



Fire Fighter-Paramedic Suffers On-Duty Cardiac Death at Fire Station – Texas

Executive Summary

On June 22, 2011, a 35-year-old male career fire fighter-paramedic (FF-P) was working a 24-hour shift on a rescue unit (ambulance). During the shift he responded to 10 emergency medical calls and participated in classroom training. After the last call at 0511 hours on June 23, 2011, the FF-P returned to the fire station at 0608 hours and went to bed. At approximately 0745 hours, the FF-P was found unresponsive. Cardiopulmonary resuscitation (CPR) and advanced life support were begun, and the FF-P was transported to the local hospital's emergency department (ED). Despite medical treatment at the fire station, in the ambulance, and in the ED, the FF-P died. The death certificate and autopsy listed "atherosclerotic coronary artery disease" as the cause of death. Whether the physical stress of emergency response was sufficient to trigger his sudden cardiac death remains unclear.

NIOSH investigators offer the following recommendations to address general safety and health issues, but these recommendations probably would not have prevented the FF-P's death.

Provide preplacement and annual medical evaluations to all fire fighters in accordance with NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments.

Discontinue lumbar spine x-rays as a screening test administered during the preplacement medical evaluation.

Introduction & Methods

On June 23, 2011, a 35-year-old male career FF-P suffered sudden cardiac death at his fire station. NIOSH contacted the affected fire department (FD) on June 24, 2011, to gather additional information, and on January 11, 2012, to initiate the investigation. On January 17, 2012, a safety and occupational health specialist from the NIOSH Fire Fighter Fatality Prevention and Investigation Program conducted an on-site investigation of the incident.

During the investigation, NIOSH personnel interviewed the following people:

- Chief officers Training Division
- Crew members
- FF-P's sister

NIOSH personnel reviewed the following documents:

- FD standard operating procedures
- FD annual report for 2011
- FD incident reports
- FD medical records
- FD emergency medical service record
- Hospital ED record
- Death certificate
- Autopsy report
- Primary care physician records

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The National Institute for Occupational Safety and Health (NIOSH), an institute within the Centers for Disease Control and Prevention (CDC), is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. In 1998, Congress appropriated funds to NIOSH to conduct a fire fighter initiative that resulted in the NIOSH “Fire Fighter Fatality Investigation and Prevention Program” which examines line-of-duty-deaths or on duty deaths of fire fighters to assist fire departments, fire fighters, the fire service and others to prevent similar fire fighter deaths in the future. The agency does not enforce compliance with State or Federal occupational safety and health standards and does not determine fault or assign blame. Participation of fire departments and individuals in NIOSH investigations is voluntary. Under its program, NIOSH investigators interview persons with knowledge of the incident who agree to be interviewed and review available records to develop a description of the conditions and circumstances leading to the death(s). Interviewees are not asked to sign sworn statements and interviews are not recorded. The agency’s reports do not name the victim, the fire department or those interviewed. The NIOSH report’s summary of the conditions and circumstances surrounding the fatality is intended to provide context to the agency’s recommendations and is not intended to be definitive for purposes of determining any claim or benefit. For further information, visit the program website at www.cdc.gov/niosh/fire or call toll free 1-800-CDC-INFO (1-800-232-4636).

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Results of Investigation

Incident. On June 22, 2011, the FF-P reported to his fire station at 0620 hours for his 24-hour shift. He was assigned as the paramedic of the rescue unit (Rescue 49). During his shift the FF-P responded to 10 emergency medical calls, none which involved heavy physical exertion. The last call was for patient assistance and did not involve transport to the hospital. Rescue 49 cleared the scene at 0605 hours and returned to the fire station at 0607 hours. Upon arrival at the fire station, the FF-P went to the restroom, then filled a medium-sized cooler with ice, loaded it into his pickup truck, and went to bed. The FF-P typically rested for about an hour before leaving the station at the end of his shift. The FF-P appeared well and did not report any symptoms.

At approximately 0745 hours, crew members noticed the FF-P was still in bed. When they tried to wake him, the FF-P was unresponsive with no pulse. They alerted other crew members in the station and moved the FF-P on to the hallway floor as the others retrieved medical equipment. The cardiac monitor revealed asystole (no heart beat), and CPR was begun. An intravenous line was placed as the FF-P was intubated. Cardiac resuscitation medications were administered via the intravenous line, and oxygen was administered via bag-valve mask. Tube placement was verified by capnography [AHA 2000]. The FF-P was placed into the rescue unit at 0812 hours, and it departed the station for the hospital's ED.

The rescue unit arrived at the ED at 0816 hours. Inside the ED, resuscitation efforts continued unsuccessfully until 0848 hours, when the attending physician pronounced the FF-P dead.

Medical Findings. The death certificate and autopsy listed “atherosclerotic coronary artery disease” as the cause of death. Specific findings from the autopsy included severe coronary artery disease (CAD) and evidence of old myocardial infarctions (heart attacks) (Appendix A).

The FF-P's only risk factor for CAD was high blood cholesterol diagnosed in 2008; it was treated unsuccessfully with diet and exercise. He was not prescribed a cholesterol-lowering medication although he regularly took vitamins and supplements. The FF-P was also diagnosed with hyperthyroidism in April 2010 but was not prescribed a thyroid-regulating medication until January 2011; the prescription was only filled once. After a trip overseas in 2010, the FF-P experienced a 20-pound weight loss and chronic fatigue. He was evaluated by a rheumatologist who ordered blood tests revealing an elevated erythrocyte sedimentation rate, elevated C-reactive protein, mild anemia, and abnormal thyroid. In March 2011, he was evaluated by a nutritionist who determined the FF-P suffered from a parasitic infection and recommended an herbal remedy.

In June 2011 the FF-P experienced radiating chest pain and a syncopal episode while driving (he awoke before crashing the vehicle) off-duty and was evaluated by a cardiologist. Testing included a resting electrocardiogram (EKG) and a Holter monitor. The EKG revealed a basic sinus rhythm with T-wave inversion (non-specific finding), and the Holter monitor showed no arrhythmias other than two episodes of sinus tachycardia (normal). He was not given any work restrictions by his primary care physician, and the FD physician was not notified about this episode.

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Description of the Fire Department

At the time of the NIOSH investigation, the FD consisted of 56 fire stations with 1,800 career uniformed personnel and served 1.2 million residents in a geographic area of 385 square miles. In 2011, the FD responded to 318,964 incidents including 145,298 fire calls and 173,666 medical calls.

Membership and Training. The FD requires new full-time fire fighter applicants to be 18 years of age with a valid state driver's license, have 45 hours of college or 4 years of active military service with an honorable discharge, have no more than three moving violations within the past 24 months, have no pending civil or criminal cases during the application process, pass a drug test, be legally eligible to work in the United States, successfully complete the candidate physical ability test (CPAT) [IAFF/IAFC 2007], and pass a pre-placement medical evaluation. Newly hired fire fighters go through 15-months of fire fighter-paramedic training. Upon completion of training, the new hire is on probation for 6 months and works a 24 hours on-duty/48 hours off-duty schedule.

Recurrent training occurs daily on each shift. The state minimum requirement for fire fighter certification is the 468-hour fire fighter I and II course and the 40-hour emergency care-ambulance course. Career fire fighters must be state certified within 1 year of employment. The state also requires a minimum of 20 hours training for recertification. Annual recertification is required for hazardous materials; emergency medical technician and paramedic recertification is biannual. The FF-P was certified as a fire fighter II and emergency medical technician-paramedic. He had 4 years of fire fighting experience.

Preplacement Medical Evaluations. The FD requires preplacement medical evaluations for all applicants. Components of this evaluation include the following:

- Complete medical history
- Physical examination
- Blood tests: chemistries (SMA 20)
- Pulmonary function test
- Audiogram
- Vision screen
- Chest x-ray
- Urinalysis
- Back x-ray

These evaluations are performed by a contracted physician who makes a determination regarding medical clearance for fire fighting duties and forwards this decision to the FD recruitment section.

Periodic Medical Evaluations. The FD requires periodic (every 18–24 months) medical evaluations and medical clearance to wear a respirator for members assigned to emergency operations. Components of this evaluation include the following:

- Complete medical history
- Physical examination
- Blood tests: blood chemistries (SMA 26) and complete blood count (CBC)
- Pulmonary function test
- Audiogram
- Vision screen
- Chest x-ray
- Urinalysis
- EKG
- Stress electrocardiogram (Bruce protocol)
- Cancer screening

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Description of the FD (cont.)

- Prostate-specific antigen for men over age 50, men over age 40 with positive family history, or if otherwise clinically indicated
- Mammograms for women over age 40, or if otherwise clinically indicated
- Urinalysis
- Mental health screening

These evaluations are performed by the FD-contracted physician who makes a determination regarding medical clearance for fire fighting duties and forwards this decision to the FD. Members may use their personal physician for all or part of the medical evaluation. When members choose to use their personal physician, the evaluation must be conducted by a licensed physician within 45 days of the member's scheduled medical evaluation with the FD-contracted physician. Results of the personal physician's medical evaluation must be submitted to the FD-contracted physician who makes the final determination for clearance for duty.

In addition to the periodic medical evaluations, 3-lead EKGs (looking at lead 2) and blood pressure measurements are performed semiannually by an FD paramedic or ambulance medical officer on all fire fighters. If an EKG is abnormal or a blood pressure is greater than 140/90 millimeters of mercury, the fire fighter is encouraged to seek follow-up with their primary care physician.

Employees who are injured at work or are ill and off work for more than three shifts must be evaluated by their personal physician. This physician forwards a recommendation regarding return to work to the FD-contracted physician, who makes the final determination. An annual self-contained breathing apparatus facepiece fit test is also required.

Health and Wellness Programs. The FD has a mandatory wellness/fitness program, and exercise equipment is available in the fire stations. Exercise time is available (30 minutes to one hour per shift) but is not protected time (i.e., the employee is not taken out of service). A medical evaluation and fitness assessment are provided every 18-24 months as funding allows. Based upon the assessed fitness level, the FD offers monetary rewards as an incentive to exercise. The FF-P participated in this program by jogging and lifting weights in the station approximately 1 hour per shift and at a local gym at least 2 additional days per week.

Discussion

Atherosclerotic Coronary Artery Disease. In the United States, atherosclerotic CAD is the most common risk factor for cardiac arrest and sudden cardiac death [Meyerburg and Castellanos 2008]. Risk factors for its development include age older than 45, male gender, family history of CAD, smoking, high blood pressure, high blood cholesterol, obesity/physical inactivity, and diabetes [AHA 2011; NHLBI 2011]. The FF-P had two CAD risk factors (male gender and high blood cholesterol).

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades [Libby 2008]. However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion [Shah 1997]. 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 [Fuster et al. 1992]. This sudden blockage is primarily due to blood clots (thromboses) forming on top of atherosclerotic plaques.

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Discussion (cont.)

Establishing a recent (acute) heart attack requires any of the following: characteristic EKG changes, elevated cardiac enzymes, or coronary artery thrombus. In this case, the EKG did not have a heart rhythm (asystole) to verify an acute heart attack (myocardial infarction), the FF-P's cardiac enzymes were not tested, and the autopsy did not reveal a thrombus. However, occasionally (16%–27% of the time) postmortem examinations do not reveal the coronary artery thrombus/ plaque rupture during acute heart attacks [Davies 1992; Farb et al. 1995]. The autopsy revealed severe CAD and microscopic evidence of a remote (old) heart attack. Although the FF-P did not report episodes of chest pain (angina), a heart attack cannot be ruled out. In up to 20% of individuals the first evidence of CAD may be myocardial infarction or sudden death [Thaulow et al. 1993; Libby 2008]. Thus, the FF-P either suffered an acute myocardial infarction (heart attack) or a primary arrhythmia due to his underlying CAD.

Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks and sudden cardiac death [Albert et al. 2000]. Heart attacks in fire fighters have been associated with alarm response, fire suppression, and heavy exertion during training (including physical fitness training) [Kales et al. 2003; Kales et al. 2007; NIOSH 2007]. The FF-P had responded to 10 alarms, expending approximately 5 METs, which is considered light-moderate physical activity [AIHA 1971; Ainsworth et al. 2011]. It is unclear if this amount of physical activity is sufficient to trigger a heart attack, even in an individual with underlying CAD.

Occupational Medical Standards for Structural Fire Fighters. To reduce the risk of sudden cardiac arrest or other incapacitating medical conditions among fire fighters, the NFPA developed NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments [NFPA 2007]. This voluntary industry standard provides the components of a preplacement medical evaluation and medical fitness for duty criteria. The FD's preplacement medical evaluation is essentially NFPA compliant (a resting EKG required by NFPA is not performed, and routine preplacement back x-rays are performed despite not being recommended by NFPA).

The FD's medical evaluations occur every 18–24 months; the FF-P's scheduled appointment was not until the fall of 2011. Because of age and lack of risk factors for CAD, no exercise stress test was indicated [Gibbons et al. 2002; NFPA 2007]. In June 2011, the FF-P had one episode of chest pain and syncope. Medical testing did not reveal the cause, and the FF-P remained on full duty status per his primary care physician. The FD physician was not made aware of this episode; however, it is unlikely that having this information would have changed the outcome because NFPA 1582 does not restrict a person with a single episode of syncope with no underlying disease after further evaluation [NFPA 2007].

The FF-P's 20-pound weight loss remained a mystery as no specific cause was identified. He was diagnosed with hyperthyroidism and an anxiety disorder. None of these conditions, however, cause CAD or sudden cardiac death.

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Recommendations

NIOSH investigators offer the following recommendation to address general safety and health issues, but it is unlikely these recommendations would have prevented the FF-P's death.

Recommendation #1: Provide preplacement and annual medical evaluations to all fire fighters in accordance with NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments.

Guidance regarding the content and frequency of these medical evaluations can be found in NFPA 1582 and in the International Association of Fire Fighters (IAFF)/International Association of Fire Chiefs (IAFC) Fire Service Joint Labor Management Wellness/Fitness Initiative [NFPA 2007; IAFF, IAFC 2008]. These evaluations are performed to determine fire fighters' medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others. The FD provides a preplacement medical evaluation to all applicants. The medical evaluation is complete except for performing a baseline resting EKG.

Additionally, NFPA requires members to provide complete and accurate information to the FD physician and to report any medical condition that could interfere with the ability of the individual to safely perform essential job tasks, such as illness, injury, and use of prescription drugs.

Recommendation #2: Discontinue lumbar spine x-rays as a screening test administered during the preplacement medical evaluation.

The FD currently performs preplacement physical evaluations, which include routine lumbar spine x-

rays. While these x-rays may be useful in evaluating individuals with existing problems, the American College of Radiology, American College of Occupational and Environmental Medicine, and NIOSH have concluded that lumbar spine x-rays have no value as a routine screening measure to determine risk for back injuries [Present 1974; Lincoln et al. 1979; Gibson 1998]. This procedure involves both an unnecessary radiation exposure for the applicant and an unnecessary expense for the FD.

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Investigator Information

This incident was investigated by the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component in Cincinnati, Ohio. Mr. Tommy Baldwin (MS) led the investigation and co-authored the report. Mr. Baldwin is a Safety and Occupational Health Specialist, a National Association of Fire Investigators (NAFI) Certified Fire and Explosion Investigator, an International Fire Service Accreditation Congress (IFSAC) Certified Fire Officer I, and a former Fire Chief and Emergency Medical Technician. Dr. Thomas Hales (MD, MPH) provided medical consultation and co-authored the report. Dr. Hales is a member of the NFPA Technical Committee on Occupational Safety and Health, and Vice-Chair of the Public Safety Medicine Section of the American College of Occupational and Environmental Medicine (ACOEM).

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Appendix A

Autopsy Findings

- Atherosclerotic coronary artery disease
 - Severe (0%–90%) focal narrowing of the right coronary artery
 - Severe (75%–80%) focal narrowing of the left anterior descending coronary artery
 - Microscopic evidence of a remote myocardial infarction as evidenced by patchy myocardial fibrosis of the left ventricle and interventricular septum
- Normal sized heart; heart weighed 330 grams (g); predicted normal weight is 317 g (ranges between 240 g and 419 g as a function of sex, age, and body weight) [Silver and Silver 2001]
- Normal cardiac valves
- No evidence of a coronary artery thrombus (blood clot)
- No evidence of a pulmonary embolus (blood clot in the lung arteries)
- Blood tests for drugs and alcohol were negative

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