



Fire Fighter Dies as a Result of a Cardiac Arrest at the Scene of a Structure Fire - Maine

SUMMARY

On January 12, 2000, a 48-year-old male volunteer Fire Fighter (the victim) responded to a fire in a two-story dwelling in which triplet children were trapped. The victim, wearing full turnout gear and driving a Tanker, arrived at a nearby hydrant and began to hook up supply lines when he collapsed.

Another Tanker Driver/Operator found the victim. Immediate assessment found the victim to be unresponsive, with no pulse or respirations. Cardiopulmonary resuscitation (CPR) (chest compressions with mouth-to-mouth ventilation) was initiated. Despite CPR and advanced life support (ALS) administered by crew members, emergency medical technicians (EMTs), and hospital emergency department (ED) personnel, the victim died. An autopsy was performed; however, medical records were not available to NIOSH personnel at the time of this report.

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 they represent published research, regulations passed by enforcement agencies such as the Occupational Safety and Health Administration (OSHA), 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). Steps that

could be taken to accomplish these ends include the following:

- *Institute preplacement and periodic medical evaluations. These should incorporate exercise stress testing, depending on the fire fighter's age and coronary artery disease risk factors.*
- *Provide fire fighters with medical evaluations to wear self-contained breathing apparatus (SCBA).*
- *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 January 12, 2000, a 48-year-old male Fire Fighter collapsed at the scene of a fire in a two-story dwelling. Despite CPR and ALS administered by crew members, emergency medical technicians, and hospital emergency department personnel, the victim

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

www.cdc.gov/niosh/firehome.html
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died. NIOSH was notified of this fatality by the United States Fire Administration (USFA) on January 13, 2000. On May 30, 2000, NIOSH contacted the affected Fire Department to initiate the investigation. On July 10, 2000, NIOSH investigators from the Fire Fighter Fatality Investigation Team, Cardiovascular Disease Component, traveled to Maine to conduct an on-site investigation.

During the investigation NIOSH personnel met with or interviewed the

- Fire Chief
- Fire Department personnel involved in this incident
- Family members

During the site visit NIOSH personnel also reviewed

- Fire Department incident report
- Fire Department policies and operating procedures
- Fire Department training records
- Fire Department annual report for 1999
- Fire Department administrative records

INVESTIGATIVE RESULTS

Emergency Scene Response. On January 12, 2000, at 1615 hours, the Sheriff's Office dispatched the involved Fire Department to a structure fire in which triplet children were trapped. The structure involved was a two-story, wood-frame structure located approximately 1 mile from the Fire Department. Engine 8 (one fire fighter), Engine 5 (Assistant Chief), Engine 9 (one fire fighter [victim]), Tanker 1 (one fire fighter), Tanker 6 (one fire fighter) and 14 additional fire fighters, including the Fire Chief, responded in their privately owned vehicles. The Fire Department has an automatic mutual-aid agreement with two neighboring volunteer fire departments to assist on structure fires, and they responded with a total of two Engines and two Tankers. The local ambulance service also responds

on all structure fires. Additional assistance was requested from four other nearby fire departments, who responded with one Engine, two Tankers, and a thermal imaging camera.

The involved Fire Department arrived on the scene at 1621 hours to find heavy fire venting out all windows on side one, first floor, with fire showing on the second floor. Wind was blowing from side two toward side four at 16 miles per hour. The temperature was 30E F (dry bulb) (24E F wet bulb) and the relative humidity was 51%.

Reports from witnesses on the scene related to fire fighters the last known location of the three children still trapped. (A neighbor had entered the back porch area and rescued one child before Fire Department arrival). Two 1¾-inch and one 2½-inch handlines were initially deployed from Engine 8 to begin fire attack. Fire fighters began attempts to gain entry to rescue the victims. Automatic-aid departments began to arrive soon thereafter, and two additional 1¾-inch handlines were deployed from one additional engine for an attack on the fire that had spread to the two-story garage nearby. Tanker 6 stopped at the scene, dropped the dump tank and filled it. The victim, wearing full turnout gear without self-contained breathing apparatus (SCBA), positioned Engine 9 past the fire at the dry hydrant located beside a pond to establish a water supply. Engine 5 laid a 4-inch supply hose from Engine 8 toward the dry hydrant but was approximately 300 feet short. A mutual-aid engine was positioned between the fire and the dry hydrant. The victim connected the hard suction hose from Engine 9 to the dry hydrant.

After filling the dump tank at the scene, Tanker 6 drove past Engine 9 to turn around. At this time, the victim was witnessed retrieving a 2½-inch hoseline to make a double hose-lay and connect to the mutual-aid engine. After turning around, Tanker 6



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approached Engine 9 and found the victim lying on the road. The Tanker 6 Driver/Operator immediately parked and assessed the victim. He was unresponsive, pulseless, and without respirations. The Driver/Operator requested assistance with CPR from the Assistant Chief on Engine 5 while the local on-scene ambulance was radioed. An additional ambulance, which carried a defibrillator, was requested. Unfortunately, that unit was located 14 miles away.

CPR (chest compressions and mouth-to-mouth ventilation) was begun. When the local ambulance arrived at the victim less than 1 minute later, the victim was reassessed and found to be unresponsive, pulseless, and not breathing. As CPR continued, the victim was loaded into the ambulance for transport to the local hospital.

Medical Findings. While an autopsy was performed, medical records were not available to NIOSH investigators.

According to a Fire Department self-administered medical questionnaire completed in 1990, the victim reported a heart attack in February 1990 and was currently under a physician's care. He also indicated that he had hypertension (high blood pressure) and was taking prescription medication. At this time he reported a height of 69" and a weight of 210 pounds.

The victim had four known risk factors for coronary artery disease (CAD): male gender, age greater than 45 years, high blood pressure, and a lack of conditioned physical activity.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the Fire Department was comprised of 19 volunteers in one station serving a population of approximately 2,000

in a geographic area of 36 square miles. In 1999 the Department responded to 96 calls: three structure fires, five grass fires, two rescue calls, one vehicle fire, eight false alarms, one hazardous condition, 11 mutual-aid calls, 27 service calls, and 38 other incidents.

Training. The Fire Department requires that all new fire fighters receive basic fire fighter and SCBA training. This training is conducted by the State and is available at local fire departments. Additional training is conducted weekly at the Fire Department. The Fire Department also requires SCBA recertification every 5 years. There is no State requirement for annual fire fighter recertification. The victim had received fire fighter, CPR, apparatus operation, and fire investigation training, and he had 26 years of fire-fighting experience.

Medical Clearance and Physical Fitness. The Fire Department does not require a medical evaluation before performing fire-fighting duties, a periodic medical evaluation, a medical clearance for respirator usage, nor a physical agility/fitness testing for new or current fire fighters, and it does not have a physical fitness/wellness program.

DISCUSSION

As mentioned previously, the death certificate and autopsy report were not available to NIOSH at the time of this report. Due to the victim's age, coronary artery disease (CAD) risk factors, and reported history of a heart attack in 1990, it is most likely a heart attack or a heart arrhythmia that triggered his sudden death. 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 increasing age, male gender, family history of CAD, smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes.²



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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. An autopsy was performed, but the extent of the victim's CAD was unknown to NIOSH investigators.

Blood clots, or thrombus formation, in coronary arteries is initiated by disruption of atherosclerotic plaques. Certain characteristics of the plaques (size, composition of the cap and core, presence of a local 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.⁸⁻¹² The victim, while wearing full bunker gear, drove the Tanker to the scene, connected one supply hose, and was retrieving another supply hose. These tasks were accomplished in a hurried manner considering the nature of the fire emergency (trapped children). This is considered a moderate level of physical exertion.¹³

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.¹⁴⁻¹⁶ The mental and physical stress of responding to the emergency, connecting the supply hose, and his probable underlying atherosclerotic CAD, all contributed to this fire fighter's "probable"

heart attack, subsequent cardiac arrest, and sudden death. The term "probable" is used because an autopsy and/or blood tests (cardiac isoenzymes) are required to "confirm" a heart attack (myocardial infarction) and medical records were not available at the time of this report.

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 research presented in the literature or 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 necessarily listed in order of priority. 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). Steps that could be taken to accomplish these include

Recommendation #1: Institute preplacement and periodic 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 1582.¹⁷ In addition to providing guidance on the frequency and content of the medical



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evaluation, NFPA 1582 provides guidance on medical requirements for persons performing fire-fighting tasks. NFPA 1582 recommends a limited annual evaluation, including a medical and occupational history, and a limited physical examination (height, weight, blood pressure, heart rate and rhythm). In addition, NFPA 1582 recommends a more extensive medical evaluation at an interval of 1 to 3 years, depending on the fire fighter's age. NFPA 1582 recommends that periodic exercise stress tests begin at age 35 for those with CAD risk factors and at age 40 for those without CAD risk factors.

Applying NFPA 1582 involves legal and economic issues, so it should be carried out in a **confidential, nondiscriminatory** manner. Appendix D 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 8-7.2.¹⁸ 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. Unfortunately, the second and third requirements may not be workable in a volunteer department and could thus impair both acceptance by fire fighters and the Fire Department's ability to recruit and retain fire fighters.

Applying this recommendation involves economic repercussions and may be particularly difficult for

small, rural, volunteer fire departments to implement. To overcome the financial obstacle, the Fire Department could urge current members to get annual medical clearances from their private physicians (but see Recommendation #2). Another option is having the brief annual medical evaluations recommended by NFPA 1582 completed by the volunteer fire fighters themselves (medical and occupational history) and by EMTs from the city/county's emergency medical service (vital signs, height, weight, and visual acuity). 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 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 financial impact on recruiting and retaining needed volunteers.

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

In 1997, OSHA published its revised respiratory protection standard.¹⁹ This standard, among other things, requires that a medical evaluation of fire fighters wearing SCBA be performed by a physician or other licensed health care professional. This evaluation could consist of a screening questionnaire (enclosed) to ascertain if additional medical evaluations or a medical examination is warranted. Because Maine does not have an Occupational Safety and Health Administration (OSHA)-approved state plan, its state and municipal employees, such as fire fighters, are not covered under the Occupational Safety and Health Act. Therefore,



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State, County, or City fire departments in Maine are not required to comply with OSHA standards. Nonetheless, we recommend voluntary compliance with this aspect of the respiratory protection standard to ensure that fire fighters can safely wear SCBA.

Recommendation #3: 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.²⁰ 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 (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.²¹ Small, volunteer fire departments should review the programs mentioned above and determine which components are applicable to them.

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INVESTIGATOR INFORMATION

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