



Fire Fighter Dies as a Result of a Cardiac Arrest While Responding to the Scene of a Reported Structure Fire—West Virginia

SUMMARY

On June 13, 1999, a 52-year-old male volunteer Fire Fighter responded in a Fire Department Engine to the scene of a reported structure fire with heavy smoke. On the way to the fire, the Fire Fighter (victim) collapsed in the cab of the Engine. Despite Advanced Cardiac Life Support (ACLS) measures administered on site, during the ambulance ride to the hospital, and in the hospital's emergency room, the victim died. The death certificate listed acute myocardial infarction (heart attack) due to coronary artery disease as the cause of death. No autopsy was performed.

Other agencies have proposed a three-pronged strategy for reducing the risk of on-duty heart attacks and cardiac arrests among fire fighters. This 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. 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 offering a wellness/fitness program for fire fighters.*
- *Perform an autopsy on all on-duty fire fighters whose death may be cardiovascular-related.*

INTRODUCTION & METHODS

On June 13, 1999, a 52-year-old male Fire Fighter collapsed en route to a building fire. Despite CPR and ACLS administered by crew members, other fire fighters, emergency medical technicians/paramedics, and hospital emergency department personnel, the victim died. NIOSH was notified of this fatality on June 15, 1999, by the United States Fire Administration. On July 7, 1999, NIOSH telephoned the affected Fire Department to initiate the investigation. On July 22, 1999, a Senior Medical Officer and an Epidemiologist from the NIOSH Fire Fighter Fatality Investigation Team traveled to West Virginia to conduct an on-site investigation of the incident.

During the investigation, NIOSH personnel met with and interviewed the

- Fire Chief and Assistant Chief
- Fire Department personnel involved in this incident
- Emergency medical technician/paramedics providing treatment

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:

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During the site visit NIOSH personnel also reviewed

- Fire Department policies and operating procedures
- Fire Department training records
- Ambulance and Emergency Room records
- Past medical records of the deceased
- Death certificate

INVESTIGATIVE RESULTS

Emergency Scene Response. On June 13, 1999, at 1917 hours, Central Dispatch notified the affected fire department of a multiple alarm structure fire with smoke showing at a college dormitory building. (The fire was found to be a small contents fire that was easily suppressed.) A neighboring fire department (first-in) was already on scene with an Engine, Rescue, and medic units. The affected fire department was backup (mutual aid) for the first-in fire department. Engine 27, driven by the Assistant Chief and staffed with one fire fighter (the victim), was the second apparatus out of their station at 1921 hours. At that time, the victim was conversant and not displaying any signs or symptoms of discomfort.

En route to the fire, at approximately 1926 hours, and 1 minute from the first-in department's fire station, the Assistant Chief asked the victim a question, but he did not respond and then slumped over in the seat. The Assistant Chief immediately called Dispatch to go out of service, indicating that there was a problem with the victim, and asked for the medic unit from the first-in department to return to their fire station where he would meet them. Upon arrival at the neighboring station, the Assistant Chief pulled the victim out of the cab through the passenger door, laid him on the ground, and assessed him for vital signs. At that time the victim was unresponsive, without a pulse or respirations. Cardiopulmonary resuscitation (CPR) was initiated. The Assistant Chief notified Dispatch of a suspected cardiac arrest and

continued CPR until the returning medic unit (with Advanced Cardiac Life Support [ACLS] capability) arrived.

At 1934 hours, the returning medic unit (staffed with two EMT/Firefighters and one Paramedic) arrived at the station. The victim was reassessed and again found to be unresponsive, without a pulse or respirations. While CPR was being maintained, a heart monitor attached to the victim found the victim's heart rhythm to be ventricular fibrillation (V.Fib). Three shocks (electrical defibrillations) were delivered, and a regular rhythm and weak pulse returned at approximately 1945 hours. Other ACLS measures, including oxygen and medications, were given, and after several minutes the victim returned to consciousness.

The victim was awake when transferred to the ambulance to begin the ride to the hospital. After about 15 minutes, however, the victim developed ventricular tachycardia and then V. Fib. with loss of consciousness. He again temporarily responded to electrical defibrillation but never regained consciousness. Arriving at the hospital emergency room at 2018 hours, the victim's cardiac rhythm had deteriorated to asystole. Resuscitation efforts, including transcutaneous pacing, were continued for 40 minutes in the emergency room, but the victim never regained spontaneous circulation and was pronounced dead at 2059 hours.

Medical Findings. The death certificate, completed by the Medical Examiner, listed the immediate cause of death as "acute myocardial infarction" due to "coronary artery disease." No blood was sent for laboratory analysis; therefore, no cardiac isoenzymes or other drug tests were available. No autopsy was performed.

Limited past medical data were available since the patient lived alone, had no family contact, and rarely



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sought medical attention beyond short emergency room (ER) visits. From ER visit data, it was documented that the victim had hypertension, obesity, and a family history of heart disease (type not stated). In 1996, the victim developed chest pains consistent with angina pectoris, and in January 1997, he was diagnosed with congestive heart failure. Both conditions were successfully treated despite being incompletely evaluated because of the patient's refusal of hospitalization and certain diagnostic procedures. However, the last available medical records (April 1999) indicated that the victim reported no cardiopulmonary symptoms; his blood pressure was well controlled on medication; and his cardiopulmonary exam was normal. Although the victim held another job, he was thought to have primarily a sedentary lifestyle.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the fire department was comprised of approximately 25 volunteers, in one station, serving a population of approximately 3,000 in a geographic area of 80 square miles. The department responds to approximately 300 calls a year, including 40-50 fire calls.

Training. The fire department provides all new fire fighters with the basic 48-hour recruit training to Fire Fighter Level I. The department also conducts weekly on-the-job training. The victim had 8.5 years of fire fighting experience, was a certified Fire Fighter Second Class and a Driver/Operator. In addition, he held certifications in Water Rescue and Recovery, Self-Defense Within Confined Spaces, Leadership Training, Pumper/Tanker Operations, Basic Handtools/Automobile Extrication, Communicable Disease, and Water Movement.

Medical Clearance and Physical Fitness. The department has no requirement for physical examinations, and thus, provides none. The department also does not require a medical clearance evaluation to wear a respirator. However, it was noted that the victim, because of his obesity and age, had not worn a self-contained breathing apparatus (SCBA) for about 5 years; instead he served primarily as a Driver/Operator. No specific fire department programs were in place to enhance the cardiovascular/respiratory fitness of the fire fighters.

DISCUSSION

Approximately 8 minutes after the victim's collapse, paramedics determined the victim was in ventricular fibrillation (V.Fib). V.Fib is the most common type of arrhythmia associated with cardiac arrest, occurring in 65-80% of all cardiac arrests.¹ In the United States, atherosclerotic coronary artery disease (CAD) is the most common risk factor for cardiac arrest and sudden cardiac death.¹ Risk factors for its development include family history of CAD, smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes.² The victim had five of these risk factors.

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.

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



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inflammatory process) predispose the plaque to disruption.⁴ 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.^{6,7} Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.⁸⁻¹¹

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.¹²⁻¹⁴ The physiologic stress of responding to the fire department alarm contributed to this fire fighter's probable heart attack, subsequent cardiac arrest, and sudden death. The term "probable" is used because autopsy findings and/or blood tests (cardiac isoenzymes) are required to "confirm" a heart attack (myocardial infarction), and neither of these was performed.

The victim reported chest pain in 1996 consistent with angina pectoris. However, he reported no chest pain during physical activity performed at work or while performing duties as a volunteer fire fighter since then. This is somewhat surprising since chest pain (angina) typically accompanies ischemic heart disease. On the other hand, some individuals may not experience angina with ischemia, as evidenced by the finding that up to 20% of heart attacks are "silent" (i.e., painless).¹⁵

In 1997, the National Fire Protection Association (NFPA) updated *Standard 1582, Medical Requirements for Fire Fighters*.¹⁶ This voluntary industry standard specifies minimum medical requirements for candidates and current fire fighters. NFPA 1582 considers individuals with CAD (history of myocardial infarction, coronary artery bypass

surgery, or coronary angioplasty) to be a "Category B Medical Condition." A Category B Medical Condition is defined as "a medical condition that, based on its severity or degree, **could** (our emphasis) preclude a person from performing as a fire fighter in a training or emergency operational environment by presenting a significant risk to the safety and health of the person or others." Appendix A of the standard contains guidance for when to preclude a fire fighter with CAD from engaging in fire fighting activities. Appendix A states that "persons at mildly increased risk for sudden incapacitation are acceptable for fire fighting. Mildly increased risk is defined by the presence of each of the following:

- Normal left ventricular ejection fraction
- Normal exercise tolerance, > 10 metabolic equivalents (METs)
- Absence of exercise-induced ischemia by exercise testing
- Absence of exercise-induced complex ventricular arrhythmias
- Absence of hemodynamically significant stenosis on all major coronary arteries (≥ 70 percent lumen diameter narrowing), or successful myocardial revascularization."

Because of the victim's self-limited medical care, it is not known whether he would have met these criteria. However, emergency room records from 1996 and 1997 suggest that cardiac disease may have been present.

RECOMMENDATIONS AND DISCUSSION

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 published research findings, regulations passed by enforcement



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agencies such as the Occupational Safety and Health Administration (OSHA), consensus votes of technical committees of the 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). Specific recommendations for this department 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.

Guidance regarding the content and frequency of periodic medical evaluation for fire fighters can be found in *NFPA Standard 1582, Medical Requirements for Fire Fighters*,¹⁶ and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs wellness/fitness initiative.¹⁷

Recommendation #2: Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by offering 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.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.¹⁷ Fire departments should review these materials to identify elements applicable to their department.

Recommendation #3: Perform an autopsy 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*.¹⁹ 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.”

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INVESTIGATOR INFORMATION

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