



Assistant Chief Dies After Suffering Aortic Dissection During a Fire Alarm Response – Connecticut

SUMMARY

On December 25, 2003, a 51-year-old male career Assistant Chief (AC) responded to a supervisory (trouble) fire alarm in a five-story building. After walking up four flights of stairs to the fifth floor, he checked the smoke detector that was showing “trouble” on the alarm panel. Since no fire was present, he walked down the same stairs and exited the building. At the same time he complained of feeling “ill.” After returning to the fire station, he complained of severe back and chest pains and he was transported to a local hospital’s emergency department (ED) for evaluation. Testing revealed a possible aortic aneurysm dissection and he was flown to a regional hospital for surgery. Despite corrective surgery, 6 days post-operatively he suffered another heart attack (myocardial infarction). Despite being successfully resuscitated, he suffered anoxic brain damage. Life support machines were disconnected on December 31, 2003, and he was pronounced dead shortly thereafter. The death certificate, completed by the attending physician, listed “multi-organ system dysfunction” due to “cardiac arrest” as the immediate cause of death with “aortic dissection” as a significant condition. No autopsy was performed.

The first three recommendations are preventive measures recommended by other fire service groups to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. The fourth recommendation is made in accordance with fire service medical guidelines. The fifth recommendation addresses a potential safety issue related to this particular event. The final recommendation addresses the need to obtain vital medical information regarding this particular event.

- *Perform mandatory annual medical evaluations consistent with NFPA 1582 to determine fire fighters’ medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others*
- *Incorporate exercise stress tests into the FD’s periodic medical evaluation program*
- *Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity*
- *Discontinue routine annual electrocardiograms (EKG) unless medically indicated*
- *Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are physically 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 www.cdc.gov/niosh/firehome.html or call toll free 1-800-35-NIOSH



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- *Perform an autopsy on all on-duty fire fighter fatalities*

INTRODUCTION & METHODS

On December 25, 2003, a 51-year-old male AC died 6 days after suffering a dissecting aortic aneurysm during a fire alarm response. On January 26, 2004, NIOSH contacted the affected fire department (FD) to initiate the investigation. On June 21, 2004, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Connecticut to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed:

- The Fire Chief
- The Chief of the Occupational Health Division
- The AC's wife

During the site visit NIOSH personnel reviewed:

- FD policies and operating guidelines
- FD training records
- The FD annual report for 2003
- FD physical examination protocols
- Ambulance response report
- Hospital records
- Past medical records of the AC from the primary care physician (PCP)
- Death certificate

INVESTIGATIVE RESULTS

Incident. On December 25, 2003, the AC reported for work at 0730 hours. The morning was spent performing roll call and checking reports from the previous day. At 0909 hours, a supervisory fire alarm was received and C-10 (the AC) and C-200 [(ambulance with two fire fighter-emergency medical technicians (FF-EMTs))] responded. Arriving at the scene approximately 2 minutes later, the AC checked

the alarm panel, which revealed trouble with a smoke detector on the fifth floor. The AC and a crew member, wearing their station uniforms, walked up four flights of stairs to the fifth floor and checked the smoke detector. Finding no problem, the two walked back down the same stairs to the first floor. Upon exiting the building, the AC complained of feeling ill and, according to crew members, appeared ashen and out of breath.

Upon returning to the fire station, the AC complained of severe back and chest pains. At first, he refused transport to the hospital, hoping the pain would subside. After approximately 30 minutes (0957 hours), his pain increased and he consented to transport to the hospital.

A paramedic unit from the local hospital was notified, met the ambulance (C-200) enroute to the hospital, and began advanced life support (ALS) treatment including administering nitroglycerin, which relieved his chest pain. An intravenous (IV) line was begun. A second dose of nitroglycerin was administered with additional relief; however the AC became anxious and diaphoretic. His blood pressure (BP) was 142/108 millimeters of mercury (mmHg) and his pulse rate was 82 beats per minute. An electrocardiogram (EKG) revealed a "cardiac event." Oxygen was administered via non-rebreather mask. The ambulance arrived at the hospital's ED at 1021 hours.

Inside the ED, the AC's BP was 106/56 mmHg. Cardiac and pain medications were administered. A 12-lead EKG was performed revealing inferior and inferoposterior myocardial infarction (MI) and left ventricular hypertrophy (LVH). His initial troponin level (a blood test to determine if heart damage had occurred) was normal [less than 0.4 nanograms per milliliter (ng/mL) (normal range 0.0–0.05 ng/mL)]. A tentative diagnosis of acute coronary syndrome was made by the ED physician. Subsequently, a chest x-ray revealed cardiomegaly. At approximately 1230

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hours, a CT scan was performed, revealing a tear in the aorta (dissecting aortic aneurysm). He was flown to a regional hospital for further evaluation and treatment.

At the regional hospital, a transesophageal echocardiogram (TEE) revealed a Type 1 aortic dissection. An operation was immediately performed to repair the dissection. The dissection was successfully repaired, however, on December 29, 2003, while he was sitting up in bed and speaking to a nurse, he became unresponsive, his heart monitor showed no heart beat (asystole), and he suffered cardiac arrest (approximately 0520 hours). ALS resuscitation efforts began immediately and eventually restored the AC's hemodynamic status (approximately 0625 hours; 65 minutes later). However, EKG, cardiac isoenzymes, and echocardiograms all strongly suggested a new right ventricular infarction (heart attack) had occurred. Due to the length of the resuscitation effort, he suffered an extended period of time of no blood flow (oxygen) to his brain. The resulting anoxic brain damage with its very poor prognosis of recovery resulted in the family and physicians' decision to discontinue life support measures. The AC died at 1750 hours on December 31, 2003.

Medical Findings. The death certificate, completed by the attending physician, listed "multi-organ system dysfunction" due to "cardiac arrest" as the immediate cause of death with "aortic dissection" as a significant condition. No autopsy was performed. Medical records indicated the AC had been diagnosed with the following:

- hypertension in 1995: He was prescribed diet and two antihypertensive agents with variable compliance.
- hypercholesterolemia in 1991: He was prescribed diet, exercise, and cholesterol-lowering medication with variable compliance.

In 2002, his PCP suggested an exercise stress test (EST) to screen for ischemic heart disease due to multiple CAD risk factors. However, for unclear reasons, an EST was never performed. At his last physical examination, the AC was noted to be 5 feet, 6 inches tall and weighed 224 pounds, giving him a body mass index (BMI) of 36.2 kilograms per square meter (kg/m²). A BMI over 30 kg/m² is considered obese.¹ The AC had not expressed any signs or symptoms of chest pain or any other discomfort to his wife, co-workers, or health care providers prior to this incident.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the FD consisted of 54 uniformed career personnel and served a population of 25,000 in a geographic area of five square miles. There are two fire stations. Fire fighters, including the AC, work one of three shifts from 0730-0730 hours, and work 24 hours on-duty, 24 hours off-duty for six tours, then are off-duty for three days.

In 2003, the FD responded to 3,440 calls: 200 fires; 25 overpressure, rupture, explosion calls; 1475 rescue and medical calls; 300 hazardous condition calls; 850 false alarm/false calls; 250 good intent calls; 325 service calls; 10 special incident calls; and 5 weather related calls.

Training. The FD requires all new fire fighters to pass a pre-placement physical examination. The new fire fighter must be pre-certified to the level required by the vacant position (minimum of Fire Fighter I). All personnel are required to pass emergency vehicle operator course (EVOC) training prior to operating FD vehicles. Subsequent training is conducted on-shift. Fire fighters certified in hazardous materials (Hazmat), CPR, and EMT are recertified annually. The AC was certified as a Fire Fighter II, Fire Officer III, EMT, Driver/Operator, Hazmat Incident

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Command, Fire Inspector II, Fire Service Instructor II, and had 32 years of fire fighting experience.

Pre-placement Medical Evaluations. The FD requires a pre-placement medical evaluation for all new hires, regardless of age. Components of this evaluation include the following:

- History
- Vital signs
- Physical examination
- Blood tests: Complete Blood Count, Metabolic Profile, Lipid Profile, and Liver Function
- Urinalysis
- Pulmonary Function Test
- Resting EKG
- Chest x-ray
- Audiometry
- Vision test: distant and near vision
- Hepatitis B antibody
- Tuberculosis skin test

These evaluations are performed by the Installation physician, who makes a determination regarding medical clearance for fire fighting duties and forwards this decision to the FD.

Periodic Medical Evaluations. Periodic medical evaluations are required annually by this FD. Components of this are the same as the pre-placement evaluation, except a chest x-ray is performed at the discretion of the physician only if medically indicated. These evaluations are performed by the Installation physician, and the medical clearance decision for each examination is forwarded to the FD. If an employee is injured at work or ill and misses more than three shifts, the employee is evaluated and must be cleared for return to work by the Occupational Health clinic at the Installation. The input from the employee's primary care physician is considered at this point. As described earlier, the AC's last FD medical examination was in August, 2000. He was never restricted for duty.

Fitness/Wellness Programs. All fire stations have exercise (strength and/or aerobic) equipment. Participation in fitness training is voluntary. Wellness programs (smoking cessation, weight control, high blood pressure, diabetes, and cholesterol) are also offered by the Installation.

DISCUSSION

Aortic Dissection and the Pathophysiology of Sudden Death. Aortic dissection, a splitting of the aortic wall, is caused by a tear of the interior lining of the aorta (intima).²⁻⁴ The initiating event is either a primary intimal tear with secondary dissection into the media or a medial hemorrhage that dissects into, and disrupts, the intima. The pulsatile aortic flow then travels between the inner and outer surfaces creating a false lumen.²⁻⁴ Risk factors for aortic dissection include systemic hypertension and cystic medial necrosis.^{2,4}

The peak incidence is in the sixth and seventh decades. Men are more affected than women by a ratio of 2:1. The presentations of aortic dissection and its variants are the consequences of intimal tear, dissecting hematoma, occlusion of involved arteries, and compression of adjacent tissues. Acute aortic dissection typically presents with the sudden onset of pain, which is often described as very severe chest pain radiating to the back frequently associated with sweating (diaphoresis).^{2,4-6} Other symptoms include syncope, dyspnea, and weakness.²

Emergent or urgent surgical correction is the preferred treatment for ascending aortic dissections (type A). The overall in-hospital mortality rate after surgical treatment of patients with aortic dissection is reported to be 15% to 20%. The major causes of perioperative mortality and morbidity include myocardial infarction (as in this case), paraplegia, renal failure, tamponade, hemorrhage, and sepsis.^{2,4}

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Coronary Artery Disease (CAD) and the Pathophysiology of Sudden Cardiac Death. In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.⁷ 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.⁸ The AC had six of these risk factors (male gender, advanced age (>45 years old), smoking, high cholesterol, hypertension, and obesity/lack of regular physical activity).

Firefighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.⁹ Firefighting 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.¹⁰⁻¹² The AC had responded to the fire alarm and walked up and down four flights of stairs. This is considered “moderate work” typically requiring over 6 or 7 metabolic equivalents (METS).^{13,14}

The FD requires a pre-placement medical examination for all new hires and annual medical evaluations in accordance with NFPA 1582. However, the AC’s last annual FD medical evaluation was in 2000, almost 4 years prior to his death. In addition, no EST was included as part of this evaluation. NFPA 1582 recommends fire fighters with two or more risk factors for CAD undergo an EST.¹⁵

Use of Exercise Stress Tests (EST) to Screen for CAD. Both the 2000 and the 2003 edition of NFPA Standard 1582, allows “sub-maximal” EST.^{15,16} On the other hand, the American Heart Association and the American College of Cardiology (AHA/ACC)

“strongly prefer” maximal EST.¹⁷ Either one of these tests may have identified his underlying CAD disease, each leading to the possibility of further evaluation and treatment of his CAD.

Conducting EST on asymptomatic individuals is controversial. As mentioned above, NFPA Standard 1582 recommends that all fire fighters with two or more risk factors for CAD take an EST. This recommendation is for informational purposes only; it is not required. The Standard goes on to list the criteria for CAD risk factors: hypercholesterolemia (total cholesterol greater than 240 mg/dL), hypertension (diastolic blood pressure greater than 90 mm Hg), smoking, diabetes mellitus, or family history of premature CAD (heart attack or sudden cardiac death in a first-degree relative less than 60 years old).¹⁵

The AHA/ACC states that the evidence to conduct EST in asymptomatic individuals with diabetes mellitus is “Class IIa: there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy but the weight of the evidence/opinion is in favor.”¹⁷ The AHA/ACC goes on to say the evidence to conduct EST is “less well established” (Class IIb) for the following groups:

1. Persons with multiple risk factors (as a guide to risk-reduction therapy with the risk factors essentially the same as the NFPA listed above)
2. Asymptomatic men older than 45 years, and women older than 55 years:
 - Who are sedentary and plan to start vigorous exercise
 - Who are involved in occupations in which impairment might jeopardize public safety [e.g. fire fighters]
 - Who are at high risk for CAD due to other diseases (e.g. peripheral vascular disease and chronic renal failure)



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Another organization weighing in on the subject is the U.S. Department of Transportation (DOT). To obtain medical certification for a commercial drivers license, DOT recommends EST for drivers over the age of 45 with more than two CAD risk factors.¹⁸ Finally, the U.S. Preventive Services Task Force (USPSTF) does not recommend EST for asymptomatic individuals, even those with risk factors for CAD; rather, they recommend the diagnosis and treatment of modifiable risk factors (hypertension, high cholesterol, smoking, and diabetes).¹⁹ The USPSTF indicates that there is insufficient evidence to recommend screening middle age and older men or women in the general population but notes that “screening individuals in certain occupations (pilots, truck drivers, etc.) can be recommended on other grounds, including the possible benefits to public safety.”

RECOMMENDATIONS AND DISCUSSION

The first three recommendations are preventive measures recommended by other fire service groups to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. The fourth recommendation is made in accordance with fire service medical guidelines. The fifth recommendation addresses a potential safety issue related to this particular event. The final recommendation addresses the need to obtain vital medical information regarding this particular event.

Recommendation #1: Perform mandatory annual medical evaluations consistent with NFPA 1582 to determine fire fighters’ 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 evaluations and examinations for fire fighters can be found in NFPA 1582, Standard

on Comprehensive Occupational Medical Program for Fire Departments,¹⁵ and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.²⁰

The success of medical programs hinges on protecting the affected fire fighter. The FD must 1) keep the medical records confidential, 2) provide alternate duty positions for fire fighters in rehabilitation programs, and 3) provide permanent alternate duty positions or other supportive and/or compensated alternatives if the fire fighter is not medically qualified to return to active fire fighting duties.

Recommendation #2: Incorporate exercise stress tests into the FD’s medical evaluation program.

NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments, recommends EST for fire fighters with two or more risk factors¹⁵ and the IAFF/IAFC wellness/fitness initiative recommends EST at any age.²⁰ The AHA states EST may be indicated for individuals with two or more risk factors for CAD who are over 45 years of age. We suggest the FD use the AHA guideline to determine who should be required to undergo an EST and which protocol to follow (maximal or symptom-limiting EST). The EST could be conducted by the fire fighter’s personal physician (at FD expense) or the Installation physician. If the fire fighter’s personal physician conducts the test, the results must be communicated to the Installation physician, who should be responsible for decisions regarding medical clearance for fire fighting duties.

Recommendation #3: Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.

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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.²¹ The IAFF and the IAFC 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 and a video detailing elements of such a program.²⁰ Wellness programs have been shown to be cost effective, typically by reducing the number of work-related injuries and lost work days.²²⁻²⁴ 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.²⁵ The FD should implement this recommendation to ensure CAD risk factors are reduced and cardiovascular capacity is increased.

Recommendation #4: Discontinue routine annual electrocardiograms (EKG) unless medically indicated.

According to NFPA 1582, “periodic resting electrocardiograms have not been shown to be useful but can be reasonable as a member’s age increases.”¹⁵ The stress EKG is a much better tool to identify heart abnormalities. Therefore, only pre-placement EKGs are recommended unless medically indicated by other information. The EKGs being conducted by the FD represent an unnecessary expense for the FD and should be performed as medically necessary.

Recommendation #5: Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are physically

capable of performing the essential job tasks of structural fire fighting.

NFPA 1500 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 8-2.1.²¹ The FD should conduct annual physical ability tests to ensure the fire fighters are physically capable of performing fire fighting duties.

Recommendation #6: Perform an autopsy on all on-duty fire fighter fatalities.

In 1995, the United States Fire Administration (USFA) published the Firefighter Autopsy Protocol.²⁶ This publication hopes to provide “a more thorough documentation of the causes of firefighter deaths for three purposes:

- 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;
- 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
- to address an increasing interest in the study of deaths that could be related to occupational illnesses among firefighters, both active and retired.”

The FD should ensure an autopsy is conducted on all on-duty fatalities.

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