



## **Lieutenant Suffers Sudden Cardiac Death After SCBA Training – Florida**

### **SUMMARY**

On May 27, 2005, a 43-year-old male career Lieutenant (LT) participated in 5 hours of physically demanding fire fighter training. The training included fire fighter survival skills and a self-contained breathing apparatus (SCBA) confidence/endurance drill. After arriving at a fire station, the LT suffered chest pain. Crew members began advanced life support (ALS) treatment and notified dispatch. An ambulance arrived at the station 5 minutes later and found the LT in severe distress due to chest pain and transported the LT to the hospital. As the ambulance arrived at the hospital's emergency department (ED), the LT suffered respiratory and cardiac arrest. Cardiopulmonary resuscitation (CPR) was performed and additional ALS treatment was given. Despite ALS and CPR for over 54 minutes, the LT died. The death certificate and the autopsy, completed by the County Medical Examiner, listed "atherosclerotic cardiovascular disease (CVD)" as the cause of death. The NIOSH investigator concluded that the LT's sudden cardiac death was due to his underlying atherosclerotic CVD, possibly triggered by the physical exertion associated with SCBA training.

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

*Ensure a comprehensive rehabilitation program is in place when operating a physically demanding training exercise.*

*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.*

*Perform periodic exercise stress tests (EST) on members above the age of 45 in accordance with the American Heart Association (AHA) recommendations.*

*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 CVD and improve cardiovascular capacity.*

### **INTRODUCTION & METHODS**

On May 27, 2005, a 43-year-old male LT suffered sudden cardiac death after performing SCBA training. NIOSH was notified of this fatality on May 31, 2005, by the United States Fire Administration. NIOSH contacted the affected fire department (FD) on June 8, 2005, to obtain further information and on January 20, 2006, to initiate the investigation. On April 3, 2006, 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 following persons:

- Fire Chief
- Assistant Chief

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/fire](http://www.cdc.gov/niosh/fire)  
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- Battalion Chief for Emergency Medical Services (EMS)
- Public Information Officer
- International Association of Fire Fighters (IAFF) Vice-President Local 3254
- Crew members
- LT's wife and father

NIOSH personnel reviewed the following documents:

- FD incident report
- FD training records
- FD annual response report for 2005
- FD standard operating guidelines
- Ambulance report
- Hospital records
- Death certificate
- Autopsy report
- Primary care provider (PCP) records

## INVESTIGATIVE RESULTS

On May 27, 2005, the LT (assigned to Engine 12 [E-12]) arrived for duty at his fire station (Station 12) at about 0745 hours. The LT reviewed the shift's activities, which included fire fighter survival skills and air consumption training. Before departing for training, the LT commented to crew members that he did not feel well.

E-12 (LT, Fire Fighter/Paramedic [FF/P], and two Fire Fighter/Emergency Medical Technicians [FF/EMTs]) left the station at 0900 hours en route to the training center and arrived at 0931 hours. Weather conditions that morning included an overcast sky, with a temperature of 75° Fahrenheit (F) and 71% humidity, giving a heat index of 77° F.

The crew took their bunker gear and SCBAs inside the training center. The Training Officer briefed the crew on the training activities which included fire fighter survival skills and an air consumption drill. Engine

13 (E-13), Rescue 13 (R-13), E-12, and Rescue 35 (R-35) (a total of 12 personnel) took part in the training exercise. E-13 and R-13 participated in the air consumption drill, while E-12 and R-35 participated in the fire fighter survival skills activity. Training began at about 0945 hours.

Components of the first half of the LT's training (fire fighter survival skills) included: 1) bringing an injured fire fighter out of a building, 2) bringing an injured fire fighter up and down stairs, and 3) removing an injured fire fighter from a hole in the floor. The LT, wearing full bunker gear and 45-minute SCBA (entire ensemble weighing about 50 pounds), not on-air, participated in drills 1) and 3) without any problems. He observed drill 2). The crew went to "Rehab" for approximately 30 minutes where they drank fluids. The rehabilitation area consisted of benches and folding chairs, large ventilation fans, and ice water.

The second portion of the training, the SCBA confidence/endurance (air consumption) drill, began at approximately 1230 hours. Each fire fighter wore full bunker gear and SCBA (on-air) and staggered their start times. Components of the drill included: 1) walking up and down a flight of 18 stairs, 2) weaving through a set of six cones placing softballs on the opposite cones, 3) advancing a 1¾-inch water-filled hoseline 50-feet and then returning it to the starting point, 4) simulating a ceiling pull with a pike pole using ½-inch rope and a pulley attached to a 50-foot section of 2½-inch hose; pulling down on the pike pole 15 times, 5) crawling through a wooden box measuring 2 feet x 2 feet x 8 feet long on the floor, 6) driving a piece of wood measuring 6 inches x 6 inches x 3 feet down a sled using an 8-pound sledge hammer; driving a distance of 5 feet, 7) dragging a 125-pound mannequin in a circle around two cones that are set 25 feet apart, and 8) lifting a section of 2½-inch hose weighing 40 pounds, carrying it to a wooden sawhorse 40 feet away, picking up a second similar section of 2½-inch hose, and carrying it back to the original sawhorse. The drill required participants to start with a minimum of 3,900 pounds per square inch (psi) of compressed air and complete as



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many laps on the course as possible until their low-air alarm sounded. The fire fighter then sat in a chair and continued breathing from the SCBA until it emptied. Each participant's vital signs (blood pressure [BP], pulse, respiration rate, and blood oxygen saturation) were taken before and after the training exercise. The LT's pre-exercise vital signs were: BP 110/73 millimeters of mercury (mmHg), pulse 89 beats per minute, and respiration rate of 20 breaths per minute.

The LT was the last person to start the air consumption drill. The temperature was about 81° F with 58% humidity, giving a heat index of 83.5° F. The LT began the drill with 4,000 psi in his SCBA and completed four laps on the course (taking 21 minutes and 30 seconds) before his low-air alarm sounded. He then sat for another 26 minutes and 21 seconds, until his cylinder emptied. His total time on-air was 47 minutes and 51 seconds. The LT removed his bunker coat and sat by a large fan to cool off. His post-training vital signs revealed a BP of 124/77 mmHg, a pulse of 120 (tachycardia [rapid heart rate]), and a pulse oximetry of 97% blood oxygen saturation. He was very tired and asked a fire fighter to get him some water as he rested his head in his hands. The LT commented to another crew member that the last 5 minutes of the drill (the sitting portion) was very difficult. The crew, including the LT, retrieved their equipment, reloaded E-12, and left the training center at approximately 1330 hours to eat lunch. The LT stated that he was not hungry, did not feel right, and asked the driver to drop him off at Station 35 which is typically staffed with a rescue/ambulance unit. However, at this time, the rescue unit was out on another call.

The LT entered Station 35, walked to the base of the stairwell, and called for help. An FF/EMT came down the stairwell and saw the LT down on one knee. The FF/EMT summoned crew members, who assisted the LT into the day room's recliner and began ALS treatment. A still alarm was called to Dispatch at 1337 hours for chest pain and an FD Rescue was requested for transport. The LT was not having breathing difficulty, but was having general pain in the abdomen and

chest area and was complaining of not feeling well. A cardiac monitor attached to the LT revealed sinus tachycardia with a rate of 107 beats per minute with a wide QRS segment; his BP was 154/111 mmHg. He was becoming increasingly diaphoretic (heavy sweating) and uncomfortable. An intravenous (IV) line was placed and oxygen was administered via non-rebreather mask. Shortly thereafter, he began turning pale and going in and out of consciousness.

R-35 arrived on the scene at 1342 hours. Paramedics and crew members loaded the LT onto a backboard and stretcher and placed him into the ambulance, departing for the hospital at 1345 hours. A 12-lead electrocardiogram (EKG) was taken which revealed a heart rate of 107 bpm, left axis deviation, left ventricular hypertrophy (LVH), and ST segment elevation in the inferior leads. Nitroglycerin and baby aspirin were administered sublingually. As the ambulance proceeded toward the hospital, the LT vomited and had to be suctioned. As the ambulance neared the hospital, the LT began seizure-like activity and stopped breathing. Crew members began rescue breathing via bag-valve-mask. The ambulance arrived at the hospital's ED at 1353 hours. Time from the still alarm to arrival at the hospital was about 16 minutes.

Inside the ED, the LT went into cardiac arrest and CPR was begun. The LT was intubated (breathing tube inserted into the trachea) and proper tube placement was confirmed by an end tidal carbon dioxide test. Cardiac resuscitation medications were given; the LT's heart rhythm reverted to ventricular fibrillation, a heart rhythm that is incompatible with life. He was defibrillated and a pulse returned. Shortly thereafter, his cardiac rhythm again degenerated into ventricular fibrillation and was unable to be restarted despite five defibrillation attempts and cardiac pacing. At 1431 hours, the LT was pronounced dead by the attending physician and resuscitation measures were discontinued.

*Medical Findings.* The death certificate and the autopsy, completed by the County Medical Examiner,



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listed “atherosclerotic cardiovascular disease (CVD)” as the cause of death. Pertinent findings from the autopsy, performed on May 29, 2005, included the following:

- Atherosclerotic CVD
  - Focal calcific narrowing (50% - 70%) of the left anterior descending coronary artery
  - Focal calcific narrowing (50% - 70%) of the left main coronary artery
  - Focal calcific narrowing (30% - 50%) of the right main coronary artery
  - Focal calcific narrowing (30% - 50%) of the left circumflex coronary artery
- Moderate cardiomegaly (enlarged heart: heart weighed 430 grams [g] [normal is <400 g])<sup>1</sup>
  - LVH and dilatation (wall thickness was 2.5 centimeters [cm] [normal is 0.6 cm - 1.1 cm])<sup>2</sup>
- Microscopic examination of the coronary arteries revealed an “apparent thrombus material identified in the lumen” with “evidence of re-canalization” (suggestive of a remote [old] myocardial infarction)
- Acute pulmonary edema
- No evidence of thromboemboli in the pulmonary arteries
- Negative carboxyhemoglobin test
- Negative drug and alcohol tests

The LT had two coronary artery disease (CAD) risk factors: male gender and high blood cholesterol (diagnosed in 1986).

In 1984, at the age of 23, the LT was diagnosed with lymphoma (diffuse large cell [or histiocytic]) involving his chest (mediastinum). He initially underwent radiation therapy to his chest for 2 days (total dose 300 Rads), followed by a complex chemotherapy regimen over 6 months that included adriamycin (400 milligrams total dose). This was followed by another cycle of radiation therapy to his chest (total dose 3500 Rads).

Since his cancer diagnosis in 1984, his exercise stress tests (ESTs) have been abnormal. In a 1986 EST, the LT was found to have ST segment depression in his inferior and lateral leads at 9 minutes into his exercise, which resolved 3 minutes post-exercise. A radionuclide study 1 month later showed a left ventricular ejection fraction (LVEF) of 44% with mild to moderate hypokinesia. At peak exercise, his LVEF increased to 51%. The cardiologists felt these findings were more consistent with cardiac complications from radiation and chemotherapy rather than myocardial ischemia. Subsequent EST every two years revealed similar findings with improving exercise tolerance (up to 17.2 metabolic equivalents [METs] in 2004). His last EST was in 2004. The LT exercised for 12 minutes and 45 seconds, stopping due to fatigue. He achieved a MET level of 17.2 and 97% of his target heart rate. There was <1 mm of ST segment depression on his EKG, and his heart rate and blood pressure response were normal; therefore the test was considered negative for ischemia (normal). At the time of his death, the LT was not taking any prescription medications. According to his wife, father, and crew members, he did not express any symptoms of cardiac-related problems during the days or months prior to his death.

However, the night prior to this incident, the LT moved from one residence to another; moving most of the furniture by himself; working until about 0200 hours. After minimal sleep, the LT reported for duty at his fire station.

### **DESCRIPTION OF THE FIRE DEPARTMENT**

At the time of the NIOSH investigation, this career FD consisted of 312 uniformed personnel, served a population of 400,000 in a 298 square-mile land area and 46 square miles of water area, and had 16 fire stations.

In 2005, the FD responded to 27,536 calls: 223 structure fires, 163 vehicle fires, 140 vegetation fires, 126 rubbish fires, 66 other fires, 17,582 rescue and emergency medical calls, 653 hazardous condition



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calls, 1,507 service calls, 5,160 good intent calls, 1,875 false calls, 16 overpressure/rupture/explosion/overheat calls, 15 special incidents and 10 severe weather calls.

*Employment and Training.* The FD requires the following of all fire fighter applicants:

- complete an application
  - possess a valid state driver's license
  - possess a high school diploma or equivalent
  - complete the state minimum fire standards (500 hours and EMT certification)
  - pass a written test on firefighting and EMS
  - pass a practical test and a swimming test
  - pass a physical ability test
  - pass an oral interview, a background investigation, and a post-offer/pre-placement physical examination (including a treadmill stress test)
- Vision screening
  - Audiogram
  - Urinalysis
  - Urine drug screen
  - Treadmill EST to rule out CAD, frequency depending on the age of the FF
  - Pulmonary function (spirometry)
  - Resting EKG
  - Chest x-ray (if indicated)
  - Tuberculin PPD (purified protein derivative)
  - Hepatitis B titer level
  - Hepatitis C screening
  - Human immunodeficiency virus (HIV) screening

The applicant is then offered employment and is placed in a 6-week training program which includes orientation, fire operations, medical, and wildland. The fire fighter is assigned to an engine lieutenant and must work 6 months prior to transfer. Fire fighters work 24 hours on-duty 0800 hours to 0800 hours, and are off-duty for 48 hours.

The LT was certified as a Fire Fighter II, EMT, Hazardous Materials Technician and a Rope Rescue Technician. He had 25 years of firefighting experience.

*Pre-placement Physical Examination.* A pre-placement physical examination is required by this FD for all candidates. The contents of the examination are as follows:

- Complete medical history
- Physical examination
- Vital signs
- Complete blood count
- Complete metabolic panel (SMA 26)

A County physician performs the medical examinations and forwards the clearance-for-duty decision through the County Human Resources office to the FD, who makes the final determination for clearance for duty.

*Periodic Evaluations.* Voluntary annual FD medical evaluations are offered to all fire fighters, based on their age. The contents of the examination differ for fire fighters and hazardous materials team members. Blood testing and urinalysis are conducted annually. ESTs are conducted approximately every 5 years for FFs between the ages of 18 and 29 (beginning at age 19 if hired at age 18). Medical clearance for SCBA use is not required. The same County physician who performs the post offer/pre-placement also performs the periodic medical evaluations. The County physician then forwards the clearance-for-duty decision through the County Human Resources Office to the FD, who makes the final clearance for duty determination.

An annual physical agility test (hose carry, hose hoist, ladder climb, advance charged hoseline, and victim carry) is required for members. There is a voluntary wellness/fitness program, with each shift having time set aside for physical fitness exercise. Exercise equipment (strength and aerobic) is available in the



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fire stations. A return-to-duty medical clearance is required from the County physician for duty-related injuries. If a non-duty-related illness prevents fire fighters from performing their duty, a return-to-duty clearance may be required by the fire fighter's PCP. The clearance is reviewed by the County physician who makes the final clearance decision.

### **DISCUSSION**

*CAD and the Pathophysiology of Sudden Cardiac Death.* In the United States, CAD (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.<sup>3</sup> Risk factors for its development include increasing age, male gender, heredity, tobacco smoking, diabetes, high blood cholesterol, high BP, and physical inactivity/obesity.<sup>4</sup> The LT had two risk factors for CAD: male gender and high blood cholesterol. On the autopsy the LT had moderate atherosclerotic narrowing of his coronary arteries, evidence of a recent coronary artery thrombus, and a remote (old) heart attack (re-canalization of a coronary artery). The LT did not, however, report symptoms of angina (e.g., chest pain on exertion) to family or crew members in the days or weeks prior to his collapse, or to his physicians during the months/years prior to his death.

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.<sup>5</sup> However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.<sup>6</sup> 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.<sup>7</sup> This sudden blockage is primarily due to blood clots (thromboses) forming on the top of atherosclerotic plaques. Blood clots, or thrombus formation, in coronary arteries is initiated by disruption of atherosclerotic plaques. Certain characteristics of the plaques (size, composition of the cap and core, presence of a local inflammatory process) predispose the plaque to disruption.<sup>7</sup> Disruption then occurs from biomechanical and hemodynamic forces, such

as increased BP, increased heart rate, increased catecholamines, and shear forces, which occur during heavy exercise.<sup>8</sup>

Firefighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.<sup>9</sup> Firefighting activities are strenuous and often require fire fighters to work at near maximal heart rates for long periods. 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.<sup>10</sup> Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.<sup>11-14</sup> The LT, while wearing bunker gear and SCBA, participated in fire fighter rescue training and an air consumption drill in a hot, humid environment. This is considered a very heavy level of physical exertion.<sup>9,15</sup> The physical stress of performing these tasks and the presence of underlying atherosclerotic CVD probably contributed to this fire fighter's sudden cardiac death.

Establishing the occurrence of a heart attack requires any of the following: coronary artery thrombus, characteristic EKG changes, or elevated cardiac enzymes. The LT was found to have a recent thrombus on microscopic examination of the coronary arteries, but a thrombus was not seen on the non-microscopic portion of the autopsy. Cardiac enzyme testing was not performed, but we would not expect the enzymes to become positive for at least 4 hours post-MI.<sup>16</sup> Finally, the EKG obtained before the LT died showed ST segment elevations, a finding characteristic of a heart attack (MI). Therefore, given the LT's clinical presentation (sudden onset of angina, post-exertion), EKG changes, and his acute thrombus found on microscopic examination, the NIOSH investigator concludes that the LT probably had an acute myocardial infarction (MI), which is the most likely cause of his sudden cardiac death. Other less likely possibilities include arrhythmias associated with hypertrophy of the heart



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muscle, dilated cardiomyopathy, and/or cardiomegaly (discussed below).

***Left Ventricular Hypertrophy (LVH).*** On autopsy, the LT had an enlarged heart and LVH. LVH is a relatively common finding among individuals with long-standing hypertension (HTN), a heart valve problem, or cardiac ischemia (reduced blood supply to the heart muscle).<sup>1</sup> The LT's LVH could be due to ischemia from his atherosclerosis (found on autopsy) or be a complication of his cancer treatment. LVH increases the risk for sudden cardiac death.<sup>17</sup>

***Cardiomyopathy.*** At autopsy, the LT was found to have dilated cardiomyopathy (DCM), probably a complication of his adriamycin chemotherapy and/or radiation therapy.<sup>18-21</sup>

DCM is associated with an increased incidence of sudden cardiac death (SCD), mostly from arrhythmias.<sup>18,22-23</sup> Although a variety of symptoms and medical tests can provide prognostic information, patients at greatest risk of sudden death or in need of anti-arrhythmic therapy are hard to identify.<sup>18</sup> Given the inability to identify patients at high risk for sudden death, the low degree of efficacy of anti-arrhythmic agents for DCM, the numerous side effects of these anti-arrhythmic agents, and the lack of symptoms in the deceased, it is unclear if an earlier diagnosis of DCM could have prevented the LT's 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) developed NFPA 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments*.<sup>24</sup> NFPA 1582 recommends, for informational purposes only, asymptomatic fire fighters with two or more risk factors for CAD be screened for obstructive CAD by an EST. NFPA defines these CAD risk factors as family history of premature (first-degree relative <age 60) cardiac event, HTN (diastolic BP >90 mmHg), diabetes mellitus, cigarette smoking,

and hypercholesterolemia (total blood cholesterol level >240 mg/deciliter [dL]).<sup>24</sup> This guidance is similar to recommendations from the American College of Cardiology/American Heart Association (ACC/AHA) and the Department of Transportation regarding ESTs in asymptomatic individuals.<sup>25,26</sup> The LT had biannual ESTs with EKG abnormalities since 1986. The abnormalities were ST segment depression (1mm – 3mm) in the inferior, lateral, and anterior regions of the heart. These changes came on during peak exercise and resolved during recovery. Due to: 1) the LT's history of chemotherapy induced cardiomyopathy, 2) the LT's excellent aerobic capacity, 3) lack of angina during the EST, 4) no arrhythmias during the EST, 5) good BP response, and 6) stable pattern since 1986, these changes were not felt to be due to ischemic CAD. Therefore, the LT was cleared for duty.

## **RECOMMENDATIONS**

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

***Recommendation #1: Ensure a comprehensive rehabilitation program is in place when operating a physically demanding training exercise.***

Emergency incident/training rehabilitation guidelines are contained within NFPA 1584, *Recommended Practice on the Rehabilitation of Members Operating at Incident Scene Operations and Training Exercises*.<sup>27</sup> NFPA 1584 states that upon entering rehabilitation, vital signs (temperature, pulse, blood pressure) should be taken. Upon entering rehabilitation after the first portion of the training, the LT received relief from climatic conditions, fluids, rest, and accountability. Prior to beginning the air consumption drill, his vital signs were taken. After completing the second portion of the training exercise, the LT went to rehabilitation where, in addition to the above, his vital signs were checked again. At this time he was noted to have a fast heart rate. While this heart rate may have been an appropriate response to his exertion, his vital signs



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were not rechecked before departing the scene. NFPA 1584 recommends that the FD physician develop vital sign parameters for extended rehabilitation. If members exceed these parameters they should remain in rehab for an additional 20 minutes. If members still exceed the parameters they should be referred to the medical treatment area.<sup>27</sup>

***Recommendation #2: 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 structural fire fighters can be found in NFPA 1582,<sup>24</sup> in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) *Wellness/Fitness Initiative*.<sup>28</sup> Although the FD is not legally required to follow any of these standards, they provide effective guidelines for implementing a medical evaluation requirement.

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*, Chapter 8-7.1 and 8-7.2,<sup>29</sup> address these issues.

***Recommendation #3: Perform periodic exercise stress tests (EST) on members above the age of 45 in accordance with the American Heart Association (AHA) recommendations.***

The FD requires all FF over the age of 40 to undergo EST bi-annually. The American Heart Association suggests that “on the basis of prognostic considerations, asymptomatic male patients older than 45 years with one or more risk factors (hypercholesterolemia, hypertension, smoking, diabetes, or family history of premature CAD) may obtain useful prognostic infor-

mation from exercise testing.”<sup>25</sup> The FD could realize a cost savings on their periodic medical evaluations by performing EST on FFs under the age of 45 with two or more risk factors for CAD, or on FFs over 45 with one or more risk factor.

***Recommendation #4: Provide fire fighters with medical evaluations and clearance to wear SCBA.***

The Occupational Safety and Health Administration (OSHA)’s Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employees using respiratory protection.<sup>30</sup> Such employees include fire fighters who utilize SCBA in the performance of their duties. 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, the NIOSH investigator recommends voluntary compliance. Given the extensive annual medical evaluation being conducted, this medical clearance would not represent any additional cost to the FD.

***Recommendation #5: Phase in a MANDATORY wellness/fitness program for fire fighters to reduce risk factors for CVD and improve cardiovascular capacity.***

Physical inactivity is the most prevalent modifiable risk factor for CAD in the United States. NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.<sup>29</sup> NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters*, provides the minimum requirements for a health-related fitness program.<sup>31</sup> In 1997, the IAFF/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 FDs across the United States joined this effort to pool information about their physical fitness programs and



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create a practical fire service program. They produced a manual and a video which details elements of such a program.<sup>28</sup> 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.<sup>32-34</sup> Similar cost savings have been reported by the wellness program at the Phoenix FD, where a 12-year commitment has resulted in a significant reduction in their disability pension costs.<sup>35</sup> The FD began a wellness program in 2000; has refurbished fire stations, bought exercise equipment (aerobic and strength), and trained Certified Peer Fitness Trainers. The FD and the union have negotiated phasing in a mandatory program.

**REFERENCES**

1. Siegel RJ [1997]. Myocardial hypertrophy. In: Bloom S ed. Diagnostic criteria for cardiovascular pathology acquired diseases. Philadelphia, PA: Lippencott-Raven, pp. 55-57.
2. Armstrong WF, Feigenbaum H [2001]. Echocardiography. In: Braunwald E, Zipes DP, Libby P, eds. Heart disease: a text of cardiovascular medicine. 6<sup>th</sup> ed. Vol. 1. Philadelphia, PA: W.B. Saunders Company, p. 167.
3. Meyerburg RJ, Castellanos A [2005]. Cardiovascular collapse, cardiac arrest, and sudden cardiac death. In: Kasper DL, Braunwald E, Fauci AS, Hauser SL, Longo DL, Jameson JL, eds. Harrison's principles of internal medicine. 16<sup>th</sup> ed. New York: McGraw Hill, pp. 1618-1624.
4. AHA [1998]. AHA scientific position, risk factors for coronary artery disease. Dallas, TX: American Heart Association.
5. Libby P [2005]. The pathogenesis of atherosclerosis. In: Kasper DL, Braunwald E, Fauci AS, Hauser SL, Longo DL, Jameson JL, eds. Harrison's principles of internal medicine. 16<sup>th</sup> ed. New York: McGraw-Hill, pp. 1425-1430.
6. Shah PK [1997]. Plaque disruption and coronary thrombosis: new insight into pathogenesis and prevention. Clin Cardiol 20(11 Suppl2):II-38-44.
7. Fuster V, Badimon JJ, Badimon JH [1992]. The pathogenesis of coronary artery disease and the acute coronary syndromes. N Engl J Med 326:242-250.
8. Kondo NI, Muller JE [1995]. Triggering of acute myocardial infarction. J Cardiovasc Risk 2:499-504.
9. Gledhill N, Jamnik VK [1992]. Characterization of the physical demands of firefighting. Can J Spt Sci 17(3):207-213.
10. 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.
11. Willich SN, Lewis M, Lowel H, et al. [1993]. Physical exertion as a trigger of acute myocardial infarction. N Engl J Med 329:1684-1690.
12. Mittleman MA, Maclure M, Tofler GH, et al. [1993]. Triggering of acute myocardial infarction by heavy physical exertion. N Engl J Med 329:1677-1683.
13. Siscovick DS, Weiss NS, Fletcher RH, Lasky T [1984]. The incidence of primary cardiac arrest during vigorous exercise. N Engl J Med 311:874-877.
14. 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.



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15. 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.
16. American Heart Association [2006]. Blood tests for rapid detection of heart attacks. Dallas, TX. [<http://www.americanheart.org/presenter.jhtml?identifier=4477>]. Date accessed: July 2006.
17. Myerburg RJ, Castellanos A [2001]. Cardiac arrest and sudden cardiac death. In: Braunwald E, Zipes DP, Libby P, eds. Heart disease. 6<sup>th</sup> ed. Philadelphia, PA: W.B. Saunders, pp. 890-931.
18. Dec GW, Fuster V [1994]. Medical progress: idiopathic dilated cardiomyopathy. N Engl J Med 331:1564-1575.
19. Sausville EA, Longo DL [2005]. Principles of cancer treatment: surgery, chemotherapy, and biologic therapy. In: Kasper DL, Braunwald E, Fauci AS, Hauser SL, Longo DL, Jameson JL, eds. Harrison's principles of internal medicine. 16<sup>th</sup> ed. New York: McGraw Hill, pp. 464-482.
20. Jensen BV, Skovsgaard T, Neilsen SL [2001]. Functional monitoring of anthracycline cardiotoxicity: a prospective, blinded, long-term observational study of outcome in 120 patients. Ann Onc 13: 699-709.
21. Felker GM, Hu W, Hare JM, Hruban RH, Baughman KL, Kasper EK [1999]. The spectrum of dilated cardiomyopathy: the Johns Hopkins experience with 1,278 patients. Medicine 78(4): July: 270-283.
22. Wynne J, Braunwald E [2001]. The cardiomyopathies and myocarditides. In: Braunwald E, Zipes DP, Libby P, eds. Heart disease. 6<sup>th</sup> ed. Philadelphia, PA: W.B. Saunders, pp. 1751-1755.
23. Bansch D, Antz M, Boczor S, et al. [2002]. Primary prevention of sudden cardiac death in idiopathic dilated cardiomyopathy. The cardiomyopathy trial (CAT). Circulation 105:1453-1458.
24. NFPA [2003]. NFPA 1582: Standard on comprehensive occupational medical program for fire departments. Quincy, MA: National Fire Protection Association.
25. ACC/AHA [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 Testing). [[www.acc.org/clinical/guidelines/exercise/dirIndex.htm](http://www.acc.org/clinical/guidelines/exercise/dirIndex.htm)].
26. U.S. Department of Transportation [2002]. Cardiovascular advisory panel guidelines for the medical examination of commercial motor vehicle drivers. Washington, DC: DOT; FMCSA, Publication No. FMCSA-MCP-02-002. [<http://www.fmcsa.dot.gov/documents/cardio.pdf>]. Date accessed: June 2005.
27. NFPA [2003]. NFPA 1584: Recommended practice on the rehabilitation of members operating at incident scene operations and training exercises. Quincy, MA: National Fire Protection Association.
28. IAFF, IAFC [2000]. The fire service joint labor management wellness/fitness initiative. Washington, DC: International Association of Fire Fighters, International Association of Fire Chiefs.
29. NFPA [2002]. NFPA 1500: Standard on fire department occupational safety and health program. Quincy, MA: National Fire Protection Association.
30. CFR. 29 CFR 1910.134, Respiratory protection. Code of Federal Regulations. Washington, DC: National Archives and Records Administration, Office of the Federal Register.



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31. NFPA [2000]. NFPA 1583: Standard on health-related fitness programs for fire fighters. Quincy, MA: National Fire Protection Association.
32. 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.
33. 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. *J Occup Environ Med* 42:1148-1155.
34. Aldana SG [2001]. Financial impact of health promotion programs: a comprehensive review of the literature. *Am J Health Promot* 15:296-320.
35. Unpublished data [1997]. City Auditor, City of Phoenix, AZ. Disability retirement program evaluation. January 28, 1997.

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