



September 5, 2007

Deputy Chief Suffers Sudden Cardiac Death after Responding to Two Incidents—North Carolina

SUMMARY

On November 29, 2006, a 38-year-old male volunteer deputy chief responded to his second fire in less than 2 hours then returned home, complaining of flank pain. Later that day, he was diagnosed with a kidney stone, admitted to the hospital for pain management, and scheduled for surgery (cystoscopy) the next morning. Just after midnight, hospital staff found him unresponsive in his bed. A code was called and despite advanced life support including external pacing, he could not be revived. No autopsy was performed. The death certificate completed by the attending physician stated the cause of death as “acute myocardial infarction” (heart attack).

The NIOSH investigator agrees with the conclusions of the attending physician. It is unlikely any of the following recommendations could have prevented the deputy chief’s death. However, NIOSH investigators offer these recommendations to reduce the risk of job-related heart attacks and sudden cardiac arrest among other fire fighters.

- *Provide mandatory pre-placement and annual medical evaluations to ALL fire fighters to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.*
- *Ensure that fire fighters are cleared for duty by a physician who is knowledgeable about the physical demands of fire fighting, the personal protective equipment used by fire fighters, and the various components of NFPA 1582 [NFPA 2007a].*
- *Provide fire fighters with medical clearance to wear self-contained breathing apparatus (SCBA) as part of the fire department’s medical evaluation program.*
- *Phase in a mandatory wellness and fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.*
- *Perform an annual physical performance (physical ability) evaluation to ensure that fire fighters are capable of performing the essential job tasks of structural fire fighting.*

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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INTRODUCTION AND METHODS

On November 30, 2006, a 38-year-old male volunteer deputy chief suffered a sudden cardiac death after responding to two fires, returning home, and then being admitted to the hospital for a kidney stone. On December 14, 2006, NIOSH contacted the affected fire department. On March 12, 2007, an occupational health nurse practitioner from the NIOSH Fire Fighter Fatality Investigation Team traveled to North Carolina to conduct an on-site investigation of the incident.

During the investigation, NIOSH personnel interviewed the following people:

- Fire chief
- Deputy chief's wife
- Fire department deputy chief
- Fire department safety officer

During the site visit, NIOSH personnel reviewed the following documents:

- Fire department policies and operating guidelines
- Fire department training records
- Fire department annual report for 2006
- Fire department incident reports
- Hospital records
- Medical records
- Death certificate

RESULTS OF INVESTIGATION

Incident. On November 29, 2006, at 1158 hours, a 38-year-old male volunteer deputy chief responded to a mutual aid call for a house

fire in a neighboring district. The call was cancelled at 1206 hours, and he returned to his home. At 0139 hours on November 30, 2006, the deputy chief and the fire chief responded to another call for a grass fire. When they arrived, the fire was approximately 20 × 20 feet in size. While wearing turnout gear, but no SCBA, the deputy chief pulled the hose approximately 20 feet and applied water for about 10 minutes, extinguishing the fire. The fire chief characterized their exertion as light to moderate. They returned to their fire station where they stowed the gear in preparation for the next call. Around 0300 hours, the deputy chief informed the fire chief that his back was hurting and he was returning home. The fire chief attributed the deputy chief's back pain to a hunting injury from about 3 weeks before.

The next morning, the deputy chief complained of lower left flank pain, which had prevented him from sleeping. Later that day he was examined by his primary care provider who immediately referred him to a urologist. A computerized tomography (CT) scan revealed an obstructive 4-mm kidney stone that would probably require surgical removal (cystoscopy) with a possible stent placement. The deputy chief was given a prescription for pain medicine and told to return the next morning for surgery. However, the pain became too severe and he was admitted to the hospital's emergency department for pain control and IV fluid resuscitation. No admission or pre-procedure electrocardiogram (EKG) was performed. His wife left the hospital at 2345 hours, at which time he was sleeping.

Around 0005 hours, a phlebotomist entered his room and found the deputy chief unresponsive and not breathing. A code was called. CPR was begun, and a cardiac monitor with defibrillator



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was attached, which showed asystole (no heart rhythm). Cardiac medications were administered, and he went into ventricular fibrillation (another heart rhythm incompatible with life). Defibrillation was attempted, but his heart rhythm returned to asystole. Over the next 1 hour and 20 minutes, advanced life support resuscitation efforts included more IV medications, additional defibrillations, and external cardiac pacing (rhythm regulation by electrical shocks), but he remained unconscious with no heart beat. At 0124 hours he was pronounced dead, and resuscitation efforts were discontinued.

Medical Findings. No autopsy was performed. The death certificate completed by the attending physician listed “acute myocardial infarction” as the cause of death.

The deputy chief had a history of hypertension diagnosed in 1999, and treated with anti-hypertensive medications. Approximately 3 weeks before his death, he had fallen 25 feet from a deer stand while hunting. Evaluation showed hematuria (blood in his urine); a CT scan and other x-rays were essentially normal. He was released with pain medicines and told to have a repeat urinalysis to ensure the hematuria had resolved.

On the day of his sudden cardiac death, the deputy chief reported left side and back pain. This was most likely due to his kidney stone but it is possible, although highly unlikely, that these symptoms represented referred pain from a heart attack.

The deputy chief exercised regularly, weighed 210 pounds and was 70 inches tall on admission to the hospital, giving him a body mass index (BMI) of 30.1 kilograms per square meter

(kg/m²). A BMI of 30.0 kg/m² to 39.9 kg/m² is considered obese [National Heart Lung and Blood Institute 2005]. He had a family history of cardiac disease; his father had died at age 41.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the fire department consisted of 35 active volunteer fire fighters. The one fire station served a population of 3,500 in a geographic area of 36 square miles. In 2006, the fire department responded to 354 calls: 25 structural fires, 24 woods fires, 34 motor vehicle incidents, 170 medical calls, and 101 other calls and incidents.

Membership and Training. The fire department requires all new fire fighter applicants to complete an application and an interview with the fire chief. During a 90-day probation, the recruits attend 72 hours of State-mandated training that certifies them as structural fire fighters. At that time, they are issued gear and pagers and allowed to ride the vehicles to responses. Fire fighter II-level classes are taught concurrently in the department during training sessions. The deputy chief was trained to level II and wildland level I. He also had EMT, and hazardous materials operations level. He had more than 4 years of volunteer fire experience with this department.

Pre-placement and Periodic Medical Evaluations. No pre-placement or periodic medical evaluations are required by this department. Fire fighters are encouraged to get a complete physical examination through their employer or at their own expense and provide a release form to the department. Medical clearance for SCBA use is not required. Fire



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fighters who are injured while volunteering are evaluated by and must be cleared for return-to-duty by their physician.

Fitness/Wellness Programs. No fitness or wellness programs and no aerobic or strength training equipment, are available at the station.

DISCUSSION

In the United States, atherosclerotic coronary artery disease (CAD) is the most common risk factor for cardiac arrest and sudden cardiac death [Meyerburg and Castellanos 2001]. Risk factors for its development include age over 45, male gender, family history of CAD, smoking, high blood pressure (systolic >140 millimeters of mercury [mmHg] or diastolic >90 mmHg), high cholesterol (total cholesterol >240 mg/dL), obesity or physical inactivity, and diabetes [AHA 1998; Jackson et al. 2001]. The deputy chief had three (possibly four) of these risk factors (male gender, family history, high blood pressure, and borderline obesity).

Narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades [Libby 2001]. However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion [Shah 1997]. 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 [Fuster et al. 1992]. This sudden blockage is primarily due to blood clots (thromboses) forming on top of atherosclerotic plaques.

The deputy chief's attending physician attributed his sudden death to a heart attack and an associated heart arrhythmia. Most life-threatening arrhythmias associated with heart

attacks occur during the 24 hours after symptoms first begin [Willich et al. 1993; Mittelman et al. 1993; Siscovick et al. 1984; Tofler et al. 1992]. Autopsy findings (thrombus formation), blood tests (cardiac isoenzymes), or EKG findings are required to confirm a heart attack. Since no autopsy was performed, cardiac isoenzymes were not drawn, and no EKG was performed before his collapse, we cannot definitively conclude that he had a heart attack. However, the clinical scenario is most consistent with this diagnosis.

Angina (chest pain) is the most common presenting symptom during a heart attack or ischemic heart disease. But, in many persons, the first evidence of CAD may be a heart attack or sudden death [Thaulow et al. 1993]. Since up to 20% of heart attacks are "silent" (i.e., painless), some persons may not experience angina with ischemia [Libby 2001]. Others experience "atypical" angina (e.g., indigestion, back pain, nausea/vomiting, or fatigue). In this case, back and left side pain may have been referred pain from his heart, but this is unlikely, given the finding of a kidney stone on CT scan.

Fire fighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations [Gledhill and Jamnik 1992]. 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 begins with responding to the fire scene and persists through the course of fire suppression activities [Barnard and Duncan 1975; Manning and Griggs 1983; Lemon and Hermiston 1977]. Even when energy costs are moderate (as measured by oxygen consumption) and work is performed in a thermoneutral environment, heart rates may be high (over 170 beats per



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minute) owing to the insulative properties of a fire fighter's personal protective clothing [Smith et al. 1995].

Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks [Willich et al. 1993; Mittelman et al. 1993; Siscovick et al. 1984; Tofler et al. 1992; Kales et al. 2007]. The deputy chief had performed at light to moderate exertional levels while extinguishing the grass fire approximately 21 hours before his sudden cardiac death [Ainsworth et al. 1993; AIHA 1971]. The physical stress of responding and fighting a fire in a person with underlying atherosclerotic CAD can contribute to sudden cardiac death.

Occupational Medical Standards for Structural Firefighting and the Use of the Exercise Stress Test to Screen for CAD. To reduce the risk of sudden cardiac arrest or other incapacitating medical conditions among fire fighters, the NFPA [2007a] has developed NFPA 1582 [NFPA 2007a]. NFPA 1582 [NFPA 2007a] recommends diagnostic screening for CAD via an exercise stress test for asymptomatic fire fighters over age 45 (55 for women) with two or more risk factors for CAD (family history of premature cardiac event, hypertension, diabetes mellitus, cigarette smoking, and hypercholesterolemia). This recommendation is consistent with recommendations from the AHA/ACC [2002] and the Department of Transportation [1987] regarding exercise stress tests in asymptomatic persons. Because the deputy chief was only 38 years old, an exercise stress test would not have been indicated by either NFPA or the American Heart Association/American College of Cardiology. Thus, even if this fire department was following

NFPA standards, it is unlikely his death could have been prevented at this time.

RECOMMENDATIONS

It is unlikely the following recommendations could have prevented the deputy chief's death. Nonetheless, the NIOSH investigators offer these recommendations to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. NIOSH recognizes the plans of the fire department to implement portions or all of the following recommendations.

Recommendation 1: Provide mandatory pre-placement and annual medical evaluations to ALL fire fighters 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 pre-placement and periodic medical evaluations and examinations for fire fighters can be found in NFPA 1582 [NFPA 2007a] and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs [IAFF/IAFC 2000] wellness/fitness initiative. The fire department is not legally required to follow the guidance provided in any of these documents.

The success of medical programs hinges on protecting the affected fire fighter. The fire department must (1) keep the fire fighters' medical records confidential, (2) provide alternate duty positions for fire fighters in rehabilitation programs, and (3) provide permanent alternate duty positions or other supportive or compensated alternatives if the



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fire fighter is not medically qualified to return to active fire fighting duties.

Recommendation 2: Ensure that fire fighters are cleared for duty by a physician who is knowledgeable about the physical demands of fire fighting, the personal protective equipment used by fire fighters, and the components of NFPA 1582 [NFPA 2007a].

Physicians who provide input regarding medical clearance for fire fighting duties should be knowledgeable about the physical demands of fire fighting and understand that fire fighters frequently respond to incidents in immediately dangerous to life and health environments. They should also be familiar with a fire fighter's personal protective equipment and the consensus guidelines published by NFPA 1582 [NFPA 2007a]. To ensure that physicians are aware of these guidelines, we recommend that the fire department or fire fighter provide the primary care providers with a copy of NFPA 1582 [NFPA 2007a].

We also recommend the fire department retain a physician to review all medical clearances. Return to work decisions require knowledge not only of the medical condition, but also of the fire fighter's job duties. Primary care providers may not be familiar with a fire fighter's job duties, or with guidance documents such as NFPA 1582 [NFPA 2007a]. In addition, they may consider themselves patient advocates and dismiss the potential public health impact of public safety officers who may be suddenly incapacitated. Therefore, we recommend that such a physician who has the final decision regarding medical clearance review all return-to-work clearances.

Recommendation 3: Provide fire fighters with clearance to wear self-contained breathing apparatus as part of the fire department's medical evaluation program.

The Occupational Safety and Health Administration (OSHA)'s *Revised Respiratory Protection Standard* requires employers to provide medical evaluations and clearance for employees using respiratory protection [29 CFR¹ 1910.134]. These clearance evaluations are required for private industry employees and public employees in States operating OSHA-approved State plans. North Carolina does operate an OSHA-approved State plan, therefore, public sector employers are required to comply with OSHA standards.

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

NFPA 1500 [1997b], *Standard on Fire Department Occupational Safety and Health Programs*, requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being NFPA 1500 [1997b]. The IAFF/IAFC joined in a comprehensive Fire Service Joint Labor Management Wellness/Fitness Initiative to improve fire fighters' quality of life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this

¹Code of Federal Regulations. See CFR in references.



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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 [IAFF, IAFC 2000]. Wellness programs have been shown to be cost effective, typically by - reducing the number of work-related injuries and lost work days [Maniscalco et al. 1999; Stein et al. 2000]. A similar cost savings has been - reported by the wellness program at the Phoenix Fire Department, where a 12-year commitment has resulted in a significant reduction in disability pension costs [City Auditor 1997].

The National Volunteer Fire Council and the United States Fire Administration [2004] published a comprehensive manual, *Health and Wellness Guide for the Volunteer Fire Service*. The guide provides suggestions for program initiation and features. This guide is useful not only for volunteer fire departments, but also small combination fire departments that could benefit from some type of fitness/wellness program. The fire department should implement this recommendation to ensure CAD risk factors are reduced and cardiovascular capacity is increased.

Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are capable of performing the essential job tasks of structural fire fighting.

NFPA 1500 [1997b] 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 of the standard.

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