



Acting Fire Chief Suffers Heart Attack After Shift and Dies – Alaska

SUMMARY

On April 15, 2004, a 57-year-old male career Acting Fire Chief worked his normal 10-hour shift, during which he participated in union negotiations. Throughout the day, he complained of not feeling well, and, after going home, his symptoms worsened. He telephoned his fire station and requested transport to the hospital. Thirty-eight minutes later, as the ambulance arrived at the hospital's emergency department (ED), he suffered cardiac arrest. Despite advanced life support (ALS) performed by ambulance service emergency medical technicians (EMTs) and paramedics and hospital emergency department (ED) personnel, he died. The death certificate listed "cardiac event" as the immediate cause of death. No autopsy was performed.

The NIOSH investigator concluded that a heart attack was the most likely cause of death.

The first five 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 last recommendation is made to ensure adequate medical information is available on which to base prevention programs

- ***Provide pre-placement and periodic medical evaluations to ALL fire fighters consistent with NFPA 1582 to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others***
- ***Conduct exercise stress tests (EST) for fire fighters with two or more risk factors for coronary artery disease (CAD)***

- ***Provide fire fighters with medical evaluations and clearance to wear SCBA***
- ***Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity***
- ***Ensure the City-contract physician reviews all "return to work" clearances for both on and off-the-job injuries***
- ***Perform an autopsy on all on-duty fire fighter fatalities***

INTRODUCTION & METHODS

On April 15, 2004, a 57-year-old male Acting Fire Chief completed his 10-hour shift. Although he had not felt well during his shift, it was not until his shift ended and he was at home that he requested transport to the hospital. Despite ALS treatment by EMS personnel and at the hospital, the Chief died. NIOSH was notified of this fatality on April 19, 2004, by the United States Fire Administration. NIOSH

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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contacted the affected Fire Department (FD) on April 19, 2004 to initiate the investigation. On July 12, 2004, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Alaska to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed:

- The current Fire Chief
- The Fire Marshal
- Ambulance personnel
- The Acting Chief's wife

During the site visit NIOSH personnel reviewed:

- FD policies and operating guidelines
- FD training records
- FD annual report for 2003
- FD incident report
- Ambulance response report
- Hospital report
- FD physical examination protocols
- Death certificate
- Past medical records

INVESTIGATIVE RESULTS

Incident. On April 15, 2004, the Acting Fire Chief arrived for duty at fire headquarters at 0700 hours. Throughout the day, he was involved with union contract negotiations. He did not respond to any emergency calls on his shift. During the day, he complained of not feeling well and being fatigued. At approximately 1700 hours, the Chief left the station and went home.

At 1930 hours, the Chief telephoned his fire station and requested transport to the hospital. Medic 2 and Engine 31 responded and notified 911 via radio. Units arrived on the scene 9 minutes later finding the Chief sitting in a chair, pale, sweaty (diaphoretic), cold to the touch, and experiencing shortness of

breath, and neck and jaw discomfort. He was loaded onto a stretcher and placed inside Medic 2.

A cardiac monitor attached to the Chief's chest revealed normal sinus rhythm. His blood pressure (BP) was 71/41 millimeters of mercury (mmHg). He was given oxygen, an aspirin, and intravenous (IV) access was gained. Normal saline fluid challenge was administered via IV and he was positioned in a sitting position, which did not relieve the diaphoresis and wheezing. Medic 2 departed the scene at 1956 hours, arriving at the hospital's ED at 2008 hours. The Chief suffered cardiac arrest just prior to entering the ED.

Inside the ED, the Chief was unresponsive, had agonal respirations, and no palpable pulse. Cardiopulmonary resuscitation (CPR) was begun. A second IV was started, a cardiac monitor revealed asystole (no heart beat). Cardiac resuscitation medications were administered and cardiac pacing was performed, resulting in a spontaneous heart rhythm and a pulse rate of approximately 100 beats per minute for 60-90 seconds, then his heart rhythm reverted to ventricular fibrillation (Vfib) and he became pulseless again. He was defibrillated twice and a pulse returned for a short time. Becoming pulseless again, his heart rhythm reverted to pulseless electrical activity (PEA). CPR and ALS measures continued until 2049 hours, when he was pronounced dead and resuscitation measures were stopped.

Medical Findings. The death certificate, completed by the attending physician, listed "cardiac event" as the immediate cause of death. No autopsy was performed.

In the ED, blood tests to determine whether heart damage had occurred revealed normal levels of Troponin I [0.04 nanograms per milliliter (ng/mL) (normal range 0.0 – 0.05 ng/mL)] and CK-MB [0.9 ng/mL (normal range 0.00 – 3.6 ng/mL)]. An

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electrocardiogram (EKG) revealed tachycardia at a rate of 100 beats per minute with changes consistent with an acute anterolateral infarction. CK-MB levels begin to rise from 2-6 hours after onset of a heart attack and reach peak levels within 18 hours. Troponin levels begin to increase from 3-12 hours after onset of a heart attack and reach peak levels from 12 hours to 2 days.¹

The Chief, also an aircraft pilot, had annual medical evaluations in accordance with Federal Aviation Administration (FAA) guidelines since 1966. He had been diagnosed with the following:

- hypercholesterolemia in 1992: was prescribed cholesterol-lowering medication, diet, and exercise with fair control.
- hypertension in 1994: was prescribed blood-pressure lowering medication with excellent control.

Exercise stress tests (EST) were conducted in October 1997, November 1998, and December 1999 using the Bruce protocol. Most recently (1999), the Chief exercised for 9 minutes and 53 seconds, stopping due to shortness of breath. He achieved 12.9 metabolic equivalents (METs), which is considered good aerobic capacity (fitness).^{2,3} He did not develop chest pain, ischemic changes on his EKG, or arrhythmias, reaching a maximum heart rate of 136 (81% of maximum). The most recent lab results for cholesterol were slightly elevated in January 2004. The last FAA physical evaluation in February 2004 was unremarkable, revealing a blood pressure of 120/86 mmHg.

At the time of his death, the Chief weighed approximately 220 pounds and was 67 inches tall, giving him a body mass index (BMI) of 34.5 kilograms per square meter (kg/m²). A BMI over 30.0 kg/m² is considered obese.⁴ According to his

wife and crew members, the Chief did not have any prior episodes of chest pain or other heart-related symptoms.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the combination FD consisted of 34 career uniformed personnel and 75 volunteers that served a population of 31,000 in a geographic area of 2,717 square miles. There are five fire stations. The FD maintains four personnel on duty and responds to structure fires with two engines and an ambulance. Incoming personnel provide staffing on each successive engine and ladder. Fire fighters work the following schedule: 24 hours on-duty, 48 hours off-duty, 0800 hours to 0800 hours. Emergency Medical Service is a component of the FD.

In 2003, the FD responded to 3,059 calls: 30 structure fires; 32 vehicle fires; 17 brush/grass fires; 19 other fires; 27 trash fires; 54 hazardous condition calls; 2,193 emergency medical calls; 39 public service calls; 241 false calls; 207 good intent calls; 4 rupture/explosions; and 196 other calls.

Training. The FD requires all new career fire fighter applicants to be a Fire Fighter I, pass a written general knowledge test, oral board interview, physical ability test, Fire Chief interview, and a psychological exam prior to being given a condition of employment. Newly hired fire fighters are on probation for 6 months. They are assigned one-on-one training with a senior fire fighter and then work individually for an additional 6 months. The new fire fighter is evaluated at 1 year to determine whether to continue employment.

Volunteer fire fighter candidates must pass an oral board interview and a physical ability test, and enroll in a 160-hour Fire Fighter I program.

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Recurrent training occurs daily on each shift. There is no State minimum requirement for fire fighter certification or recertification. The State does provide training in Firefighter I and II; Fire Service Instructor I, II, III, and IV; Marine Shipboard Firefighter; Marine Fire Instructor; Fire Investigator I and II; Basic Aircraft Rescue Firefighter; Company Officer; Fire Officer I; Industrial Fire Brigade (two levels); and Rural Fire Protection Specialist. Each fire department has individual requirements for fire fighter certification. The Chief was certified as a Fire Fighter I and an Emergency Medical Technician and had 33 years of fire fighting experience.

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

- A complete medical history
- Vital signs
- Physical examination
- Pulmonary function test (PFT)
- Resting EKG
- Complete blood count (CBC)
- Audiogram
- Vision screen

These evaluations are performed by a City-contracted physician. Once this evaluation is complete, the physician makes a determination regarding medical clearance for fire fighting duties and forwards this decision to the City's personnel director.

Periodic Medical Evaluations. Beginning in 2004, annual fire fighter physical examinations are no longer provided due to budgetary constraints. Medical clearance for self-contained breathing apparatus (SCBA) use and for fire suppression is not currently required.

Employees injured at work may be required to obtain an evaluation from their personal physician. The

physician forwards the return to work recommendation to the FD, which makes the final determination.

Fitness/Wellness Programs. There is a voluntary wellness/fitness program for fire fighters. The City employs a full-time wellness nurse to coordinate health and wellness programs. Exercise (strength and aerobic) equipment is available in the fire station. The Chief exercised regularly by walking on a treadmill and lifting weights.

DISCUSSION

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.⁵ Risk factors for its development include increasing age, male gender, family history of coronary artery disease, smoking, high blood pressure (systolic >140 mmHg or diastolic > 90 mmHg), high blood cholesterol (total cholesterol > 240 mg/dL), obesity/physical inactivity, and diabetes.⁶ The Chief had five of these risk factors (increasing age, male gender, high blood pressure, high blood cholesterol, and obesity).

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.⁷ However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.⁸ 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.⁹ This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques.

The Chief suffered a probable heart attack, also known as myocardial infarction (MI). The term "probable" is used because autopsy findings

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(thrombus formation), blood tests (cardiac isoenzymes), or ECG findings are required to confirm a MI. No autopsy was performed and the Chief died prior to the cardiac isoenzymes becoming positive. However, the EKG was consistent with an acute anterolateral MI. Another explanation for the Chief's sudden cardiac death could be dissected aortic aneurysm. He had a positive family history of aortic aneurysm, but chest CT scans and ultrasounds several years prior to his death were negative. Although it cannot be ruled out without an autopsy, we feel this is an unlikely diagnosis.

Angina is the most common presenting symptom of myocardial ischemia and underlying CAD; the Chief's symptoms (neck and jaw pain, chest pressure) were consistent with angina.

RECOMMENDATIONS

Recommendation #1: Provide pre-placement and periodic medical evaluations to ALL fire fighters consistent with NFPA 1582 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 evaluations and examinations for fire fighters can be found in NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments,¹⁰ and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.¹¹ The FD is not legally required to follow any of these standards.

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: Conduct exercise stress tests (EST) for fire fighters with two or more risk factors for coronary artery disease (CAD).

NFPA 1582 and the IAFF/IAFC wellness/fitness initiative recommend EST for fire fighters with two or more CAD risk factors.^{10,11} The AHA states EST may be indicated for individuals with two or more risk factors for CAD who are over 45 years of age.¹² The EST could be conducted by the fire fighter's personal physician or the City contract physician. If the fire fighter's personal physician conducts the test, the results must be communicated to the City physician, who should be responsible for decisions regarding medical clearance for fire fighting duties.

The American College of Cardiology/American Heart Association (ACC/AHA) recommends conducting EST with increasing speed AND **grade** terminating when symptoms appear, rather than an arbitrary percentage of predicted maximal heart rate.¹³ Exercise testing should be supervised by an appropriately trained physician. Symptom-limited testing with the Borg scale as an aid is very important when the test is used to assess functional capacity.

Although the FD did not require EST, the Chief did have EST to maintain his FAA pilot's license. It is unclear why he hadn't had an EST since 1999.

Recommendation #3: Provide fire fighters with medical evaluations and clearance to wear SCBA.

OSHA's Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employees using respiratory protection.¹⁴ This includes fire fighters who utilize



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SCBA while performing their duties. These clearance evaluations are required for private industry employees and public employees in states operating OSHA-approved State plans. Alaska is a state-plan state, therefore, public sector employers must comply with OSHA standards. We have provided the FD with a copy of the OSHA-approved respiratory protection clearance form and recommend the FD provide SCBA clearance medical evaluations.

Recommendation #4: 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. Physical inactivity, or lack of exercise, is associated with other CAD risk factors, namely obesity and diabetes.¹⁵ 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.¹⁶ NFPA 1583, Standard on Health-Related Fitness Programs for Fire Fighters, provides the minimum requirements for a health-related fitness program.¹⁷ 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.¹¹ The FD and the Union should review these materials to identify applicable elements for their Department and implement a mandatory program. Other large-city negotiated programs can also be reviewed as potential

models. Wellness programs have been shown to be cost effective, typically by reducing the number of work-related injuries and lost work days.¹⁸⁻²⁰ 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 their disability pension costs.²¹

Recommendation #5: Ensure the City-contract physician reviews all “return to work” clearances for both on- and off-the-job injuries.

NFPA 1582 requires the FD physician to review and approve medical evaluations conducted by a physician or medical provider other than the FD physician.¹⁰ NFPA 1582 also recommends protocols that require physician evaluation following specific lengths of absence from duty and/or certain medical conditions that require the FD physician to evaluate a member.¹⁰

Currently, the primary care physician provides medical clearance for return to work in this FD. The FD should ensure the FD physician reviews all return to work clearances to ensure continuity and increased safety and health.

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.²² This publication hopes to provide “a more thorough documentation of the causes of firefighter deaths for the following 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;

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- 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 fire fighter fatalities.

REFERENCES

1. Antman EM and Braunwald E [2001]. Acute myocardial infarction. In: Braunwald E, Zipes DP, Libby P, eds. Heart Disease. 6th Edition. Philadelphia: Saunders. p. 1132.
2. WorldAR [2002]. Bruce treadmill protocol. World Wide Web (Accessed March 2004). Available from <http://www.worldar.com/endurance/bruce.htm>
3. ExRx.net [2004]. Maximum treadmill cardiovascular test. World Wide Web (Accessed March 2004). Available from <http://www.exrx.net/Calculators/Treadmill.html>
4. National Heart Lung Blood Institute [2004]. Obesity education initiative. World Wide Web (Accessed March 2004). Available from <http://www.nhlbisupport.com/bmi/bmicalc.htm>
5. Meyerburg RJ, Castellanos A [2001]. Cardiovascular collapse, cardiac arrest, and sudden cardiac death. In: Braunwald E, Fauci AS, Kasper DL, Hauser SL, Longo DL, Jameson JL, eds. Harrison's principles of internal medicine. 15th Edition. New York: McGraw-Hill. pp. 228-233.

6. AHA [1998]. AHA Scientific Position, Risk Factors for Coronary Artery Disease. Dallas, TX: American Heart Association.
7. Libby P [2001]. The pathogenesis of atherosclerosis. In: Braunwald E, Fauci AS, Kasper DL, Hauser SL, Longo DL, Jameson JL, eds. Harrison's principles of internal medicine. 15th Edition. New York: McGraw-Hill. p.1378.
8. Shah PK [1997]. Plaque disruption and coronary thrombosis: new insight into pathogenesis and prevention. Clin Cardiol 20 (11 Suppl2): II-38-44.
9. 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.
10. NFPA [2003]. Standard on comprehensive occupational medical program for fire departments. Quincy MA: National Fire Protection Association. NFPA 1582.
11. IAFF, IAFC. [2000]. The fire service joint labor management wellness/fitness initiative. Washington, D.C.: International Association of Fire Fighters, International Association of Fire Chiefs.
12. Gibbons RJ, Balady GJ, Bricker JT, et al. [2002]. ACC/AHA 2002 guideline update for exercise testing: Summary Article: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1997 Exercise Testing Guidelines). eds. Circulation 106:1883-1892.
13. American College of Cardiology/American Heart Association [2002]. Guideline update for exercise testing: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise



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Testing). Gibbons RJ, Balady GJ, Bricker JT, et al., eds. American College of Cardiology web site. Available at: www.acc.org/clinical/guidelines/exercise/dirIndex.htm

14. CFR. 29 CFR 1910.134, Respiratory protection. Code of Federal Regulations. Washington, DC: National Archives and Records Administration, Office of the Federal Register.

15. Plowman SA and Smith DL [1997]. Exercise physiology: for health, fitness and performance. Boston, MA: Allyn and Bacon.

16. NFPA [2002]. Standard on fire department occupational safety and health program. Quincy MA: National Fire Protection Association. NFPA 1500.

17. NFPA [2000]. Standard on health-related fitness programs for fire fighters. Quincy MA: National Fire Protection Association. NFPA 1583.

18. Maniscalco P, Lane R, Welke M, Mitchell J, Husting L [1999]. Decreased rate of back injuries through a wellness program for offshore petroleum employees. *J Occup Environ Med* 41:813-820.

19. Stein AD, Shakour SK, Zuidema RA [2000]. Financial incentives, participation in employer

sponsored health promotion, and changes in employee health and productivity: HealthPlus health quotient program. *JOEM* 42:1148-1155.

20. Aldana SG [2001]. Financial impact of health promotion programs: A comprehensive review of the literature. *Am J Health Promot* 15:296-320.

21. Unpublished data [1997]. City Auditor, City of Phoenix, AZ. Disability retirement program evaluation. Jan 28, 1997.

22. United States Fire Administration [1995]. Firefighter Autopsy Protocol. Emmitsburg: Federal No. FA-156.

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