pulseless electrical activity (PEA) (another heart rhythm incompatible with life). He was transported to the hospital leaving the scene at 2032 hours.

The fire fighter was given further ALS medications enroute to the hospital. The ambulance arrived at the hospital's ED at 2043 hours, at that time the ED's cardiac monitor showed asystole (no heart rhythm). The ED staff verified breath sounds and regained IV access lost during transport. Further ALS medications were administered but no further defibrillation (shocks) were administered. The fire fighter was pronounced dead by the attending physician at 2057 hours and resuscitation attempts were discontinued.

Medical Findings. The death certificate was completed by the ED physician, who listed "Myocardial Infarction" as the immediate cause of death. No autopsy was performed. In September 1993, the deceased was diagnosed with hypertension and an EKG (electrocardiogram) was performed which presented an inverted T wave (an electrical disturbance of his heart of unknown significance). In June 1996, the fire fighter was diagnosed with Congestive Heart Failure (CHF) and treated with antihypertensive and diuretic medications and released for work. In May 1997, the patient presented with an exacerbation of his CHF, probably due to non-compliance with his medications. In October 1999 the fire fighter again was hospitalized for an exacerbation of his CHF. An echocardiogram measured an ejection fraction of 20% (normal usually around greater than 50%). At this time he was diagnosed with diabetes mellitus (DM). His CHF was treated with diuresis and antihypertensives, while his DM was treated by diet, weight loss, and increased physical activity. He returned to work in November 1999.

In January 2000, the fire fighter was found to have a Hemoglobin A1c of 7.8% (Hgb A1c is a blood test to identify diabetic glucose control over the last 2-3

months, normal is 4.4%-6.4%) which is an estimated sixty day blood glucose mean of 165 mg/dl. In March 2000, a blood sugar of 379 mg/dl (normal is 70-115 mg/dl) resulted in insulin treatment, followed by oral anti-diabetic medications. In March 2000 he was scheduled for an exercise stress test (EST). Although the family states that he underwent an EST, no records of an EST could be found. The last time the fire fighter was seen by his private physician was in January 2003 for a follow-up visit regarding back pain and swelling. At that time he weighed 231.5 pounds and his previous height was 72 inches tall, giving him a body mass index (BMI) of 31.4 kilograms/meter² (kg/m²) (A BMI above 30 kg/m² is considered obese.)¹ The fire fighter had a blood pressure of 130/90, glucose of 144 mg/dl (normal 70-115 mg/dl), and a Hemoglobin (Hgb) A1c of 7.1%. He was given another anti-hypertensive, sent home, and no mention was made of clearance for fire fighter duties. According to the fellow crewmembers, the deceased did not complain of angina or any other heart-related illness, the day of, or the weeks preceding, the incident.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the Fire Department consisted of 117 uniformed personnel serving a population of 300,000 in an area of 273 square miles. There are eight fire stations staffed by nine companies. In 2002 the department made 2,587 fire response runs and 3,912 first responder calls. Fire fighters work the following schedule: 24 hours on-duty, 24 hours off-duty for three shifts, then three days off. Shifts change at 0700 hours.

Training To become a member of the FD, applicants are ranked by their written application, a comprehensive examination and a physical agility test score. The comprehensive examination includes no fire fighting questions but is a general academic test.



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The physical agility test scores fire fighters based the Candidate Physical Ability Test of The Fire Service Joint Labor Management Wellness/Fitness Initiative.¹⁸ The top ranked candidates are then offered a position. Once hired as a fire fighter recruit, the candidate must complete the 26 week fire fighter academy. Upon academy completion, the fire fighter will be certified as a Fire Fighter I and EMT-basic and assigned to one of the fire companies. After serving 18 months as a fire fighter I the fire fighter is promoted to fire fighter II. Recurrent training occurs daily on each shift. Recertification classes are conducted as needed. The deceased was certified as a Fire Fighter II, and Driver/Operator. He had 23 years of fire fighting experience.

Pre-placement Evaluations The Fire Department requires a pre-placement medical evaluation for new members. The examination is conducted by a neighboring health clinic. The components of the medical evaluation include:

- Complete medical history and questionnaire
- Height, weight, and vital signs
- Physical examination
- Vision test
- Audiogram
- Urinalysis
- Urine drug screen
- Blood tests: complete metabolic panel including a lipid profile
- Spirometry (lung function tests)
- Chest X-ray
- Lumbar Spine X-ray
- Resting EKG
- Maximal stress test using a treadmill and the Bruce Protocol
- Skin test for tuberculosis (PPD).

At the time the deceased fire fighter joined this fire department in 1980, there was no pre-placement medical evaluation offered or required.

Periodic Evaluations. No annual medical evaluations or physical ability tests are required by the Department. Fire fighters are encouraged to receive a complete physical examination at their own expense. Medical clearance for SCBA use is not required. If a fire fighter is injured on duty, he/she must be cleared for return to work by the contract clinic. A non-occupational illness lasting more than one shift usually requires a personal physician release, at the discretion of the Battalion Commander. Strength equipment is available at the fire station but not aerobic equipment. There is no mandatory fitness program or wellness programs available.

DISCUSSION

Because no autopsy was performed, a definitive “cause of death” cannot be determined. Possible causes of death include a heart attack (myocardial infarction), cardiac arrhythmia due to heart failure, or pulmonary embolus. We use the term “possible” because confirmation of a heart attack requires any of the following: autopsy findings (thrombus formation), ECG findings, or blood tests (cardiac isoenzymes). Since an autopsy was not performed, no heart beat was available to show the EKG’s changes, and cardiac enzymes were not drawn, we cannot confirm a heart attack. The fire fighter also had a reduced ejection fraction consistent with a diagnosis of CHF. Patients with CHF are at an increased risk of sudden cardiac death.² The patient also had been diagnosed with diabetes mellitus since October 1999. Thus, a combination of these factors (possible CAD, CHF, and diabetes) all increased the risk for Sudden Cardiac Death (SCD). Finally, although much less likely, it is possible his sudden death was secondary to a pulmonary embolus (blood clot in the artery).

In the United States, CAD due to atherosclerosis, is the most common risk factor for cardiac arrest and sudden cardiac death.³ Risk factors for its

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development include age over 45, male gender, family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes.^{4,5} The victim had all nine of these risk factors.

To reduce the risk of heart attacks, sudden cardiac arrest and other medical conditions among fire fighters, the NFPA has developed the guideline, *Standard 1582 Comprehensive Occupational Medicine Program for Fire Departments*.⁶ The guideline recommends an annual medical examination to be performed on all members. For fire fighters with two or more risk factors for CAD (family history of premature [less than age 60] cardiac event, hypertension, diabetes mellitus, hypercholesterolemia [total cholesterol greater than 240 mg/dL or HDL cholesterol less than 35 mg/dL], and cigarette smoking), the standard recommends an EST.⁶ These recommendations are similar to those of the American College of Cardiology/American Heart Association (ACC/AHA).⁷ Unfortunately, this Fire Department does not currently offer EST or any other periodic physical evaluations to fire fighters.

If the Fire Fighter had been examined by a physician familiar with NFPA 1582, he probably would have been precluded from duty as a firefighter. The NFPA 1582 2000 edition⁸, under which the fire fighter would have been examined, has different standards than the NFPA 1582 2003 edition. According to the 2000 edition, the deceased had one category A condition (a medical condition that **WOULD** preclude a person from performing as a member in a training or emergency operational environment by presenting a significant risk to the safety and health of the person or others). The one category A condition was CHF as diagnosed by his reduced ejection fraction on echocardiogram in 1999. However, this ejection fraction was taken during an acute exacerbation of his CHF. Once his condition was treated and stabilized, his ejection fraction would

probably have increased, but no additional testing was done to document this improvement.

The victim also had, according to the NFPA 1582 standard, two category B disorders (a medical condition that, based on its severity or degree, **COULD** preclude a person from performing as a member in a training or emergency operational environment by presenting a significant risk to the safety and health of the person or others). These conditions were hypertension, and diabetes with no history of incapacitating hypoglycemia. Given these three conditions, a physician following the NFPA 1582 guidelines would have precluded the fire fighter from active duty fire suppression. Also, if NFPA 1582, 2000 edition, had been followed an exercise stress test would have been performed which may have identified underlying CAD, which could have been treated, thereby preventing his untimely death at this point in time.

RECOMMENDATIONS

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 they represent published research or consensus votes of technical committees of the NFPA or fire service labor/management groups.

Recommendation #1: Conduct periodic medical evaluations to determine a fire fighter's medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

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

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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, 2003 edition.⁶ In addition, NFPA 1582 also provides guidance on medical requirements for persons performing fire fighting tasks.

Applying NFPA 1582 involves legal and economic issues, so it should be carried out in a **confidential, nondiscriminatory** manner. Annex B of NFPA 1582 provides guidance for Fire Department administrators regarding legal considerations in applying the standard. The 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 8-7.2.⁹ 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: Fire fighters with two or more CAD risk factors should have an EST.

NFPA 1582 and the IAFF/IAFC wellness/fitness initiative both recommend EST for some fire fighters to screen for obstructive CAD.^{6,10} NFPA 1582 recommends EST for those fire fighters with two or more CAD risk factors. According to NFPA 1582, these CAD risk factors are:

- (family history of premature [less than age 60] cardiac event,
- hypertension,
- diabetes mellitus,

- hypercholesterolemia [total cholesterol greater than 240 mg/dL or HDL cholesterol less than 35 mg/dL], and
- cigarette smoking).⁶

These recommendations are similar to those of the American College of Cardiology/American Heart Association (ACC/AHA).⁷

The EST could be conducted by the fire fighter's personal physician or the Department's contract physician. If the fire fighter's personal physician or the contracted physician conducts the test, the results must be communicated to the Department physician, who should be responsible for decisions regarding medical clearance for fire fighting duties.

Recommendation #3: Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting.

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. To ensure physicians are aware of these guidelines, we recommend that the Fire Department provide the contract and private physicians with a copy of NFPA 1582. In addition, we recommend the Fire Department not automatically accept the opinion of the employee's private physician regarding return to work. This decision requires knowledge not only of the employee's medical condition but also of the employee's job duties. Many, private physicians are not familiar with an employee's job duties or with guidance documents such as NFPA 1582. To overcome this problem, we recommend that all return-to-work clearances be reviewed by a Fire Department contracted physician. Thus, the final decision regarding medical clearance for return to

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work lies with the Fire Department Physician with input from many sources including the employee's private physician.

Recommendation #4: Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.

Physical inactivity is the most prevalent modifiable risk factor for CAD in the United States. Additionally, physical inactivity, or lack of exercise, is associated with other risk factors, namely obesity and diabetes.¹¹ NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, and NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters*, require a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.^{9,12} In 1997, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) published 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.¹⁰ The Fire Department should review these materials to identify applicable elements. Other large-city negotiated programs can also be reviewed as potential models.

The following recommendations were unrelated to this fatality, but were safety issues identified by NIOSH during its evaluation:

Recommendation #1: Perform an annual physical performance (physical ability) evaluation.

NFPA 1500 requires fire department members who engage in emergency operations to be annually evaluated and certified by the fire department as meeting the physical performance requirements identified in paragraph 8-2.1.¹³

Recommendation #2: Perform an autopsy on all on-duty fire fighter fatalities.

In 1995, the United States Fire Administration (USFA) published the Firefighter Autopsy Protocol.¹⁴ 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 #3: Provide fire fighters with medical evaluations and clearance to wear SCBA.

OSHA's Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employees using respiratory protection.¹⁵ These clearance evaluations are required for private industry employees and public employees in States operating OSHA-approved State plans. Tennessee is an OSHA-approved State plan and therefore the department is required to comply with the standard.

Recommendation #4: Discontinue routine use of x-rays of the lumbar spine.

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Pre-placement screening radiography (X-rays) of the low back, lack clinical and predictive value, while exposing the candidate to unnecessary radiation.¹⁹ This screening test represent an unnecessary expense for the department.

Recommendation #5: Designate an employee to administer the pre-placement and annual medical evaluations and their outcomes.

This employee should maintain the confidentiality of the medical records. If this employee is a member of the FD and participating in the Department's annual medical evaluation, a policy should prevent them from administering the program to themselves.

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INVESTIGATOR INFORMATION

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