



Fire-Police Officer Dies as a Result of a Cardiac Arrest at the Scene of a Motor Vehicle Accident - Pennsylvania

SUMMARY

On December 18, 1998, a 55-year-old male volunteer Fire-Police Officer responded to a motor vehicle accident (MVA) in his privately owned vehicle. The victim's vehicle, equipped with emergency bar lights, stopped on the highway shoulder approximately 500 yards in front of the MVA scene, presumably to warn oncoming motorists. When his fire company was released from the scene, the victim did not respond to the radio message. Shortly thereafter, he was found unresponsive, slumped over the steering wheel, with his foot on the brake and the vehicle still in gear. Despite basic life support (BLS) and advanced life support (ALS) applied in the field, in the ambulance, and in the hospital's emergency department, the victim died. The death certificate listed the immediate cause of death as "sudden cardiac death" due to "coronary artery disease" due to "diabetes mellitus." No blood was sent for laboratory analysis; therefore, no carboxyhemoglobin levels, cardiac isoenzymes, or drug tests were available. No autopsy was performed.

Eight years prior to his death, the victim had a myocardial infarction (heart attack) and subsequent coronary artery bypass surgery. Four months prior to his death, the victim was hospitalized for congestive heart failure (CHF) and, at that time, had a persantine/thallium stress test which showed a moderate amount of scarring from his previous myocardial infarction and a mild amount of myocardial ischemia (reduced blood supply to the heart). Approximately 5 weeks after discharge, with his CHF stabilized, the victim requested medical release to fire/ police duties.

The following recommendations address preventative 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 research presented in the literature, consensus votes of technical committees of the National Fire Protection Association (NFPA), or products of labor/management technical committees within the fire service. In addition, they are presented in a logical programmatic order, and are not necessarily listed in order of priority. This preventative 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:

- ***Individuals with medical conditions that would present a significant risk to the safety and health of themselves or others should be precluded from emergency response activities.***

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**



Fatality Assessment and Control Evaluation Investigative Report #99F-10

Fire-Police Officer Dies as a Result of a Cardiac Arrest at the Scene of a Motor Vehicle Accident - Pennsylvania

- *Emergency response personnel 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 emergency response personnel.*
 - *Carboxyhemoglobin levels should be tested on symptomatic or unresponsive emergency response personnel.*
 - *Perform an autopsy on all on-duty emergency response personnel who were fatally injured while on duty.*
- Fire Chief
 - Fire Department personnel involved in this incident
 - Emergency medical technician/paramedic providing treatment

During the site visit NIOSH personnel also reviewed

- Fire Department Incident Report
- Existing Fire Department investigative records
- Fire Department policies and operating procedures
- Fire Department training records
- Fire Department annual report for 1998
- Past medical records of the deceased

INTRODUCTION & METHODS

On December 18, 1998, a 55-year-old male fire-police officer was found in cardiac arrest at the scene of a motor vehicle accident. Despite CPR and ALS administered by the fire fighters, emergency medical technicians/paramedics, and hospital emergency department personnel, the victim died on December 19, 1998. NIOSH was notified of this fatality on December 21, 1998, by the United States Fire Administration. On January 25, 1999, NIOSH telephoned the affected Fire Department to initiate the investigation. On March 30, 1999, a Safety and Occupational Health Specialist and the Senior Medical Officer 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 interviewed the

- Fire Commissioner

Finally, the scene of the motor vehicle accident and the area where the victim was found in cardiac arrest were surveyed.

INVESTIGATIVE RESULTS

Emergency Scene Response. On December 18, 1998, at 2312 hours, County Dispatch notified Company 11, Company 14, Company 15 (the affected fire department), and Ambulance 61 of a motor vehicle accident. The Companies responded at 2313 hours. The affected department responded with Engine 15 (Driver/Operator, two Fire Fighters, and an Assistant Chief) plus a Fire-Police officer (the victim) in his privately owned vehicle (POV). Company 11 was first to arrive at 2315 hours. After “sizing up” the scene, the officer in charge notified Dispatch to cancel Company 14 and 15, and the Fire-Police units were to continue to the scene.



Fatality Assessment and Control Evaluation Investigative Report #99F-10

Fire-Police Officer Dies as a Result of a Cardiac Arrest at the Scene of a Motor Vehicle Accident - Pennsylvania

At approximately 2316 hours, the victim, traveling in his personal vehicle, equipped with emergency bar lights and siren, stopped approximately 500 yards in front of the MVA scene. Although he did not radio his position to the Incident Commander, it was assumed he had taken this position to warn and slow down oncoming motorists. The MVA involved a small car which had collided with a tractor-trailer. The driver of the passenger vehicle sustained injuries and required extrication and emergency transport to the nearby hospital. Company 11 crew members assisted with patient stabilization, debris removal from the roadway, and applying “hi-dry” on the roadway to absorb leaking antifreeze. At approximately 2400 hours all remaining units were released from the scene.

At this time, one of the Fire-Police officers tried to radio the victim to inform him of the company’s release from the scene, but the victim did not respond to the radio message. The Fire-Police officer then drove his vehicle to the victim’s location and found him unresponsive and slumped over the wheel at approximately 0003 hours. The victim’s vehicle was running, in gear, and with the victim’s foot on the brake. The Fire-Police officer notified Station 15 that a fire fighter was down.

At 0006 hours, Chief 115, who responded from home, arrived at the MVA scene in his POV, picked up three remaining personnel (a Captain, a Fire Fighter, and a Fire Fighter/Paramedic), and drove to the victim’s location. The paramedic removed the victim from his vehicle and reassessed him. Again, he was unresponsive, without a pulse or respirations. An oral airway was inserted and assisted respirations were initiated with a bag-valve-mask, and chest compressions were begun. Chief 115 advised Dispatch of the situation and requested ALS and BLS. Medic 1 (ALS) and Medic 10 (BLS) were dispatched at 0008 hours.

At 0014 hours, Medic 1 arrived. The victim was reassessed and found to be unresponsive, pulseless, and without respirations. A defibrillator was attached to the victim and displayed a cardiac rhythm of ventricular fibrillation for which the victim was shocked (electrical cardioversion). Unfortunately, the victim’s heart rhythm reverted into asystole (no heart beat). CPR was reinitiated and the victim was subsequently intubated and given intravenous medications consistent with ALS protocols. At 0027 hours, the victim was moved to Medic 1 and transported to the nearest hospital.

At 0040 hours, the victim arrived at the hospital’s emergency department. He was unresponsive, pulseless, and without spontaneous respirations. The placement of the endotracheal tube was re-checked and found to be in the proper position. His initial heart rhythm was asystole. ALS measures were continued for 5 minutes until 0045 hours, when he was pronounced dead.

Medical Findings. The death certificate was completed by the attending emergency department physician. The immediate cause of death was listed as “sudden cardiac death” due to “coronary artery disease” due to “diabetes mellitus.” No blood was sent for laboratory analysis; therefore, no carboxyhemoglobin levels, cardiac isoenzymes, or drug tests were available. No autopsy was performed.

In 1984, the victim was diagnosed with adult onset diabetes mellitus which was controlled with diet and oral medications. In 1990, the victim suffered a myocardial infarction (MI). Six weeks post-MI, he underwent an exercise treadmill test which technically did not meet criteria for ischemic change, but was positive for exercise-related arrhythmias (ventricular tachycardia and ventricular fibrillation) and sudden cardiac death from which he was successfully resuscitated by electrocardioversion (shock).



Fire-Police Officer Dies as a Result of a Cardiac Arrest at the Scene of a Motor Vehicle Accident - Pennsylvania

Subsequently, cardiac bypass surgery was performed followed by biannual exercise stress EKGs. His last stress test (persantine/thallium stress test) was performed 4 months prior to his death during a hospitalization for congestive heart failure (CHF). Results from that test showed a moderate amount of scarring from his previous myocardial infarction and a mild amount of myocardial ischemia (reduced blood supply to the heart).

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the fire department was comprised of 40 volunteers in one station serving a population of approximately 3,000 in a geographic area of 3 square miles. In 1998, the department responded to 373 calls: 117 structure fires, 102 automobile accidents, 51 automatic fire alarms, 34 emergency service, 18 vehicle fires, 13 nonstructure fire responses, 13 medical emergency responses, 9 wildland fires, 7 hazardous materials responses, 7 investigations, and 2 transfer assignments.

Training. The victim had 10 years of fire-police experience and was a certified Fire-Police Officer. The state does not require basic fire fighter certification training. The individual fire department is responsible for training based on its local requirements.

Medical Clearance and Physical Fitness. Prior to joining the department, all volunteers must complete an application for membership. A criminal background check is performed and is the only factor that would preclude membership. No questions address the applicant's medical history. Once a person becomes a member of the department, the department does require physician clearance for return to work following an absence for medical reasons. In September 1998, the victim requested

medical release to fire/police duties. The department does not have a specific medical clearance evaluation for respirator use, nor do they have a physical agility/fitness requirement for new or current fire fighters. However, they do require all fire fighters to pass an SCBA drill that is similar to the physical agility requirement.

DISCUSSION

This victim had an unwitnessed collapse. When paramedics arrived, the victim's heart rhythm was reported to be 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 increasing age, male gender, family history of CAD, smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes.² The victim had a few of these risk factors, had known CAD as evidenced by a previous MI, and had subsequent cardiac bypass surgery.

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 inflammatory process) predispose the plaque to

Fire-Police Officer Dies as a Result of a Cardiac Arrest at the Scene of a Motor Vehicle Accident - Pennsylvania

disruption.⁴ Disruption then occurs from biomechanical and hemodynamic forces, such as increased blood pressure, increased HR, 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

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.¹²⁻¹⁴ The mental and physical stress of responding to the MVA, his underlying atherosclerotic CAD, and his areas of myocardial ischemia documented by his stress test 4 months prior to this event, all 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. (If there is a heartbeat, an electrocardiogram [EKG] can also confirm a heart attack.)

In 1997, the National Fire Protection Association (NFPA) updated *Standard 1582, Medical Requirements for Fire Fighters*.¹⁵ 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 (> or = 70 percent lumen diameter narrowing), or successful myocardial revascularization."

Based upon this fire fighter's last stress test in August 1998, he would not meet these criteria.

RECOMMENDATIONS AND DISCUSSION

The following recommendations address preventative 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 research presented in the literature, regulations passed by enforcement 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. In addition, they are presented in a logical programmatic order, and



Fire-Police Officer Dies as a Result of a Cardiac Arrest at the Scene of a Motor Vehicle Accident - Pennsylvania

are not necessarily listed in order of priority. This preventative 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:

Recommendation #1: Individuals with medical conditions that would present a significant risk to the safety and health of themselves or others should be precluded from fire fighting and other emergency response activities.

NFPA 1582, Standard on Medical Requirements of Fire Fighters lists medical conditions that **should** (Category A) or **could** (Category B) preclude individuals from performing fire fighter activities.¹⁵ We recommend fire departments adopt these recommendations and share this standard (NFPA 1582) with physicians responsible for these decisions.

Recommendation #2: Emergency response personnel 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 1582, Standard on Medical Requirements for Fire Fighters*¹⁵, and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs wellness/fitness initiative.¹⁶

Recommendation #3: Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by offering a wellness/fitness program for emergency response personnel.

NFPA 1500, Standard on Fire Department Occupational Safety and Health Program requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.¹⁷ 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.¹⁸ Fire departments should review these materials to identify applicable elements for their department.

Recommendation #4 Carboxyhemoglobin levels should be tested on symptomatic or unresponsive emergency response personnel.

Unfortunately, a carboxyhemoglobin level was not done at the hospital; this would have provided a good assessment of the victim's exposure to carbon monoxide. Vehicle exhaust has been known to cause carbon monoxide poisoning. However, knowledge of his carboxyhemoglobin level would not have affected his treatment or outcome since he was already receiving oxygen and was pronounced dead minutes after arrival at the hospital. Nonetheless, we recommend performing carboxyhemoglobin levels to rule out carbon monoxide poisoning.

Recommendation #5: Perform an autopsy on all emergency response personnel who were fatally injured while on duty.

In 1995, the United States Fire Administration (USFA) published the *Firefighter Autopsy Protocol*.¹⁹ This publication hopes to provide "a



Fire-Police Officer Dies as a Result of a Cardiac Arrest at the Scene of a Motor Vehicle Accident - Pennsylvania

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."

REFERENCES

1. Fauci AS, Braunwald E, Isselbacher KJ, et al. [1998]. Harrison's principles of internal medicine. 14th ed. New York, NY: McGraw-Hill, pp. 222-225.
2. American Heart Association (AHA) [1998]. AHA scientific position, risk factors for coronary artery disease. Dallas, TX.
3. Fauci AS, Braunwald E, Isselbacher KJ, et al. [1998]. Harrison's principles of internal medicine. 14th ed. New York, NY: McGraw-Hill, p. 1348.
4. Shah PK [1997]. Plaque disruption and coronary thrombosis: new insight into pathogenesis and prevention. *Clin Cardiol* 20(11 Suppl2): II-38-44.
5. Fuster V, Badimon JJ, Badimon JH [1992]. The pathogenesis of coronary artery disease and the acute coronary syndromes. *N Eng J Med* 326:242-250.

6. Kondo NI, Muller JE [1995]. Triggering of acute myocardial infarction. *J Cardiovasc Risk* 2(6):499-504.
7. Opie LH [1995]. New concepts regarding events that lead to myocardial infarction. *Cardiovasc Drug Ther* 9 Suppl 3:479-487.
8. Willich SN, Lewis M, Lowel H, et al. [1993]. Physical exertion as a trigger of acute myocardial infarction. *N Eng J Med* 329:1684-1690.
9. Mittleman MA, Maclure M, Tofler GH, et al. [1993]. Triggering of acute myocardial infarction by heavy physical exertion. *N Eng J Med* 329:1677-1683.
10. Siscovick DS, Weiss NS, Fletcher RH, Lasky T [1984]. The incidence of primary cardiac arrest during vigorous exercise. *N Eng J Med* 311:874-877.
11. Tofler GH, Muller JE, Stone PH, et al. [1992]. Modifiers of timing and possible triggers of acute myocardial infarction in the Thrombolysis in Myocardial Infarction Phase II (TIMI II) Study Group. *J Am Coll Cardiol* 20:1049-1055.
12. Barnard RJ, Duncan HW [1975]. Heart rate and ECG responses of fire fighters. *J Occup Med* 17:247-250.
13. Manning JE, Griggs TR [1983]. Heart rate in fire fighters using light and heavy breathing equipment: simulated near maximal exertion in response to multiple work load conditions. *J Occup Med* 25:215-218.
14. Lemon PW, Hermiston RT [1977]. The human energy cost of fire fighting. *J Occup Med* 19:558-562.



Fatality Assessment and Control Evaluation
Investigative Report #99F-10

Fire-Police Officer Dies as a Result of a Cardiac Arrest at the Scene of a Motor Vehicle Accident - Pennsylvania

15. National Fire Protection Association [1997]. NFPA 1582: standard on medical requirements for fire fighters. Quincy, MA: National Fire Protection Association.
16. 29 CFR 1910.134. Code of Federal Regulations. Occupational Safety and Health Administration: Respiratory Protection. Washington, DC: National Archives and Records Administration, Office of the Federal Register.
17. National Fire Protection Association [1997]. NFPA 1500: standard on fire department occupational safety and health program. Quincy, MA: National Fire Protection Association..
18. International Association of Fire Fighters [1997]. The fire service joint labor management wellness/fitness initiative. Washington, DC: International Association of Fire Fighters, Department of Occupational Health and Safety.
19. United States Fire Administration (USFA) [1995]. Fire fighter autopsy protocol. Emmittsburg, MD: Federal Emergency Management Agency, USFA, Publication No. FA-156.

INVESTIGATOR INFORMATION

This investigation was conducted by and the report was written by Thomas Hales, MD, MPH, Senior Medical Epidemiologist; and Tommy N. Baldwin, MS, Safety and Occupational Health Specialist. Both investigators are with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component, located in Cincinnati, Ohio.