



Fire Fighter Dies While Exercising - Florida

SUMMARY

On August 29, 2001, a 36-year-old male career Captain was walking around a parking lot as part of his exercise routine. He heard his station being dispatched to a call and proceeded to run toward his station. After taking a few steps, he had a witnessed collapse. Approximately 63 minutes later, despite cardiopulmonary resuscitation (CPR) and advanced life support (ALS) administered on the scene and at the hospital, the victim died. An autopsy, conducted by the Associate Medical Examiner, listed “arteriosclerotic and hypertensive heart disease” as the cause of death.

The following recommendations address some general health and safety issues. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These selected recommendations have not been evaluated by NIOSH, but they represent published research or consensus votes of technical committees of the National Fire Protection Association (NFPA) or fire service labor/management groups.

- *Provide **mandatory 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.***
- *Provide fire fighters with medical evaluations and clearance to wear SCBA.*
- *Implement a mandatory wellness/fitness program.*

- *Provide exercise equipment in all fire stations.*

INTRODUCTION & METHODS

On August 29, 2001, a 36-year-old male Captain lost consciousness while exercising. Despite CPR and ALS administered by crew members, the ambulance crew, and personnel in the hospital’s emergency department (ED), the victim died. NIOSH was notified of this fatality on August 30, 2001, by the United States Fire Administration. On September 5, 2001, NIOSH contacted the affected Fire Department to initiate the investigation. On April 1, 2002, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Florida to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed the

- Fire Chief,
- Personnel Chief
- Crew members on duty with the victim
- Victim’s wife

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**



Fire Fighter Dies While Exercising - Florida

During the site visit NIOSH personnel reviewed the following:

- Fire Department policies and operating guidelines
- Fire Department training records
- Fire Department annual report for 2001
- Fire Department incident report
- Dispatch records
- Witness statements
- Emergency medical service (ambulance) incident report
- Hospital emergency department report
- Fire Department physical examination protocols
- Death certificate
- Autopsy record
- Past medical records of the deceased

INVESTIGATIVE RESULTS

Incident. On August 29, 2001, the victim reported for work at Station 14, which housed Engine 14, Engine 14A, Ladder 14, Rescue 14, and Battalion 2, at approximately 0730 hours. Before the victim began his shift at 0800 hours, Engine 14 and Rescue 14 were dispatched to a traffic accident. After returning to the station, the crew later rotated 450 feet of 3-inch and 2½-inch hoseline on Engine 14. Between 0947 hours and 1414 hours, Engine 14 was dispatched to three medical calls.

At 1602 hours, Engine 14, Engine 14A, Engine 19, Ladder 14, Battalion 2, and Rescue 74 were dispatched to a fire on a balcony of a three-story wood-frame building. Wearing full turnout gear and carrying hand tools, the victim and one crew member advanced to the third floor. Once on the balcony, they hoisted a booster line to their location. While the fire was being extinguished, the victim used a Halligan bar and axe to remove sheet rock and stucco from the wall to check for fire spread. The fire was declared under control and units returned to their stations.

Between 1711 hours and 1828 hours, Engine 14 was dispatched to a traffic accident, a medical call, and a lock-in. At approximately 1845 hours, the crew ate dinner, and afterwards the victim left the station for his evening walk/exercise. The current temperature was 79E Fahrenheit (F) and the humidity was 93%; the daytime temperature had been 91E Fahrenheit (F) and the humidity had been 66%. He would typically walk/jog for approximately 45 minutes to 1 hour around a nearby parking lot.

At 2016 hours, Engine 14A was dispatched to a traffic accident and responded at 2018 hours. The dispatch tones for Engine 14 and 14A are the same. The response sheet (tear and go) identifies which apparatus is to respond. The victim, hearing the dispatch tones and Engine 14A leave the station, began running toward Station 14, probably to determine which unit would be responding.

After going a short distance, the victim collapsed. Two civilians saw the victim collapse and went to his aid. One person checked the victim while the other ran to Station 14 to alert the remaining crew members. The Battalion Chief notified Dispatch of the situation (2021 hours) while crew members ran to the parking lot, where they found the victim to be unresponsive, pulseless, and with agonal breaths. CPR (chest compressions and assisted ventilations via bag-valve-mask) was initiated. Rescue 74, which just happened to be at Station 14 for fuel, also assisted. A cardiac monitor was attached to the victim which revealed ventricular fibrillation (V.Fib.) and one shock (defibrillation) was administered. The victim's pulse returned for less than 1 minute. The cardiac monitor again revealed V.Fib. and three additional shocks were delivered with no change in patient status. The victim was intubated and intravenous access was established. The cardiac monitor again revealed V.Fib. and a fifth shock was administered. Medications consistent with ALS protocols were



Fire Fighter Dies While Exercising - Florida

given while CPR continued. A sixth shock was administered and the victim's heart rhythm reverted to pulseless electrical activity (PEA). The victim was placed onto a long spine board and loaded into Rescue 74. Once inside the Rescue, the cardiac monitor revealed V.Fib. and the victim was defibrillated a seventh time. Rescue 74 departed the scene at 2035 hours and he was defibrillated an eighth time while en route to the hospital.

Rescue 74 arrived at the emergency department at 2043 hours. Inside the ED, CPR and ALS continued. A cardiac monitor revealed asystole (no heartbeat). At 2123 hours the victim was pronounced dead by the attending physician, and CPR/ALS was discontinued.

Medical Findings. The autopsy, performed by the Associate Medical Examiner on August 30, 2001, listed "arteriosclerotic and hypertensive heart disease" as the cause of death. A carboxyhemoglobin level (to assess the victim's carbon monoxide exposure) was measured at 0%. Pertinent findings from the autopsy included the following:

- Cardiomegaly (an enlarged heart weighing 700 grams) (normal < 400 grams)
- Biventricular dilatation
- Left ventricular hypertrophy with patchy fibrosis
- Scarring consistent with a remote (old) heart attack (myocardial infarction)
- Moderate to severe occlusive coronary artery disease (CAD)
 - 20-75% diffuse narrowing of the left anterior descending coronary artery
 - 40% focal proximal narrowing of the left circumflex
- Moderate obesity (Body Mass Index of 43 kilograms per square meter [kg/m^2] [normal #26 kg/m^2])

The Fire Fighter had the following risk factors for coronary artery disease (CAD): male gender and obesity. The victim was not currently prescribed any medications. In May 2000, the victim had a physical examination given by his private physician. The exam revealed moderate obesity, an elevated blood pressure of 150/100 mmHg (millimeters of mercury) (normal < 140/90), an elevated cholesterol (LDL cholesterol of 149mg/dl [milligrams per deciliter][normal < 130] and total cholesterol of 238 [mg/dl] [normal < 200]), and elevated triglycerides of 207 mg/dl (normal < 200). In June 2000, his private physician diagnosed the victim with hyperlipidemia to be treated via dietary restrictions (not prescription medications).

According to his family, coworkers, and crew members, the victim had no complaints of chest pains or any other heart-related illness. There was no family history of heart disease. The victim also worked a full-time, regular schedule as coordinator of the Fire Science program at a local college. During the 2 weeks before the incident, he did not report any symptoms suggestive of angina or heart problems to his family or coworkers. The day of the incident, the victim reported for duty and worked a normal shift while responding to eight calls.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the combination Fire Department consisted of 662 uniformed career personnel and 210 volunteers and served a population of 654,000 residents in a geographic area of 931 square miles. There are 41 fire stations (27 career, 7 volunteer, 2 combination, and 5 stand-alone Rescue stations). Fire fighters work the following schedule: 24 hours on duty and 48 hours off duty, from 0800 hours to 0800 hours.



Fire Fighter Dies While Exercising - Florida

In 2001, the Department responded to 62,777 calls: 39,277 medical calls, 7,350 traffic accidents, 4,734 investigations, 3,848 assistance calls, 2,310 critical care transports, 2,025 brush fires, 2,010 structure fires, 1,041 vehicle fires, 113 hazardous materials calls, 50 MERT calls, 17 other calls, and 2 extrication calls.

The victim was Captain on Engine 14. In 2001, Engine 14 was the busiest unit 4 months out of the year and was the second busiest the remaining 8 months of the year, responding to 3,170 calls. Engine 14 and Engine 14A, both housed at Station 14, were the busiest units for 11 months in 2001.

Training. The Fire Department requires all new career fire fighter applicants to be State-certified Fire Fighter/EMTs or Paramedics, pass a background check, a driver's license check, pass a Task Readiness (physical ability test), pass a written exam based on the position and certification required, and pass an interview before being selected. The newly hired fire fighters must then pass a preplacement physical examination. The fire fighter must obtain any remaining certification to become a Fire Fighter/Paramedic within 2 years of being hired. Recurrent training occurs on each shift.

Volunteer fire fighter applicants must pass a background check, a driver's license check, and complete a medical screening before being selected as a member. The fire fighter must then pass a 40-hour training course. Recurrent training occurs weekly. The volunteer Fire Chief oversees volunteer fire fighter training.

The State minimum requirement for career fire fighter certification is 440 hours plus the EMT course. There is no State requirement for fire fighter recertification. Any fire fighter must remain active within a 3-year time frame to maintain certification. EMT/Paramedics recertify every 3 years (State requirement) and

hazardous materials technicians recertify every 3 years (Fire Department requirement). The victim was certified as a Fire Fighter II, Driver/Engineer, EMT, and Fire Service Instructor, and he had 18 years of fire fighting experience (15 years of career and 3 years of volunteer).

Preplacement Evaluations. The Fire Department requires a preplacement medical evaluation for all new hires, regardless of age. The components of this evaluation are listed below:

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Blood tests:SMAC
 - complete blood count with differential (CBC), chemistry, lipid, and liver profile cholinesterase
- Urine tests: urinalysis drug screen
- Spirometry
- Resting electrocardiogram (ECG)
- Stress electrocardiogram (Stress ECG)
- Chest X-ray
- Audiogram
- Vision test
- Skin test for tuberculosis (PPD)
- Baseline carbon monoxide level

In accordance with the State presumptive law (in effect since 1995), the County also requires that the candidate have a viral hepatitis screen (A, B, C) performed and be vaccinated for Hepatitis A and Hepatitis B. A tuberculosis screen is performed every 6 months.

These evaluations are performed by a local medical clinic under contract with the County. Once this evaluation is complete, a decision regarding medical clearance for fire fighting duties is made by the examining physician and forwarded to the FD.



Fire Fighter Dies While Exercising - Florida

The Fire Department requires all career fire fighter candidates to complete a timed performance evaluation of typical fire fighting duties (Task Readiness) (physical ability test). No medical clearance is required before the Task Readiness evaluation.

Periodic Evaluations. Periodic medical evaluations are not required by this FD except for hazardous materials technicians. These specially trained fire fighters have a periodic medical evaluation every 18 months consisting of

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Blood tests: SMAC
complete blood count with differential (CBC), chemistry, lipid, and liver profile cholinesterase
- Urine tests: urinalysis drug screen
- Spirometry
- Resting electrocardiogram (ECG)
- Chest X-ray
- Audiogram
- Vision test
- Skin test for tuberculosis (PPD)

These evaluations are performed by a local medical clinic under contract with the County. Once this evaluation is complete, a decision regarding medical clearance for fire fighting duties is made by the examining physician and forwarded to the FD.

The Fire Department requires all career fire fighters to complete an annual Task Readiness evaluation. No medical clearance is required before the Task Readiness evaluation.

The County will implement a voluntary wellness program beginning in August 2002 which will include

an annual physical examination and nutrition and wellness information. Components of the examination vary based on job tasks of the employee. This program will be performed by the same medical clinic performing the preplacement and HazMat medical evaluations.

Medical clearance for SCBA use is not conducted by this FD. If an employee is injured at work, he/she must be cleared for return to work by the contract physician. In addition, if a fire fighter has a nonoccupational injury or medical condition, the employee must be cleared for return to work by the private physician unless return to work is an issue. In that case, return to work is determined by the contract physician.

No mandatory fitness program exists. Most fire stations have exercise (strength) equipment. The victim exercised at least 3 days per week, fast-pace walking and weight training. He also worked out with a punching bag, skied, and performed scuba diving.

DISCUSSION

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.¹ Risk factors for its development include age over 45, male gender, family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes.^{2,3} The victim had only two of these risk factors (male gender and obesity), yet his autopsy revealed CAD, scarring consistent with an old heart attack, and patchy fibrosis consistent with ischemic heart disease. By all accounts, the victim never reported symptoms of angina (e.g., chest pain on exertion), or congestive heart failure (e.g., shortness of breath on exertion, swollen



Fire Fighter Dies While Exercising - Florida

ankles). Unfortunately, sudden cardiac death is often the first overt manifestation of ischemic heart disease.⁴⁻⁶

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. No thrombus was present at autopsy; however, there was an irregular scar on the anterior interventricular septum and patchy fibrosis in the left ventricular myocardium, suggesting his acute demise was due to an arrhythmia associated with his underlying cardiomyopathy, and not a heart attack.

Fire fighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.¹⁰ Fire fighting activities are strenuous and often require fire fighters to work at near maximal heart rates for long periods. The increase in heart rate has been shown to begin with responding to the initial alarm and persist through the course of fire suppression activities.¹¹⁻¹³ Before his collapse, the victim had rotated out fire hose, responded to eight calls (including a structure fire), and exercised during his shift. This is considered a moderate-heavy level of physical exertion.¹⁴

The victim's autopsy also revealed biventricular dilatation, left ventricular hypertrophy, and an enlarged heart. These findings are probably due to ischemic cardiomyopathy, a condition in which CAD results in severe myocardial dysfunction.¹⁵ In addition, the Associate Medical Examiner also considered his left ventricular hypertrophy due to hypertension (high blood pressure), despite his young age and mildly

elevated blood pressures noted during his physician visits.

To reduce the risk of sudden cardiac arrest and heart attacks among fire fighters, the NFPA has developed the NFPA 1582 guideline entitled *Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians*.¹⁶ NFPA 1582 recommends a yearly physical evaluation to include a medical history, height, weight, blood pressure, and visual acuity test.¹⁶ NFPA 1582 recommends a thorough examination to include vision testing, audiometry, pulmonary function testing, a complete blood count, urinalysis, and biochemical (blood) test battery be conducted on a periodic basis according to the age of the fire fighter (less than 30: every 3 years; 30-39: every 2 years; over 40 years: every year). The FD does not currently offer periodic physical evaluations to all fire fighters.

NFPA 1582 also recommends fire fighters over the age of 35 with risk factors for CAD be screened for obstructive CAD by an EST.¹⁶ Unfortunately, the EST has problems with both false negatives (inadequate sensitivity) and false positives (inadequate specificity), particularly for asymptomatic individuals (individuals without symptoms suggestive of angina), young men, and women.^{17,18} This has led other expert groups to **not** recommend EST for asymptomatic individuals without risk factors for CAD.^{19,20}

When these asymptomatic individuals **have** risk factors for CAD, however, recommendations vary by organization. The American College of Cardiology/American Heart Association (ACC/AHA) identifies two groups for EST: (1) men over the age of 40 with a history of cardiac disease (as a screening test before beginning a strenuous exercise program), and (2) men over age 40 with one or more risk factors.¹⁹ They define five risk factors for CAD: hypercholesterolemia (total cholesterol > 240 mg/dL), hypertension (systolic >140 mm Hg or diastolic



Fire Fighter Dies While Exercising - Florida

> 90 mm Hg), smoking, diabetes, and family history of premature CAD (cardiac event in first-degree relative < 60 years old).¹⁸ 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).²⁰

These recommendations change for individuals who might endanger public safety if an acute episode were experienced or those who require high cardiovascular performance such as police and fire fighters. The NFPA recommends fire fighters without CAD risk factors get their first EST at age 40; for those with one or more CAD risk factors, at age 35.¹⁶ NFPA considers CAD risk factors to be family history of premature (< age 55) cardiac event, hypertension, diabetes mellitus, cigarette smoking, and hypercholesterolemia (total cholesterol > 240 or HDL cholesterol < 35).¹⁶ The EST should then be performed on a periodic basis, at least once every 2 years.¹⁶ The ACC/AHA indicates that the data are insufficient to justify periodic EST in people involved in public safety; however, as mentioned previously, they recommend that men over age 40 with a history of cardiac disease be screened before beginning a strenuous exercise program.¹⁹ Fire suppression activities involve strenuous physical activity; therefore, the ACC/AHA seem to be making a distinction between those already engaged in strenuous physical activity (conditioning), and those **beginning** a strenuous exercise program. The USPSTF indicates that the evidence is insufficient to recommend screening middle-age and older men or women in the general population; however, “screening individuals in certain occupations (pilots, truck drivers, etc.) can be recommended on other grounds, including the possible benefits to public safety.”²⁰

Since the victim had borderline risk factors for CAD (hypertension and cholesterol) and he was under 40 years old, even if NFPA 1582 were being followed, an EST would not have been indicated. However, if an EST would have been performed, it is possible his cardiac condition would have been identified and referred for further evaluation and treatment.

RECOMMENDATIONS

The following recommendations address health and safety generally. However, it is unclear if any of these recommendations could have prevented the sudden cardiac arrest and subsequent death of this fire fighter. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These recommendations have not been evaluated by NIOSH, but they represent published research or consensus votes of technical committees of the NFPA or fire service labor/management groups.

Recommendation #1: Provide mandatory 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 periodic medical evaluations and examinations for fire fighters can be found in NFPA 1582, *Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians*,¹⁶ and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.²¹

In addition to providing guidance on the frequency and content of the medical evaluation, NFPA 1582



Fire Fighter Dies While Exercising - Florida

provides guidance on medical requirements for persons performing fire fighting tasks. NFPA 1582 should be applied in a **confidential, nondiscriminatory** manner. Appendix D of NFPA 1582 provides guidance for Fire Department Administrators regarding legal considerations in applying the standard.

Applying NFPA 1582 also involves economic issues. These economic concerns go beyond the costs of administering the medical program; they involve the personal and economic costs of dealing with the medical evaluation results. NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, addresses these issues in Chapter 8-7.1 and 8-7.2.²¹

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

The Fire Department is not legally required to follow any of these standards. Nonetheless, we recommend the County and Union **work together** to establish the content and frequency to be consistent with the above guidelines.

Recommendation #2: 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.²² These clearance evaluations are required for private industry employees and public employees in states operating OSHA-approved

State plans. Florida is not a State-plan State; therefore, public-sector employers are not required to comply with OSHA standards. However, we recommend following this standard, and a copy of the OSHA medical checklist has been provided to the Fire Department.

Recommendation #3: Implement a mandatory wellness/fitness program.

Physical inactivity is the most prevalent modifiable risk factor for CAD in the United States. Additionally, physical inactivity, or lack of exercise, is associated with other risk factors, namely obesity and diabetes.²³ 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 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.²⁴ The Fire Department and the Union should review these materials to identify applicable elements for their Department. Other large-city negotiated programs can also be reviewed as potential models.

Recommendation #4: Provide exercise equipment in all fire stations.

Currently, most of the 41 fire stations have strength exercise equipment purchased by the fire fighters. NFPA 1583 recommends providing exercise equipment through the contracted use of a public



Fire Fighter Dies While Exercising - Florida

gym or other facility or placing the equipment directly in the fire stations.²⁵ Contracting the use of a facility requires a company (engine, ladder, etc.) of fire fighters to exercise at the same time daily at a location separate from their fire station. The gym should be centrally located, but due to emergency responses and daily work duties, the facility may not be convenient and thus, may be underutilized. The fire companies may also have to be taken out of service during the time of exercise, depending on the location of the facility and the staffing level of the Fire Department. To place the equipment in the fire stations allows the fire fighters to exercise within the constraints of their daily work schedules and emergency responses while remaining more readily available for response.

REFERENCES

1. Fauci AS, Braunwald E, Isselbacher KJ, et al. [1998]. Harrison's principles of internal medicine. 14th ed. New York: McGraw-Hill, pp. 222-225.
2. American Heart Association (AHA) [1998]. AHA scientific position, risk factors for coronary artery disease. Dallas, TX.
3. Jackson E, Skerrett PJ, Ridker PM [2001]. Epidemiology of arterial thrombosis. In: Coleman RW, Hirsh J, Marder VIJ, et al., eds. 4th ed. Homeostasis and thrombosis: basic principles and clinical practice. Philadelphia, PA: Lippincott Williams and Wilkins.
4. Selwyn AP, Braunwald E [2001]. Ischemic heart disease. In: Braunwald E, Fauci AS, Kasper DL, Hauser SL, Longo DL, Jameson JL, eds. Harrison's principles of internal medicine. 15th ed. New York: McGraw Hill, p. 1399-1410.
5. Kannel WB, Abbott RD [1996]. Incidence and prognosis of unrecognized myocardial infarction. In: Fuster V, Ross R, Topol EJ, eds. Atherosclerosis and coronary artery disease. Philadelphia, PA: JB Lippincott, pp. 1561-1576.
6. Sigurdsson E, Thorgeirsson G, Sigvaldason H, et al. [1995]. Unrecognized myocardial infarction: epidemiology, clinical characteristics, and the prognostic role of angina pectoris: the Reykjavik study. *Ann Intern Med* 122:66
7. Fauci AS, Braunwald E, Isselbacher KJ, et al. [1998]. Harrison's principles of internal medicine. 14th ed. New York: McGraw-Hill, p. 1348.
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. Gledhill N, Jamnik, VK [1992]. Characterization of the physical demands of firefighting. *Can J Sport Sci* 17(3):207-213.
11. Barnard RJ, Duncan HW [1975]. Heart rate and ECG responses of fire fighters. *J Occup Med* 17:247-250.
12. 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.
13. Lemon PW, Hermiston RT [1997]. The human energy cost of fire fighting. *J Occup Med* 19:558-562.
14. American Industrial Hygiene Association Journal [1971]. Ergonomics guide to



Fire Fighter Dies While Exercising - Florida

- assessment of metabolic and cardiac costs of physical work. *Am Ind Hyg Assoc J*, pp. 560-564.
15. Wynne J, Braunwald E [2001]. The cardiomyopathies and myocarditides. In: Braunwald E, ed. *Heart disease: a textbook of cardiovascular medicine*. 6th ed. Philadelphia, PA: W.B. Saunders Company, p. 1753.
16. NFPA [2000]. NFPA 1582, Standard on medical requirements for fire fighters and information for fire department physicians. Quincy, Ma: National Fire Protection Association.
17. Michaelides AP, Psomadaki ZD, Dilaveris PE [1999]. Improved detection of coronary artery disease by exercise electrocardiography with the use of right precordial leads. *New Eng J Med* 340:340-345.
18. Darrow MD [1999]. Ordering and understanding the exercise stress test. *American Family Physician*. January 15, 1999.
19. Gibbons RJ, Balady GJ, Beasley JW, Bricker JT, Duvernoy WFC, Froelicher VF, Mark DB, Marwick TH, McCallister BD, Thompson PD, Winters WL Jr, Yanowitz FG [1997]. ACC/AHA guidelines for exercise testing: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing). *J Am Coll Cardiol* 30:260-315.
20. U.S. Preventive Services Task Force [1996]. *Guide to clinical prevention services*. 2nd ed. Baltimore, MD: Williams & Wilkins, pp. 3-15.
21. NFPA [1997]. NFPA 1500, Standard on Fire department occupational safety and health program. Quincy, MA: National Fire Protection Association.
22. 29 CFR 1910.134. Code of Federal Regulations. Occupational Safety and Health Administration: Respiratory Protection. Washington, D.C.: National Archives and Records Administration, Office of the Federal Register.
23. Plowman SA, Smith DL [1997]. *Exercise physiology: for health, fitness and performance*. Boston, MA: Allyn and Bacon.
24. 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.
25. NFPA [2000]. NFPA 1583, Standard on health-related fitness programs for fire fighters. Quincy, MA: National Fire Protection Association.

INVESTIGATOR INFORMATION

This investigation was conducted by and the report written by Tommy N. Baldwin, MS, Safety and Occupational Health Specialist. Mr. Baldwin is with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component, located in Cincinnati, Ohio.