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NIOSH

Fire Fighter Fatality Investigation and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation *November 7, 2005*

Fire Chief Suffers Sudden Cardiac Death While Returning to the Fire Station After a Structure Fire – Georgia

SUMMARY

On December 13, 2004, a 56-year-old male career Fire Chief responded to three fire calls, including two residential and one commercial fire. After the last fire, the Chief returned to the scene to "cordon off" the scene. As he was driving the rescue truck back to the fire station, he suddenly collapsed. The truck left the roadway, struck a culvert, and came to a stop. Witnesses called 911 and removed the Chief from the truck. Despite cardiopulmonary resuscitation (CPR) and advanced life support (ALS) performed by bystanders, crew members, ambulance service paramedics, and hospital emergency department (ED) personnel, the Chief died. The death certificate, completed by the Deputy Coroner, listed "cardiorespiratory arrest" due to "ASCVD" (atherosclerotic cardiovascular disease) as the cause of death. No autopsy was performed. The NIOSH investigator concluded the physical stress of responding to three structure fires, assisting with on-scene operations, and the Chief's underlying atherosclerotic cardiovascular disease all contributed to his sudden cardiac death.

NIOSH investigators offer the following recommendations to prevent similar incidents or to address general safety and health issues:

Provide 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.

Consider including exercise stress tests (EST) for male fire fighters over the age of 45 years with two or more risk factors for coronary artery disease (CAD) as part of the annual medical evaluation.

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

***Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting, the personal protective equipment used by fire fighters, and the various components of NFPA 1582,* Standard on Comprehensive Occupational Medicine Program for Fire Departments.**

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.

Use a secondary (technological) test to confirm appropriate placement of the endotracheal (ET) tube during emergency intubations.

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

Provide fire fighters with medical evaluations and clearance to wear self-contained breathing apparatus (SCBA).

Consider annual respirator fit testing.

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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INTRODUCTION & METHODS

On December 13, 2004, a 56-year-old male Fire Chief suffered sudden cardiac death after responding to three structure fires. Despite CPR performed by bystanders, and CPR and ALS performed by crew members, ambulance service personnel, and hospital ED personnel, the Chief died. NIOSH was notified of this fatality on December 14, 2004, by the United States Fire Administration. NIOSH contacted the affected Fire Department (FD) on January 10, 2005, to obtain further information, and on March 24, 2005, to initiate the investigation. On April 20, 2005, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation and Prevention Team traveled to Georgia to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel met and/or interviewed the following people:

- Current Fire Chief
- Wife of the deceased Fire Chief

During the site visit NIOSH personnel reviewed the following documents:

- FD incident report
- FD training records
- Primary care physician (PCP) records
- Ambulance report
- Hospital ED report
- Death certificate

INVESTIGATIVE RESULTS

On December 13, 2004, the Fire Chief arrived for duty at 0730 hours and performed his regular duties until the FD was dispatched at 1127 hours to a residential kitchen fire. The fire had been reported through the neighboring county's 911 system. The Chief responded in the rescue truck, but the truck experienced mechanical problems and had to be towed to a local service station for repair. Volunteer fire fighters responded to the residence and extinguished the fire. A volunteer fire fighter who was returning to the fire station picked up the Chief and took him back to the fire station.

Upon returning to the fire station, the Chief learned of a problem with the neighboring county's 911 call center. The problem resulted in a delay in transmitting the call to the involved FD. The Chief followed up on the problem by contacting the neighboring county's 911 center and the involved homeowner. After this, the Chief met with one of the night-time dispatchers for an unrelated reason.

At 1332 hours, the FD was dispatched to a residential fire. The Chief, wearing his station uniform, acted as Driver/Engineer and drove the pumper to the scene. The fire occurred in the electrical panel box; the power company responded to disconnect electrical power to the residence to prevent further damage. During this response, a third fire call occurred.

At 1350 hours, the FD was dispatched to a fire involving a commercial chicken growing complex. The chicken complex consisted of four chicken houses, each containing live chickens and measuring 40 feet by 500 feet. The Chief, leaving a Lieutenant in charge at the residential fire, responded to the chicken complex fire. Three mutual aid neighboring FDs were dispatched, sending three pumpers and seven fire fighters. The involved FD sent one pumper, a tanker, and seven fire fighters to the scene.

Upon arrival at the scene at 1355 hours, the Chief found one chicken house fully involved and fire threatening another. By 1405 hours, all dispatched apparatus were on scene. The Chief, acting as the Incident Commander, assisted fire fighters by advancing hoselines, setting up draft operations, and operating a pumper. As the drafting operation was being set up, the hard suction hose damaged the side of the pumper, which greatly concerned the Chief according to witnesses.

About 1.5 hours later, after the fire had been extinguished, the Chief assisted other fire fighters in breaking down attack lines, breaking down the drafting operations, and reloading the equipment.

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Units departed the scene at 1515 hours back to their respective fire stations. Once back in the fire station, the Chief assisted in getting the trucks back into service (cleaning, reloading hoses, and refilling the self-contained breathing apparatus cylinders). Once this was completed, a fire fighter drove the Chief to retrieve the rescue truck from the service station.

The Chief returned to the station and called the State Fire Marshal's Office to make a report on the chicken complex fire due to the excessive loss of property and because of a previous fire in the same location 18 months earlier. After speaking with the State Fire Marshal, the Chief drove the rescue truck to the chicken complex to secure (tape off) the scene for their joint investigation scheduled for the next morning.

After taping off the scene and while driving back to the station, the Chief collapsed inside the rescue truck. The truck traveled across the oncoming lane, exited the roadway onto the shoulder and traveled about 96 feet before striking a culvert in a ditch. After this contact, the truck traveled another 27 feet and came to rest in a private driveway at about 1735 hours. As witnesses checked on the Chief, a volunteer fire fighter who happened upon the scene notified 911 of the accident. Finding the Chief restrained by a seat belt and slumped over, bystanders and the volunteer fire fighter removed the Chief from the truck. Assessment revealed the Chief was unresponsive, with no respirations and no pulse. CPR was begun.

An ambulance staffed with two paramedics was dispatched at 1739 hours. The ambulance arrived on the scene at 1743 hours to find the Chief lying on the ground with CPR in progress. Patient assessment revealed agonal respirations with a very faint carotid pulse rate of 10 beats per minute. The Chief was placed onto a long spine board, a cervical collar was placed, he was intubated (a breathing tube inserted into the trachea), and oxygen was provided via bag-valve-mask. Breath sounds were confirmed by bilateral auscultation. One paramedic attached a cardiac monitor to the Chief, revealing ventricular fibrillation initially, then pulseless electrical activity. Intravenous (IV) access was attempted multiple times without success. The Chief was placed into the ambulance, which departed the scene at 1756 hours en route to the hospital.

The ambulance arrived at the hospital ED at 1800 hours. Inside the ED, ALS resuscitation measures were continued. An IV was started and cardiac resuscitation medications were administered. Blood tests to determine whether heart damage had occurred revealed elevated levels of troponin (0.09 nanograms per milliliter [ng/mL]) (normal range 0.0 – 0.05 ng/mL) and creatinine phosphokinase (CPK) (204 international units per liter [IU/L]) (normal range 38 IU/L - 174 IU/L), and a normal level of creatine kinase isoenzyme (CK-MB) (4.4 ng/mL) (normal range 0.06 – 6.3 ng/mL). An electrocardiogram (EKG) revealed pulseless electrical activity and asystole (no heart beat).

Despite CPR for 36 minutes and ALS for 31 minutes, there was no improvement in the Chief's condition. At 1615 hours the attending physician pronounced the Chief dead, and resuscitation measures were discontinued.

Medical Findings. The death certificate, completed by the Deputy Coroner, listed "cardiorespiratory arrest" due to "ASCVD" (atherosclerotic cardiovascular disease) as the cause of death. No autopsy was performed.

At his last medical check up in November 2004, the Chief weighed 199 pounds and was 68 inches tall, giving him a body mass index (BMI) of 30.25 kilograms per square meter (kg/m^2). (A BMI 30 kg/m^2 and over is considered obese[1]). The Chief had a history of high blood pressure successfully treated with an antihypertensive medication. His last blood pressure reading in November 2004 was normal. The Chief also had a history of hyperlipidemia and was prescribed lipid lowering and triglyceride lowering medications. His last blood lipid readings in June 2004 were normal.

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The Chief had an episode of chest discomfort and shortness of breath in 1990. Testing, including electrocardiograms and an exercise stress test (EST) was conducted. The Chief exercised for 9 minutes, 23 seconds using the Bruce protocol,[2] achieving a work level of 9 metabolic equivalents (METS) and a maximum heart rate of 156 beats per minute (87% of the maximal age-predicted heart rate). The test was discontinued due to fatigue. His resting blood pressure was 140/80 mmHg, which rose to 150/70 mmHg during exercise. His heart rate and blood pressure responses to exertion were appropriate. No chest pain and no ischemic changes were found on the EKG, and no arrhythmias were identified. The EST was deemed negative, and the Chief's chest discomfort was felt to be musculoskeletal in origin. In 1993, the Chief's cardiologist repeated the EST. This time the Chief exercised for 12 minutes, 27 seconds using the Bruce protocol[2] achieving a work level of 12.6 METS and a maximum heart rate of 171 beats per minute (97% of the maximal age-predicted heart rate). The test was discontinued when the Chief reached 97% of the maximal heart rate. His blood pressure rose to 185/80 mmHg during exercise. His heart rate and blood pressure responses to exertion were appropriate. No chest pain and no ischemic changes were found on the EKG, and no arrhythmias were identified. The EST was deemed negative.

According to the Chief's wife, the Chief was active at home and had walked on a treadmill for about 3 months, but had simply quit about 3 months prior to this event and did not perform other regular strenuous exercise. He had not complained of any recent chest pain or other cardiac symptoms.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, this combination FD consisted of 21 volunteers and one career position (the Fire Chief), served a population of 10,500 in a 187-square mile area, and had two fire stations.

In 2004, the FD responded to 186 calls: 22 residential fires, 6 commercial structure fires, 21 vehicle fires, 46 brush/grass fires, 5 rubbish fires, 11 other fires, 10 smoke scares, 10 investigations, 19 standbys, 10 rescue calls, and 26 false alarms.

Training. The FD requires all volunteer fire fighter applicants to complete an application that is reviewed by the FD officers. Volunteers are then accepted conditionally for 6 months. During the probationary period, the fire fighter candidate responds to different types of emergencies. At the end of this period, if the candidate has performed satisfactorily, full membership is given. The new member receives training in self-contained breathing apparatus, turnout gear, and other subjects contained in the International Fire Service Training Association (IFSTA) manuals. Drills occur twice monthly, and there are additional special drills during the year. The member must be a FD member for 1 year prior to receiving driver/engineer training. The State does not have a minimum training standard for volunteer fire fighters.

The Chief was certified as a State Fire Fighter, State Wildland Fire Fighter, Driver Operator, Emergency Medical Technician, Instructor, Telecommunicator, Fire Inspector, and at the Hazardous Materials Responder level. He had 30 years of fire fighting experience and had been Fire Chief for 23 years.

Pre-placement and Periodic Evaluations. No pre-placement or periodic medical evaluations are required by this FD. In addition, no periodic medical evaluations, physical agility test, or wellness/fitness programs are required. The FD is unable to offer these programs due to financial constraints and concerns that such requirements would hamper recruitment efforts.

A return-to-duty medical clearance is required for illnesses and injuries that prevent fire fighters from performing their duty. The member's primary care physician provides the clearance, which is forwarded to the Fire Chief, who makes the final determination

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for return-to-duty. No annual medical clearance to wear SCBA is required and no SCBA fit test is conducted.

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.[3] Risk factors for CAD development include age over 45, male gender, family history of coronary artery disease, smoking, high blood pressure (systolic > 140 millimeters of mercury [mmHg] or diastolic > 90 mmHg), high blood cholesterol (total cholesterol > 240 milligrams per deciliter [mg/dL]), obesity/physical inactivity, and diabetes.[4,5] The Chief had six of these risk factors (age over 45, male gender, family history, high blood pressure, high blood cholesterol, and obesity/physical inactivity).

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.[6] However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.[7] 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.[8] This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. The Chief probably suffered a heart attack. The term "probably" is used because autopsy findings (thrombus formation), blood tests (cardiac isoenzymes), or EKG findings are required to confirm a heart attack (myocardial infarction [MI]). No autopsy was performed and the Chief had no heart rhythm on which to conduct an EKG. However, his cardiac isoenzymes become positive, suggesting he had an MI about 3 hours prior to his sudden cardiac death. 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.[9]

Firefighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.[10] 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.[11-13] 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 minute) owing to the insulative properties of the personal protective clothing.[14] Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.[15-18] The Chief responded to three emergency calls, dealt with the broken down rescue truck, assisted with apparatus operation, and helped in getting the apparatus back into service by reloading hose and refilling SCBA cylinders. This is considered a moderate level of physical exertion.[19,20] The physical stress of responding to the calls, dealing with the broken down truck, apparatus operation, reloading the hose, refilling the SCBA cylinders, and his underlying atherosclerotic CAD contributed to this fire fighter's cardiac arrest and sudden death.

Occupational Medical Standards for Structural Fire Fighters. To reduce the risk of sudden cardiac arrest or other incapacitating medical conditions among fire fighters, the National Fire Protection Association (NFPA) has developed the NFPA 1582 guideline, *Standard on Comprehensive Occupational Medicine Program for Fire Departments*.[21] NFPA 1582 recommends an annual fire fighter medical evaluation.

Use of Exercise Stress Tests to Screen for CAD. In addition to screening for CAD risk factors, NFPA 1582 recommends an EST for some asymptomatic (i.e., no symptoms of angina) fire fighters. Conducting EST on asymptomatic individuals is somewhat controversial due to false positive and false negative test results. NFPA 1582 recommends, not as a part of the requirements but for informational purposes only,

an EST for fire fighters with two or more risk factors for CAD. The Standard lists the following criteria for CAD risk factors: hypercholesterolemia (total cholesterol greater than 240 mg/dL), hypertension (systolic greater than 140 mm Hg or diastolic greater than 90 mm Hg), smoking, diabetes, or family history of premature CAD (cardiac event in first degree relative less than 60 years old).[21]

The American College of Cardiology/American Heart Association (ACC/AHA) states that the evidence to conduct EST in asymptomatic individuals is "less well established" (Class IIb) for evaluating 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 standard listed above
2. Asymptomatic men older than 45 years, and women older than 55 years who are sedentary and plan to start vigorous exercise
3. Asymptomatic men older than 45 years, and women older than 55 years who are involved in occupations in which impairment might jeopardize public safety (e.g., fire fighters)
4. Asymptomatic men older than 45 years, and women older than 55 years who are at high risk for CAD due to other diseases (e.g., peripheral vascular disease and chronic renal failure)[22]

The U.S. Department of Transportation (DOT) also addresses the issue of EST. To obtain medical certification for a commercial driver's license, DOT recommends EST for drivers over the age of 45 with more than two CAD risk factors.[23] The U.S. Preventive Services Task Force (USPSTF), however does not recommend EST for asymptomatic individuals, even those with risk factors for CAD; rather, it recommends the diagnosis and treatment of modifiable risk factors (hypertension, high cholesterol, smoking, and diabetes).[24] 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."

Because the Chief had two CAD risk factors (hypertension and high cholesterol) for EST determination, an EST would have been recommended by the NFPA and ACC/AHA. He had EST in 1988, 1990, and 1993. Perhaps if EST were repeated every 2-3 years, his underlying CAD would have been identified and his death could have been prevented. While a mandatory comprehensive wellness/fitness program, including weight reduction, dietary education, and exercise would have benefited this fire fighter, it is unclear if these alone would have prevented his death at this time.

RECOMMENDATIONS

The following recommendations are preventive measures recommended by other fire service groups to reduce, among other things, the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These recommendations are listed in order of priority.

Recommendation #1: Provide 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 structural fire fighters can be found in NFPA 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments*,[21] in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) *Wellness/Fitness Initiative*,[25] and the National Volunteer Fire Council (NVFC) *Health and Wellness Guide*.[26] The FD is not legally required to follow any of these standards.

Applying this recommendation involves economic repercussions and may be particularly difficult for small, rural, volunteer fire departments to implement. To overcome the financial obstacle, the FD could urge current members to get annual medical clearances from their private physicians. Another option is having the annual medical evaluations recommended by NFPA 1582 completed by other members of the volunteer FD (medical and occupational history) and by EMTs from the county's emergency medical system (vital signs, height, weight, visual acuity, EKG). This information could then be provided to a community physician, perhaps volunteering his or her time, to review the data and provide medical clearance (or further evaluation, if needed). The more extensive portions of the medical examinations could be performed by a private physician at the fire fighter's expense, provided by a physician volunteer, or paid for by the FD. Sharing the financial responsibility for these evaluations between volunteers, the FD, and physician volunteers may reduce the financial impact on recruiting and retaining needed volunteers. NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, Chapter 8-7.1 and 8-7.2[27]and the NVFC *Health and Wellness Guide*[26] address these issues.

Recommendation #2: Consider including EST for male fire fighters over the age of 45 years with two or more risk factors for CAD as part of the annual medical evaluation.

As mentioned in the discussion section, NFPA, IAFF/IAFC, and AHA/ACC recommend EST for fire fighters with two or more CAD risk factors every 2-3 years.[21,22, 25]

Recommendation #3: 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. Additionally, physical inactivity, or lack of exercise, is associated with other risk factors, namely obesity and diabetes.[28] NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.[27] NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters*, provides the minimum requirements for a health-related fitness program.[29]

In 1997, the IAFF and the 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.[25] 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.[30-32] 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.[33] The NVFC Health and Wellness Guide addresses wellness/fitness programs as they relate to volunteer fire departments.[26]

Recommendation #4: 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.[27]

Recommendation #5: Use a secondary (technological) test to confirm appropriate placement of the endotracheal (ET) tube during emergency intubations.

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To reduce the risk of improper intubation, the American Heart Association and the International Liaison Committee on Resuscitation published recommendations in the Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care.[34] These guidelines recommend confirming tube placement by primary and secondary methods. Primary confirmation is the 5-point auscultation: left and right anterior chest, left and right midaxillary, and over the stomach. Secondary confirmation requires a technology test, either an end-tidal carbon dioxide detector or an esophageal detector device. In this incident, the Chief had bilateral breath sounds confirmed by auscultation, however, according to records obtained by the NIOSH investigator, secondary confirmation was not performed. While this in no way influenced the outcome of this case, it is mentioned here to ensure resuscitation efforts comply with published protocols.

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.[35] With this publication the USFA hopes to provide "a more thorough documentation of the causes of firefighter deaths for three purposes:

1. to advance the analysis of the causes of firefighter deaths to aid in the development of improved firefighter health and safety equipment, procedures, and standards;

2. to help determine eligibility for death benefits under the Federal government's Public Safety Officer Benefits Program, as well as state and local programs; and

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

Recommendation #7: Provide fire fighters with medical evaluations and clearance to wear SCBA.

The Occupational Safety and Health Administration (OSHA) Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employees who use respiratory protection.[36] This includes fire fighters who utilize SCBA while performing their duties. These clearance evaluations are required for private industry employees and public employees in states operating OSHA-approved State plans. Although Georgia is not a state-plan state[37] we recommend voluntary compliance 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 #8: Consider annual respirator fit testing.

The Occupational Safety and Health Administration (OSHA) respiratory protection standard requires employers whose employees are required to use respirators to have a formal respiratory protection program, including annual fit testing.[36] Georgia does not have an OSHA-approved State plan, so public employers, including volunteer or career fire departments, are not legally subject to OSHA standards.[37] Nevertheless, we recommend that the FD voluntarily follow the health and safety related provisions of the OSHA standard, including annual fit testing.

REFERENCES

1. National Heart Lung Blood Institute [2003]. Obesity education initiative. World Wide Web (Accessed September 2003.) Available from http://www.nhlbisupport.com/bmi/bmicalc.htm.

2. WorldAR [2002]. Bruce treadmill protocol. World Wide Web (Accessed March 2004). Available from http://www.worldar.com/endurance/bruce.htm.

3. 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.

4. AHA [1998]. AHA Scientific Position, Risk Factors for Coronary Artery Disease. Dallas, TX: American Heart Association.

5. Jackson E, Skerrett PJ, and Ridker PM [2001]. Epidemiology of arterial thrombosis. In: Coleman RW, Hirsh J, Marder VIJ, et al. eds. Homeostasis and thrombosis: basic principles and clinical practice. 4th edition. Philadelphia: Lippincott Williams and Wilkins.

6. 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.

7. Shah PK [1997]. Plaque disruption and coronary thrombosis: new insight into pathogenesis and prevention. Clin Cardiol 20 (11 Suppl2): II-38-44.

8. 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.

9. 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.

10. Gledhill N, Jamnik, VK [1992]. Characterization of the physical demands of firefighting. Can J Spt 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 [1977]. The human energy cost of fire fighting. J Occup Med 19:558-562.

14. Smith DL, Petruzzello SJ, Kramer JM, et al. [1995]. Selected physiological and psychobiological responses to physical activity in different configurations of firefighting gear. Ergonomics 38(10):2065-2077.

15. Willich SN, Lewis M, Lowel H, et al. [1993]. Physical exertion as a trigger of acute myocardial infarction. N Eng J Med 329:1684-1690.

16. Mittleman MA, Maclure M, Tofler GH, et al. [1993]. Triggering of acute myocardial infarction by heavy physical exertion. N Eng J Med 329:1677-1683.

17. Siscovick DS, Weiss NS, Fletcher RH, Lasky T [1984]. The incidence of primary cardiac arrest during vigorous exercise. N Eng J Med 311:874-877.

18. Tofler GH, Muller JE, Stone PH, et al. [1992]. Modifiers of timing and possible triggers of acute myocardial infarction in the Thrombolysis in Myocardial Infarction Phase II (TIMI II) Study Group. J Am Coll Cardiol 20:1049-1055.

19. Ainsworth BE, Haskell WL, Leon AS, et al. [1993]. Compendium of physical activities: classification of energy costs of human physical activities. Med Sci Sports Exerc 25(1):71-80.

20. American Industrial Hygiene Association Journal [1971]. Ergonomics guide to assessment of metabolic and cardiac costs of physical work. Am Ind Hyg Assoc J 560-564.

21. NFPA [2003]. Standard on comprehensive occupational medical program for fire departments. Quincy MA: National Fire Protection Association. NFPA 1582.

22. Gibbons RJ, Balady GJ, Bricker JT, Chaitman BR, Fletcher GF, Froelicher VF, Mark DB, McCallister BD, Mooss AN, O'Reilly MG, Winters WL Jr, [2002]. ACC/AHA guidelines update for exercise testing: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing). American College of Cardiology Web site. Available at: www.acc.org/clinical/guidelines/exercise/dirIndex.htm.

23. U.S. Department of Transportation [1987]. Medical advisory criteria for evaluation under 49 CFR Part 391.41 (http://www.fmcsa.dot.gov/rulesregs/fmcsr/medical.htm). Conference on cardiac disorders and commercial drivers - FHWA-MC-88-040, December. Available at www.fmcsa.dot.gov/documents/cardiac.pdf. Accessed June 2005.

24. U.S. Preventive Services Task Force [1996]. Guide to clinical prevention services, 2nd Ed. Baltimore, MD: Williams & Wilkins, pp. 3-15.

25. 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.

26. United States Fire Administration [2004]. Health and wellness guide. Emmitsburg: Federal Emergency Management Agency; USFA, Publication No. FA-267.

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

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

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

30. 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.

31. 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.

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

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

34. American Heart Association (AHA), International Liaison Committee on Resuscitation (ILCOR) [2000]. Guidelines 2000 for cardiopulmonary resuscitation and emergency cardiovascular care: international consensus on science. Circulation 102(8):I95.

35. United States Fire Administration [1995]. Firefighter Autopsy Protocol. Emmitsburg: Federal Emergency Management Agency; USFA, Publication No. FA-156.

36. 42 CFR 1910.134. Available at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=12716&p_text_version=FALSE. Accessed Dec 2004.

37. OSHA [2004]. State Occupational Safety and Health Plans. Available at http://www.osha.gov/fso/osp/index.html. Accessed December 2004.

INVESTIGATOR INFORMATION

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