2006
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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

February 2, 2007

Fire Fighter Suffers Heart Attack During Firefighting Operation and Dies Forty Days Later – Georgia

SUMMARY

On May 3, 2006, a 37-year-old male career Fire Fighter (FF) conducted and participated in an 8-hour live-fire training class prior to beginning his shift at 1800 hours. In the early morning hours of May 4th, he responded to a residential fire. Wearing full turnout gear and self-contained breathing apparatus (SCBA), the FF participated in fire suppression and overhaul activities. Afterward, he complained of not feeling well and intermittent chest pain. On scene ambulance personnel evaluated the FF and despite normal vital signs, they transported the FF to the local hospital's emergency department (ED).

An acute myocardial infarction (MI) was diagnosed in the ED by electrocardiogram (EKG) and cardiac enzyme tests. Despite treatment with intravenous (IV) medications (clot dissolving drugs), the FF's condition deteriorated and he was intubated and transferred to a tertiary care medical center. At that institution a cardiac catheterization showed a thrombus (blood clot) in his coronary artery which was partially removed by a specialized catheter (Rheolytic coronary thrombectomy with AngioJet® Catheter). Although the FF survived this initial event, his condition deteriorated in the intensive care unit (ICU) over the next 40 days. Due to his poor prognosis, on June 15, 2006, life support was withdrawn and he was pronounced dead at 1945 hours. The death certificate and autopsy (completed by the County Medical Examiner) listed "hemodynamic failure" due to "healing and remote myocardial infarctions (MIs)" due to "atherosclerotic coronary artery disease (CAD)" as the cause of death. "Acinobacter septicemia" and "excessive physical exertion during firefighting activities" were listed as significant contributing conditions.

It is unclear if any of the following recommendations could have prevented this FF's death at this time. Nonetheless, NIOSH offers these recommendations to improve the FD's overall health and safety program.

- ***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.**

- ***Provide fire fighters with medical evaluations and medical clearance to wear SCBA.***

- ***Develop a wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease (CVD) and improve cardiovascular capacity.***

- ***Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are physically capable of performing the essential job tasks of structural firefighting.***

- ***Discontinue routine annual resting electrocardiograms (EKGs) unless medically indicated.***

- ***Discontinue annual screening chest x-rays unless medically indicated.***

INTRODUCTION & METHODS

On May 4, 2006, a 37-year-old male FF suffered a heart attack while performing fire suppression and overhaul activities. Despite advanced cardiac life support (ACLS), he died 40 days later. NIOSH was notified of this fatality on June 14, 2006 by the United States Fire Administration. NIOSH contacted the affected fire department (FD) on June 20, 2006 to obtain further information and to initiate the investigation. On August 7, 2006, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Georgia to conduct an on-site investigation of the incident.

During the investigation, NIOSH personnel interviewed the following people:

- Fire Chief
- FD Assistant Director
- FD Deputy Chief
- FD Operations Officer
- FD Battalion Chief for Special Operations
- International Association of Fire Fighters (IAFF) Local President
- Crew members
- FF's wife

NIOSH personnel reviewed the following documents:

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

INVESTIGATIVE RESULTS

On May 2nd and 3rd, 2006, the FF participated in fire fighter training at the County Fire Academy. On May 2, 2006, the FF conducted interior search and rescue training from 0800 hours until 1800 hours. The morning training session included moving and raising 24-foot and 35-foot extension ladders, ascending/ descending ladders, and victim (mannequin) removal. The afternoon training session included a) searching a smoke-filled structure and b) two live-burn evolutions (see Photograph 1). The search component included ventilation practices, wall breach, window bailout, raise and lower systems from ladders, and SCBA air consumption. The FF participated in 15-20 searches, all while wearing full turnout gear. The FF's live-burn evolutions were also conducted while wearing

Photograph 1. Fire Training Structure

turnout gear including his SCBA. The temperature for the day rose to a high of 80º Fahrenheit (º F) with 41% relative humidity. On May 3, 2006, the same training occurred from 0800 hours until 1700 hours. The temperature on the 2nd day rose to a high of 84º F and 43% relative humidity.

After the training, the FF reported to Station 24 for duty and was assigned to Heavy Rescue 24 (HR24). The FD was dispatched to three calls that evening. At 1814 hours, units including Truck 425 (T425) (including the FF) were dispatched to a house fire. T425 was cancelled en route at 1819 hours. At 1908 hours, units including Truck 426 (T426) (including the FF) were dispatched to a roof fire. T426 returned to the station at 1920 hours. The FF did not perform any fire fighting duties at these two calls. Finally, at 1926 hours, units including HR24 (including the FF) were dispatched to a motor vehicle accident with entrapment. The FF assisted with packaging and loading the patient into the ambulance. HR24 returned to the station at 1943 hours. The FF spoke with his wife at 2000 hours and stated he was hot, tired, and hungry. Otherwise, he had no complaints and ate dinner soon afterward. The FF retired to his quarters at 2100 hours.

At 0030 hours on May 4, 2006, multiple FD apparatus including HR24 (a total of 17 personnel including the FF) were dispatched to a house fire with entrapment. Units arrived on scene at 0039 hours to find heavy smoke and flames. (See Table 1: Timeline). The occupants had escaped the flames prior to the FD's arrival. The house was a tri-level, single family dwelling, constructed of wood frame with brick and vinyl exterior (see Photograph 2). It was located about 50 feet from the roadway and six feet above grade. Door burglar bars were cut to gain access, thus delaying entry. The fire was at the left (Side 2) and rear (Side 3) of the house. L20, E20, R20, and HR 24 were assigned fire suppression duties.

Photograph 2. Fire Incident

The FF and his crew entered the structure and advanced a charged 1¾-inch hose line to the second story to stop the forward extension of the fire. Crew members breached the wall of a

bathroom to expose the fire, and the FF attacked the fire through the hole in the wall. After passing the hose line to another crew member, the FF and a crew member breached walls in two other rooms to check for fire spread. The FF's SCBA low air alarm sounded, and he told his Captain that he was tired and needed a break.

The FF left the structure and, once outside, dropped to his knees and removed his SCBA facepiece. Crew members assisted the removal of his turnout coat. About 10 minutes later, the Captain went outside and noticed that the FF did not look well. The Captain notified the Safety Officer (SO) that a fire fighter needed immediate medical attention. As the SO approached the FF, he noticed the FF was rocking back and forth and sweating heavily. (Note: the weather was warm [65ºF with 85% relative humidity] and the fire conditions were very hot, therefore this amount of sweating would not have been unusual). Regardless, the SO notified B4 and Rescue 10 (R10) of the situation.

The FF laid down onto the ground and commented that he was dehydrated and tired. After drinking some water, he reported some chest pain. Crew members retrieved medical equipment. An intravenous (IV) line was started, fluids were administered, and the FF began to feel better and his chest pain resolved. R10 personnel checked the FF (0120 hours) and his vital signs were as follows: blood pressure (BP) - 120/84 millimeters of mercury (mmHg), pulse - 89 beats per minute (bpm), and blood oxygen saturation - 99%. Despite these normal vital signs and the FF not wanting to go to the hospital, B4 ordered him transported. At 0134 hours, R10 left the scene en route to the hospital's ED. En route, additional IV fluids and oxygen were administered. R10 arrived at the ED at 0159 hours.

Inside the ED, the FF reported being weak and dizzy, but denied chest pain. A second IV was started, and the FF complained of worsening shortness of breath. He had an ashen skin color and was sweating profusely. Cardiac auscultation revealed a heart murmur (grade 2/6 systolic ejection murmur) and an S3 gallop, both signs consistent with heart failure. An EKG revealed changes consistent with an acute anteroseptal MI (heart attack). Despite treatment with oxygen, aspirin, Heparin, and an intravenous clot dissolving drug (thrombolytic agent), the FF's condition deteriorated. His blood pressure went down requiring IV medications (pressors), while his heart rate and respiratory rate increased. He was intubated (a breathing tube placed into the trachea) just prior to transfer to a tertiary care hospital. Tube placement was confirmed by bilateral breath sounds, end tidal carbon dioxide, and chest x-ray. A carboxyhemoglobin (CoHb) level was not obtained.

As the FF was being loaded into the ambulance for transfer, his heart rhythm changed to ventricular tachycardia (Vtach) (a life threatening heart rhythm), but IV medications successfully returned his rhythm to sinus tachycardia. The FF arrived at the tertiary care hospital where an echocardiogram revealed a left ventricular ejection fraction (LVEF) of 15%-20% with essentially normal heart valves and ventricular walls. A cardiac catheterization revealed a 90% occluded left anterior descending (LAD) coronary artery with a large thrombus (blood clot), with a diffusely diseased left circumflex and right

coronary artery (RCA). The anterior wall of the left ventricle was severely hypokinetic (diminished/slow moving) with an akinetic (not moving) apical wall. The LVEF was estimated to be 20%. Using a specialized catheter (AngioJet®), the LAD thrombus was partially removed which improved the blood flow down the LAD and past the thrombus.

Although the FF survived his acute MI, he remained in critical condition in the ICU. Over the next 39 days, he suffered a number of complications including a deep venous thrombosis/pulmonary embolus, stroke (cerebrovascular accident [CVA]), Acute Respiratory Distress Syndrome (ARDS) secondary to multi-drug resistant Acinetobacter infection (sepsis), acute renal failure, and pneumonia. On June 12th, an intraaortic balloon pump was placed for hemodynamic support. On June 13th, due to his poor prognosis, the FF was removed from the life support machines and he died at 1945 hours.

Medical Findings. The death certificate and autopsy (completed by the County Medical Examiner) listed "hemodynamic failure" due to "healing and remote MIs" due to "CAD" as the cause of death. "Acinetobacter septicemia" and "excessive physical exertion during firefighting activities" were listed as significant contributing conditions. Pertinent findings from the autopsy, performed on June 14, 2006, included the following:

- Atherosclerotic CAD
  - Normal sized heart at 400 grams
  - Old (healed) MI in the lateral portion of the left ventricle
  - Recent MI in the anteroseptal portion of the left ventricle
  - Atherosclerotic lesions (50% - 60% blockage) in most of the coronary arteries
  - Recent plaque hemorrhage and rupture of the proximal portion of the LAD
- No valve abnormalities
- No chamber dilation or hypertrophy

On autopsy, the FF weighed 278 pounds and was 72 inches tall, giving him a body mass index (BMI) of 37.69 kilograms per square meter (kg/m^2). A BMI >30.0 kg/m^2 is considered obese.[1]

In 1988, at the age of 19, the FF was diagnosed with lymphoma (Hodgkin's Disease). He underwent radiation therapy. NIOSH could not verify reports stating that the FF also received chemotherapy. In 1989 the FF had his spleen removed, reportedly due to a physical trauma.

In 2005, he was hospitalized for chest pain which occurred during firefighting activities and was relieved by sublingual nitroglycerin (medication for acute angina). A 12-lead EKG conducted by the paramedics in the field revealed ST-segment depression in the anterior and lateral leads suggestive of ischemia. The paramedics also reported a non-sustained episode of Vtach and a 5-6 second episode of asystole (no heart beat). In the ED, all his subsequent EKGs were normal and he displayed no arrhythmias. Three sets of sequential cardiac enzymes (Table 2) were performed which showed a rise and subsequent fall of the enzymes; a finding very suggestive of an MI. Two days later a cardiac catheterization revealed a 99% blockage of a small branch (mid-lateral obtuse marginal) of his left circumflex coronary artery. This artery

would have been responsible for blood flow to the inferior/lateral portion of the left ventricle. He was also noted to have a reduced left ventricle function (an LVEF of 40%), global hypokinesis, and minimal blockages (40%) of his other coronary arteries. The consulting cardiologist was perplexed by the degree of LV dysfunction in relation to his relatively mild CAD. Therefore, the FF was discharged with a diagnosis of primary cardiomyopathy possibly due to the following: viral, alcohol abuse, or radiation therapy. He was held out of work and then returned to restricted (driver or teaching) duty after one week.

Follow-up by another cardiologist one month later stated that the FF "has a dilated cardiomyopathy" and "he clearly has not had a myocardial infarction." Three months later a follow-up echocardiogram revealed normal ventricle function (LVEF 60%, normal sized chambers and physiologically normal valves). The FF was released to return to full duty with no restrictions.

At the time of his death, the FF was taking two cardiac prescription medications. According to his wife and crew members, he did not express any symptoms of cardiac-related problems during the days or months prior to his death.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, this career FD consisted of 812 uniformed personnel, served a population of 678,000 in a 286 square-mile-area, and had 26 fire stations.

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
- pass a written general knowledge test
- pass a background check
- pass a pre-employment physical examination
- pass a voice analysis test (lie detector)
- pass an oral interview
- pass a physical ability test

The applicant is then offered employment. The new hire is placed into a 16-week training program to achieve the Fire Fighter I level. The fire fighter is then placed into a 6-month Emergency Medical Technician (EMT) school, if the fire fighter is not already an EMT. Once the fire fighter becomes an FF/EMT, the fire fighter is assigned to a fire station and receives further FD-specific orientation and training. Fire fighters work 24 hours on-duty 0800 hours to 0800 hours, and 48 hours off-duty. Every ninth shift is a "Kelly Day" off.

The FF was certified as a Fire Fighter III, Driver/Operator, EMT – Intermediate, Hazardous Materials Technician, Fire Service Instructor, Wildland Fire Fighter, Divemaster, Confined Space Rescue Technician, and certified in Technical Rope Rescue. He had 10 years of firefighting experience. He also served as an adjunct instructor for the Georgia State Fire Academy for 8 years and was an Assistant Chief for his hometown's volunteer FD.

Pre-placement/Periodic Medical Evaluation. A pre-placement medical evaluation is required by this FD for all candidates. In addition, an annual medical evaluation is required for all members. The medical evaluations include the following components:

- Complete medical history
- Physical examination
- Vital signs
- Complete blood count
- Complete metabolic panel (SMA 20)
- Vision screening
- Audiogram
- Urinalysis
- Urine drug screen
- Pulmonary function (spirometry)
- Resting EKG
- Chest x-ray

A County-contract physician performs the medical evaluations and forwards the clearance-for-duty opinion to the County Human Resources Office, who makes the final decision regarding medical clearance for duty. Medical clearance for SCBA use is not required, but annual respirator fit tests are performed. A return-to-duty medical clearance is required from the fire fighter's PCP 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. A job description is included in the forms the PCP must review and endorse. The clearance is reviewed by the County Health Department physician, who forwards the clearance form (without specific medical information) to the fire fighter's Battalion Chief and Risk Management; the latter makes the final medical clearance-for-duty decision.

Health/Wellness. An annual physical agility test is not 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 fire stations. Health and nutrition information is made available to all firefighters.

DISCUSSION

CAD and the Pathophysiology of Sudden Cardiac Death (SCD). In the United States, CAD (atherosclerosis) is the most common risk factor for cardiac arrest and SCD.[2] Risk factors for its development include increasing age, male gender, heredity, tobacco smoking, diabetes, high blood cholesterol, high BP, and physical inactivity/obesity.[2] The FF had three American Heart Association (AHA) risk factors for CAD: male gender, high blood cholesterol, and obesity; he had CAD based on his cardiac catheterizations in 2005 and 2006 and his autopsy report.

Narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.[3] However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.[4] 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.[5] This sudden blockage is primarily due to blood clots (thromboses) forming on the top of atherosclerotic plaques. The FF suffered a heart attack in 2005 as determined by EKG and blood tests of cardiac enzymes; his autopsy showed scarring (fibrosis) in the

lateral portion of his left ventricle. The FF also had a heart attack in May 2006 as determined by EKG, cardiac catheterization, and autopsy. Blood clot (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.[5] 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.[6]

Firefighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.[7] 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.[8] Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.[9-12] Immediately preceding the onset of symptoms and in the 2 days before, the FF participated in multiple fire suppression and overhaul activities while wearing full turnout gear and SCBA. Most of these activities occurred during periods of elevated temperatures and humidity. This is considered a very heavy level of physical exertion.[7,13] The physical stress of performing these tasks, the elevated temperatures, and the presence of underlying atherosclerotic CVD contributed to the FF's death.

In February 2005, the FF was diagnosed with dilated cardiomyopathy. This diagnosis was made because the consulting cardiologist felt the FF's relatively minor CAD could not be responsible for his moderate LV dysfunction. However, a subsequent echocardiogram three months later showed a normal-sized heart and heart chambers with fully recovered LV function. Therefore, the diagnosis was changed to probable stress cardiomyopathy. Stress cardiomyopathy is defined as temporarily weakened heart muscles.[14-16] It can easily be confused with a heart attack. However, instead of an acute blood clot (thrombus) triggering the event, sudden emotional stress may trigger stress cardiomyopathy.[14-16] The stress can precipitate severe, reversible LV dysfunction in patients without coronary disease. Exaggerated sympathetic stimulation is probably the underlying mechanism. It was originally described in Japan as Takotsubo Syndrome and, only recently, has it has been recognized in the Western world.[14-16] Because the FF had no known emotional stress prior to his February 2005 episode, NIOSH investigators consider his relatively small heart attack to be responsible for his reversible LV dysfunction.

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.*[17] NFPA 1582 states that a history of MI compromises a member's ability to safely perform such essential job tasks as firefighting, wearing an SCBA, climbing six or more flights of stairs

while wearing fire protective ensemble weighing at least 50 pounds, victim search and rescue, advancing water-filled hoselines (weighing up to 130 pounds for a 50 foot section of 2½-inch hoseline), prolonged periods of extreme physical exertion, and functioning as an integral component of a team.[17] When evaluating a fire fighter after an MI, NFPA 1582 recommends a radionuclide stress test to evaluate exercise tolerance and the presence of exercise-induced myocardial ischemia or ventricular arrhythmias.[17] Even though this FF's LVEF had returned to normal levels after his MI in 2005, had an imaging exercise stress test been performed, perhaps an abnormality might have been identified and he would have been restricted from full fire fighting duty, thus preventing his sudden cardiac death at this time.

RECOMMENDATIONS

It is unclear if any of these recommendations could have prevented this FF's death at this time. Nonetheless, NIOSH offers these recommendations to improve the FD's overall health and safety program.

***Recommendation #1: 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.**

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[17] and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.[18] Although the FD is not legally required to follow any of these standards, they provide effective guidelines for implementing a medical evaluation requirement.

Applying NFPA 1582 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*, Chapter 8-7.1 and 8-7.2[19] addresses these issues.

The physical evaluation could be conducted by the fire fighter's primary care physician. However, if the evaluation is performed by the fire fighter's primary care physician, the results must be communicated to the County physician, who makes the final determination for clearance for duty.

For fire fighters with a previous history of an MI, NFPA 1582 recommends restricted duty if any of the following are present:

(1) Current angina pectoris even if relieved by medication

(2) Persistent significant stenosis in any coronary artery (> 70% lumen diameter narrowing) following treatment

(3) Lower than normal LVEF as measured by radionuclide scan, contrast ventriculography, or echocardiography

(4) Maximal exercise tolerance of < 42 milliliters of oxygen per minute per kilogram or < 12 metabolic equivalents (METS)

(5) Exercise-induced ischemia or ventricular arrhythmias observed by radionuclide stress test during an evaluation reaching at least a 12-METS workload

(6) History of MI, angina, or CAD with persistence of modifiable risk factor(s) for acute coronary plaque rupture.

Recommendation #2: Provide fire fighters with medical evaluations and medical 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.[20] 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. Georgia 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 #3: Develop a 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.[19] NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters*, provides the minimum requirements for a health-related fitness program.[21] 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 create a practical fire service program. They produced a manual and a video which details elements of such a program.[18] Wellness programs have been shown to be cost effective, typically by reducing the number of work-related injuries and lost work days.[22-24] 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.[25]

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 firefighting.

NFPA 1500 requires FD members who engage in emergency operations to be annually evaluated and certified by the FD as meeting the physical performance requirements identified in paragraph 8-2.1 of the standard.[19] The FD should conduct annual physical ability tests to ensure the fire fighters are physically capable of performing firefighting duties.

Recommendation #5: Discontinue routine annual resting EKGs unless medically indicated.

According to NFPA 1582, "periodic resting electrocardiograms have not been shown to be useful, but can be reasonable as a member's age increases."[17] These should be replaced by stress EKGs for fire fighters at increased risk for CAD defined as males over age 45 (or females over age 55) with two or more CAD risk factors.[17] The stress EKG is a much better tool for uncovering occult CAD or those at risk for SCD. Therefore, only pre-placement resting EKGs are recommended unless medically indicated by other information. The current annual resting EKGs being conducted by the FD represent an unnecessary expense for the FD.

Recommendation #6: Discontinue annual screening chest x-rays unless medically indicated.

According to NFPA 1582, "chest x-rays shall include an initial baseline and shall be repeated every 5 years or as medically indicated."[17] Chest x-rays are currently being conducted every year during the FD's annual medical evaluation. These x-rays expose members to unnecessary radiation and represent an unnecessary expense for the FD. In addition, these x-rays are not recommended by the OSHA Hazmat Standard unless clinically indicated (e.g., respiratory symptoms).[26,27]

REFERENCES

1. National Heart Lung Blood Institute [2003]. Obesity education initiative. [http://www.nhlbisupport.com/bmi/bmicalc.htm]. Date accessed: September 2006.

2. AHA [1998]. AHA scientific position, risk factors for coronary artery disease. Dallas, TX: American Heart Association.

3. 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. 16th ed. New York: McGraw-Hill, pp. 1425-1430.

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

5. 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.

6. Kondo NI, Muller JE [1995]. Triggering of acute myocardial infarction. J Cardiovasc Risk 2:499-504.

7. Gledhill N, Jamnik VK [1992]. Characterization of the physical demands of firefighting. Can J Spt Sci 17(3):207-213.

8. 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.

9. 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.

10. 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.

11. 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.

12. 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.

13. 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.

14. Stress cardiomyopathy [2006]. [http://en.wikipedia.org/wiki/Stress_cardiomyopathy]. Date accessed: October 2006.

15. Wittstein IS, Thiemann DR, Lima JAC, Baughman KL, Schulman SP, Gerstenblith G, Wu KC, Rade JJ, Bivalacqua TJ, Champion HC [2005]. Neurohumoral features of myocardial stunning due to sudden emotional stress. N Engl J Med 352(6):539-548.

16. Pavin D, Le Breton H, Daubert C [1997]. Human stress cardiomyopathy mimicking acute myocardial syndrome. Heart 78:509-511.

17. NFPA [2007]. NFPA 1582: Standard on comprehensive occupational medical program for fire departments. Quincy, MA: National Fire Protection Association.

18. IAFF, IAFC [2000]. The fire service joint labor management wellness/fitness initiative. Washington, DC: International Association of Fire Fighters, International Association of Fire Chiefs.

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

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

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

22. 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.

23. 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.

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

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

26. CFR [2002]. 29 CFR 1910.120. Hazardous waste operations and emergency response. Subpart F – Medical Surveillance. Code of Federal Regulations. [http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=975]. Date accessed: January 2006.

27. NIOSH [1985]. Occupational safety and health guidance manual for hazardous waste site activities. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 85-115. [http://www.cdc.gov/niosh/pdfs/85-115-a.pdf]. Date accessed: September 2006.

28. 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.

INVESTIGATOR INFORMATION

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Table 1: TIMELINE (FD Dispatch Center)

0030 hours:	Rescue 20 (R20), Squad 7 (S7), Engine 20 (E20), Engine 4 (E4), Engine 10 (E10), Ladder 20 (L20), Battalion 3 (B3), Battalion 4 (B4), Heavy Rescue 24 (HR24) respond to structure fire with heavy smoke and flames. Everyone is out of the house.
0032 hours:	E10, L20, E4, B3, B4, S7, R20, E20, and HR24 en route
0039 hours:	L20 and E10 on scene
0040 hours:	E4 on scene
0041 hours:	L20 assuming command
0043 hours:	B3 on scene
0044 hours:	R20 on scene
0045 hours:	Car 7, Engine 7 (E7), and Engine 6 (E6) en route. B3 requests two more Engines due to very heavy smoke
0046 hours:	E6 and HR 24 on scene
0047 hours:	E7 on scene
0048 hours:	Car 7 and S7 on scene
0050 hours:	B4 on scene
0052 hours:	Rescue 10 (R10) en route. B3 requests another Rescue.
0055 hours:	E6 on scene. E20, R20, L20, and B3 PAR
0056 hours:	E7 and E20 charge the 2½s
0057 hours:	E4 PAR
0058 hours:	E7, E10, S7, and B3 PAR
0059 hours:	B4 and E6 PAR. B3 PAR concluded
0100 hours:	R10 on scene. L20 is out of the building. Fire under control
0104 hours:	R10 assigned to rehab section
0125 hours:	R10 – fire fighter being transported to hospital for heat exhaustion

Table 2

Cardiac Enzymes

	02/19/05 0135	02/19/05 0958	02/20/05 0645	
CK:	428 U/L	786 U/L	591 U/L	(normal range is 22 - 269 U/L)
CK-MB:	9.1 ng/mL	59.4 ng/mL	42.6 ng/mL	(normal range is 0.1 - 5.0 ng/mL)
Troponin I:	0.06 ng/mL	1.06 ng/mL	0.70 ng/mL	(normal range is 0.01 - 0.03 ng/mL)

Creatine kinase (CK) is the blood test most commonly used to confirm the existence of heart muscle damage.

CK-MB, a small fraction of the CK enzyme, is often measured as well. CK-MB shows an increase above normal in a person's blood test about six hours after the start of a heart attack. It reaches its peak level in about 18 hours and returns to normal in 24 to 36 hours. The peak level and the return to normal can be delayed in a person who's had a large heart attack, especially if they don't get early and aggressive treatment.

Tests can measure the level of other cardiac muscle proteins called troponins, specifically troponin T (cTnT) and troponin I (cTnI). These proteins control the interactions between actin and myosin, which contracts or squeezes the heart muscle. Troponins specific to heart muscle have been found, allowing the development of blood tests (assays) that can detect minor heart muscle injury ("microinfarction") not detected by CK-MB. Normally the level of cTnT and cTnI in the blood is very low. It increases substantially within several hours (on average four to six hours) of muscle damage. It peaks at 10 to 24 hours and can be detected for up to 10 to 14 days.[28]

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