



## **Volunteer Fire Fighter Has a Cardiac Arrest and Dies at the Scene of a Commercial Structure Fire - Pennsylvania**

### **SUMMARY**

On November 26, 1997, a 69-year-old male volunteer fire fighter responded to a structural fire of a wood-framed trailer. The victim was directing traffic around the fire scene and was not engaged in fire suppression activities when he had a witnessed collapse. Almost immediately, on-scene emergency rescue personnel reached the unconscious fire fighter and initiated cardiopulmonary resuscitation (CPR), which was followed by advanced life support (ALS) administered first by ambulance paramedics and then hospital emergency department personnel. Despite 50 minutes of attempted resuscitation activity, the victim died. The death certificate listed "arteriosclerotic cardiovascular disease" as the immediate cause of death. Autopsy confirmed the presence of triple vessel coronary artery disease, listed an enlarged heart (left ventricular hypertrophy), and found evidence of a remote (old) heart attack (myocardial infarction).

The following recommendations address health and safety issues in general. It cannot be determined, however, whether these recommendations, had they been in effect in his department, could have prevented the sudden cardiac arrest and subsequent death of this fire fighter. These recommendations rely on a two-pronged strategy proposed by other agencies for reducing the risk of on-duty heart attacks and cardiac arrests among fire fighters. This strategy consists of (1) screening to identify and subsequently rehabilitate individuals at higher risk, and (2) encouraging increased individual physical capacity. Steps that could be taken to accomplish these ends 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.***

- ***Provide fire fighters with medical evaluations to wear self-contained breathing apparatus (SCBA).***
- ***Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by implementing a wellness/fitness program for fire fighters.***

### **INTRODUCTION**

On November 26, 1997, a 69-year-old male volunteer fire fighter collapsed in cardiac arrest while directing traffic at a structural fire. Despite CPR administered by the emergency response personnel, and ALS administered by the ambulance service and hospital staff, the fire fighter died. The National Institute for Occupational Safety and Health (NIOSH) was notified of this fatality on December 4, 1997. On December 29, 1997, NIOSH telephoned the affected Fire Department to initiate

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>

or call toll free 1-800-35-NIOSH

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an investigation. On January 14, 1997, and November 29, 1999, an investigator from the NIOSH Fire Fighter Fatality Investigation Team traveled to Pennsylvania to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel met with and/or interviewed the

- Fire Department Chief, who was present at the fire scene
- Fire Department Assistant Chief, who was present at the fire scene
- Family members
- Victim's personal physician

During the site visit NIOSH personnel also reviewed

- Fire Department incident report
- County Fire Marshal's investigative report
- Death certificate of the deceased
- Autopsy report
- Ambulance response form
- Emergency department records related to this incident
- Fire Department policies and operating procedures

NIOSH personnel also visited the fire scene, although the cleanup operation had removed the damaged structure.

## **INVESTIGATION**

***Fire Scene Activities.*** On November 26, 1997, at 1754 hours, central dispatch notified the victim's Fire Department of a structural fire at a single-story, wood-framed trailer within its jurisdiction. The Department responded with two of its engines (E-20 and E-6), its rescue vehicle (R-20), its ambulance (A-20), and its salvage vehicle (Salvage-6), in addition to 13 of its volunteer fire fighters. The first fire fighters arrived on

scene at 1804 hours and found heavy smoke and fire at the rear of the trailer. At this time two additional fire departments arrived as part of their mutual aid policy. The victim arrived on scene via his personal vehicle and was assigned to direct traffic at 1806 hours. He was wearing a hard hat and a reflective jacket but not bunker gear or self-contained breathing apparatus (SCBA). At 1810 hours, the paramedic driving A-20 to the fire scene drove past the victim as he was directing traffic. As the paramedic looked into his rear view mirror, he saw the victim clutch his chest and collapse onto the pavement.

The paramedic reached the victim within a minute and found him unconscious and without a pulse or respirations. CPR was started, and then another ambulance arrived to assist the victim at 1812 hours. A heart monitor placed on the victim showed ventricular fibrillation, an ineffective heart rhythm incompatible with life. He received two defibrillations (shocks), but his subsequent heart rhythm was asystole (no heart beat). CPR continued as the victim was intubated with an endotracheal (breathing) tube (ETT) and given multiple doses of heart medications consistent with ALS protocols. A third shock was unsuccessful, as was a transcutaneous pacing attempt. The ambulance left the fire scene at approximately 1845 hours. On arrival in the emergency department, the victim was unconscious without a heart rhythm. The ETT was checked for proper placement, and after several minutes of continued ALS, resuscitation efforts were stopped and the victim was pronounced dead at 1902 hours.

The death certificate listed "arteriosclerotic cardiovascular disease" as the immediate cause of death. An autopsy confirmed the presence of arteriosclerotic cardiovascular disease in his aorta and coronary arteries. Specific atherosclerotic lesions in his coronary arteries included a 90% blockage of his left main coronary artery, a 75%

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blockage of his left anterior descending artery, and 75% blockage of his right coronary artery. The autopsy also found evidence of an enlarged heart (left ventricular hypertrophy) and fibrosis consistent with a remote (at least several months old) heart attack (myocardial infarction) of the posterior wall of his left ventricle. Urine and blood tests revealed no alcohol, drugs, or elevated carboxyhemoglobin level (suggesting the victim was not exposed to significant amount of carbon monoxide).

Discussions with family members and the personal physician indicate that the victim had only one modifiable risk factor for coronary artery disease (elevated cholesterol), and that he reported no symptoms suggestive of heart disease. In February 1995, the victim passed his commercial drivers license physical examination, but this examination did not include an EKG or an exercise stress test. The victim was taking no medications.

**DESCRIPTION OF THE FIRE DEPARTMENT**

At the time of the NIOSH investigation, the Fire Department manned a single fire station run by 50 volunteer fire fighters and served a population of 2,600 covering 1 square mile. In 1998, the Fire Department responded to 108 incidents.

*Training.* New volunteers are currently required to obtain 88 hours of essential fire fighter training provided at the County Fire School before participating in fire suppression. Once completed, no re-certification is required. New volunteers are encouraged to obtain training in emergency medical services, with certification required by the State. Rescue training, which is administered by the State's Department of Health, is also encouraged. The victim had been a member of this fire department for 45 years and had received fire fighter training. Over the past few years, the victim had reduced his role in

active-duty fire suppression. His responsibilities at the fire scene typically involved directing traffic around the fire or motor vehicle injury scene, as was the case in this incident.

*Medical Clearance and Physical Fitness.* The department does not require a medical evaluation before performing fire fighting duties, does not require medical clearance for respirator usage, and does not require physical agility/fitness testing for new or current fire fighters.

**DISCUSSION**

Approximately 2 minutes after the victim's collapse, paramedics found the victim in ventricular fibrillation, an ineffective heart rhythm that, unless converted, is universally fatal. This arrhythmia is the most common type associated with cardiac arrest, occurring in 65-80% of all cardiac arrests.<sup>1</sup> In the United States, atherosclerotic coronary artery disease (CAD) leading to a myocardial infarction (heart attack) is the most common cause of cardiac arrest and subsequent sudden cardiac death, and was the probable cause of the victim's sudden death. This fatality occurred despite very prompt and appropriate CPR and ALS efforts.

Risk factors for the development of CAD include modifiable risk factors (smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes) and non-modifiable risk factors (increasing age, male gender, and family history of CAD).<sup>2</sup> The victim had only one modifiable risk factor (high cholesterol), and he never expressed symptoms of heart problems to his family, his fire fighting peers, or his personal physician. This is somewhat surprising since chest pain (angina) typically accompanies ischemic heart disease. On the other hand, some individuals may not experience angina, as evidenced by up to 20% of heart attacks being "silent," i.e., painless.<sup>3</sup>

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Emergency response activities are strenuous and often require emergency responders 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>4-6</sup> Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.<sup>7-10</sup> The victim's probable increase in heart rate and blood pressure while responding to this fire alarm, along with his underlying atherosclerotic CAD, contributed to this fire fighter's "probable" heart attack, subsequent cardiac arrest, and sudden death." The term "probable" is used because an acute (recent) heart attack can only be confirmed by one of the following:

1. blood tests finding elevated cardiac iso-enzymes;
2. on autopsy, thrombus (blood clot) formation in one of the coronary arteries;
3. if there is a heart beat, characteristic finding on electrocardiogram [EKG].

Unfortunately, the victim did not have a heartbeat, did not have blood taken in the emergency room for cardiac iso-enzymes, and did not have a thrombus formation on autopsy. It is important to note that thrombus formation on autopsy is present in less than 50% of individuals dying from acute heart attacks. Both his autopsy finding of marked atherosclerotic disease in three coronary arteries and his clinical course were consistent with an acute heart attack leading to his sudden cardiac death.

To reduce the risk of heart attacks and sudden cardiac arrests among fire fighters, the National Fire Protection Association (NFPA) has developed guidelines entitled "Medical Requirement for Fire Fighters," otherwise known as Standard 1582.<sup>11</sup> They recommend, in addition to screening for risk factors for CAD, an exercise stress EKG. They recommend this test despite finding that "no firm

guidelines for stress electrocardiography in asymptomatic individuals have been developed." However, they note that a reasonable approach would be to include treadmill testing for fire fighters at age 40, or at age 35 for those with a risk factor for coronary artery disease. This exercise stress testing procedure has errors both in over-diagnosis and in under-diagnosis, although newer techniques, including the thallium administration or additional monitoring, can improve the accuracy of the procedure.<sup>12</sup> It is thus possible that asymptomatic fire fighters could have coronary artery disease detected before an event such as a myocardial infarction occurs.

**RECOMMENDATIONS AND DISCUSSION**

The following recommendations address some general health and safety issues. It cannot be determined, however, whether these recommendations could have prevented the sudden cardiac arrest and subsequent death of this fire fighter. 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 medical literature or of consensus votes of Technical Committees of the National Fire Protection Association or labor/management groups within the fire service. This strategy consists of (1) medical screening to identify and subsequently rehabilitate individuals at higher risk, and (2) encouraging increased individual physical capacity. Steps that could be taken to accomplish these ends include

***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.***

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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*<sup>11</sup>. 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. Applying this recommendation involves economic repercussions and may be particularly difficult for small volunteer fire departments, such as the one involved in this incident, to implement.

To overcome the financial obstacle, this Fire Department could urge new volunteers to get medical clearances from their private physicians before engaging in fire suppression activities. The recommended content of these evaluations is contained in NFPA 1582. The brief annual medical evaluations recommended by NFPA could be completed by the volunteer (medical and occupational history), and by EMT/paramedics already on staff (vital signs, height, weight, and visual acuity), and this information could be shared with a local physician, perhaps volunteering his or her time, to review this data and provide medical clearance (or further evaluation, if needed). The more extensive periodic medical examinations could be performed by a private physician at the fire fighter's expense, provided by a physician volunteer, or paid for by the Fire Department. Sharing the financial responsibility for these evaluations between volunteers, the Fire Department, and willing physician volunteers should reduce the negative impact to recruit and retain needed volunteers.

***Recommendation #2: Provide fire fighters with medical evaluations to wear self-contained breathing apparatus (SCBA).***

OSHA's revised respiratory protection standard requires employers to provide medical evaluations

and clearance for employees using respiratory protection.<sup>13</sup> These clearance evaluations are required for private industry employees and public employees in States operating OSHA-approved State plans. Since Pennsylvania is not a State plan state, public employees are **NOT** required to comply with OSHA standards. Nonetheless, we recommend voluntary compliance with this aspect of the respiratory protection standard to help ensure that fire fighters can safely wear SCBA (and safely do fire fighting work, with or without an SCBA). A copy of the OSHA medical checklist has been provided to the Fire Department and should not involve a financial burden to the Fire Department beyond that required for the fitness-for-duty medical evaluation.

***Recommendation #3: Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by implementing a wellness/fitness program for fire fighters.***

NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.<sup>14</sup> 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.<sup>15</sup> Fire Departments should review these materials to identify applicable elements for their department.

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**INVESTIGATOR INFORMATION**

This investigation was conducted by Thomas Hales, MD, MPH, Senior Medical Epidemiologist from the NIOSH Fire Fighter Fatality Investigation Team, located in Cincinnati, Ohio.