



Death in the line of duty...

NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

A summary of a NIOSH fire fighter fatality investigation

June, 2012

Lieutenant suffers on duty cardiac death at a Regional Dispatch Center - Ohio

Executive Summary

On October 29-30, 2010, a 52-year-old male career Lieutenant (LT) was on duty at the Regional Dispatch Center. During his 24-hour shift which began at 0700 hours, he monitored dispatches and provided supervision, assistance, and training to dispatchers. During his shift he also went jogging and underwent a respirator medical clearance examination. He was last seen at 2230 hours in the Dispatch Center. At approximately 0620 hours on October 30, 2010, he was found unresponsive in his office within the Dispatch Center with no pulse or respirations. Local paramedics were summoned and arrived on scene at 0631 hours. Cardiopulmonary resuscitation (CPR) and advanced life support (ALS) were performed until the LT was pronounced dead at 0700 hours and resuscitation efforts were discontinued. The death certificate completed by the attending physician listed “sudden cardiac death” as the immediate cause of death, “cardiomyopathy” and “ventricular ectopy” as underlying causes, and “obstructive sleep apnea” as another significant condition. No autopsy was performed.

NIOSH investigators offer the following recommendations to address general safety and health issues. Had some of these recommended programs been implemented, specifically incorporating exercise stress tests into the Fire Department’s medical evaluation program, perhaps the FF’s death could have been prevented.

Institute a policy for conducting exercise stress tests based on a member’s coronary heart disease risk profile.

Phase in a comprehensive wellness and fitness program for fire fighters.

Ensure fire fighters are cleared for return to duty by a healthcare provider knowledgeable about the physical demands of fire fighting, the personal protective equipment used by fire fighters, and the various components of National Fire Protection Association (NFPA) 1582.

Provide an annual medical evaluation to all fire fighters.

Perform an annual physical performance (physical ability) evaluation for all members.

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

Introduction & Methods

On October 30, 2010, a 52-year-old LT died during a 24-hour work shift. NIOSH was notified of this fatality on November 1, 2010, by the U.S. Fire Administration. NIOSH contacted the affected FD shortly thereafter to request further information and to schedule the investigation. On March 8, 2011, a contractor for the NIOSH Fire Fighter Fatality Investigation Team (the NIOSH

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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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Introduction & Methods (cont.)

investigator) conducted an on-site investigation of the incident.

During the investigation, the NIOSH investigator interviewed the following people:

- Fire Chief
- Assistant Fire Chief
- Dispatch Center employees working with the LT

The NIOSH investigator reviewed the following documents in preparing this report:

- Death certificate
- Personal physician medical records
- Emergency medical service report
- Coroner's toxicology laboratory report
- Sheriff's office report
- FD annual report for 2010
- Respirator clearance medical records

Investigative Results

Work Shift. On October 29-30, 2010, a 52-year-old male career LT was on duty at the Regional Dispatch Center. During his 24-hour shift which began at 0700 hours on October 29, 2010, he monitored dispatches and provided supervision and assistance to dispatchers. During his shift he jogged as part of a physical fitness program. At 1100 hours the LT also participated in a respirator medical clearance examination at the local healthcare provider providing this service to the FD. He was last seen by co-workers at 2230 hours on October 29. At approximately 0620 hours on October 30, 2010, he was found unresponsive in his office within the Dispatch Center with no pulse or respirations. Local paramedics were summoned and arrived at 0631 hours. Cardiopulmonary resuscitation (CPR) and advanced life support (ALS) were performed for approximately 30 minutes without a change in the LT's clinical condition. At 0700

Investigative Results (cont.)

hours the LT was pronounced dead and resuscitation efforts were discontinued.

Medical Findings. The death certificate, completed by the attending physician, listed "sudden cardiac death" as the immediate cause of death, "cardiomyopathy" and "ventricular ectopy" as underlying causes, and "obstructive sleep apnea" as another significant condition. No autopsy was performed.

The LT was 72 inches tall and weighed 185 pounds, giving a body mass index (BMI) of 25.1 kilograms per meters squared. A BMI of 25.0-29.9 kilograms per meter squared is considered overweight [CDC 2011]. The LT had a history of left ventricular hypertrophy (LVH) and cardiac arrhythmias (ventricular ectopy). In 2002 the LT was hospitalized for palpitations and a workup included an imaging exercise stress test using the Bruce protocol. He exercised for 12 minutes before the test was stopped when he reached a maximum heart rate of 151 beats per minute (85% of maximum predicted). He reported no angina, but did have electrocardiogram (EKG) changes and arrhythmias. Specifically, he had a 1 millimeter ST segment depression, mild left ventricular cavity dilatation, and mild apical hypokinesia with a slight reduction in the pumping function of his heart [left ventricular ejection fraction (LVEF) of 49%]. He also had premature ventricular contractions, couplets, and a 3 beat run of ventricular tachycardia during recovery. Due to these abnormalities, a cardiac catheterization was performed. It was negative for coronary artery disease but revealed mild LVH and a LVEF of 45% (normal >50%). His treatment included beta blockers and angiotension converting enzyme (ACE) inhibitors. He had annual follow-up evaluations with a cardiologist, which included echocardiograms in 2005

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Investigative Results (cont.)

and 2009. The 2005 electrocardiogram showed minimal LVH and a normal LVEF. The 2009 echocardiogram revealed no LVH and a normal LVEF.

In 2008, the LT was diagnosed with sleep apnea and placed on a continuous positive airway pressure (CPAP) unit. His most recent medical evaluation was on October 29, 2010 (the day before his death), when he had a physical examination, spirometry testing, and received his annual respirator clearance.

Description of the Fire Department

The FD consists of approximately 300 career firefighters working out of 12 fire stations and serving a population of approximately 141,000 residents. The FD provides services in an area of 56 square miles and responded to 33,918 calls in 2010.

Employment and Training. The FD requires applicants be at least 18 years old with a high school diploma (or equivalent). Applicants must pass a physical agility test (PAT) and a written test. The LT was certified as a Fire Fighter Level II, Fire Safety Inspector, Driver/Operator, and EMT-Paramedic. He had 26 years of firefighting experience.

Post-Offer/Pre-placement Medical Evaluations. Under the current requirements, new hires receive a complete medical evaluation which includes a health history, physical examination, urinalysis, spirometry, vision testing, hearing testing, resting EKG, treadmill stress testing, and chest X-ray. The examinations fall under the City's civil service system and are performed by medical contractors. No records were found

Description of the FD (cont.)

documenting a similar evaluation when the LT joined the department 26 years ago.

Periodic Medical Evaluations. All firefighters are required to undergo annual respirator clearance which includes a health care provider physical examination and spirometry testing. The LT was cleared to wear a respirator the day before his death. Only certain FD members receive annual medical evaluations (e.g., hazardous materials and FEMA equipment certified firefighters). The LT was not one of these FF and did not receive an FD annual medical evaluation.

Firefighters with injuries require medical clearance from their personal physician for return to work. Firefighters with illnesses are required to provide clearance for return to work from their personal physician under certain circumstances (based on duration of time off and whether the firefighter saw a physician). Medical records suggest the issue of medical clearance for fire fighting was never addressed by either the LT's cardiologist or primary care physician.

Fitness/Wellness Programs. The FD has voluntary employee assistance and fitness/strength programs for firefighters. Firefighters can work out on fitness equipment available at fire stations and are offered incentives for their participation. Incumbent physical agility assessments are performed.

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Discussion

Primary Ventricular Arrhythmia. The LT had a history of ventricular arrhythmias diagnosed during an imaging exercise stress test. Risk factors for ventricular arrhythmias include heart disease (e.g., coronary heart disease, heart failure, and cardiomyopathies), dietary supplements, smoking, alcohol, drug abuse, medications, diabetes, and hyperthyroidism [AHA 2012; Mayo Clinic 2011]. The LT did not have any of these risk factors. Therefore, the LT was diagnosed with a primary ventricular arrhythmia (ventricular tachycardia) of unknown etiology. This condition was most likely responsible for the LT's sudden cardiac death.

Left Ventricular Hypertrophy. From 2002 to 2005, the LT was found to have mild LVH by echocardiogram. LVH increases the risk for sudden cardiac death [Levy et al. 1990]. Hypertrophy of the heart's left ventricle is a relatively common finding among individuals with long-standing high blood pressure, a heart valve problem, or chronic cardiac ischemia (reduced blood supply to the heart muscle) [Siegel 1997]. However, the LT was not known to have any of these medical conditions, his LVH was mild, and his last echocardiogram in 2009 did not report this finding. Therefore, it is unlikely LVH was responsible for his sudden cardiac 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 NFPA developed 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments [NFPA 2007a]. This voluntary industry standard provides (1) the components of a preplacement and annual medical evaluation and (2) medical fitness for duty criteria. The LT had three conditions related to decisions about medical clearance for duty: ventricular

arrhythmias, medication use (beta-blocker medication), and sleep apnea.

In 2008, the LT was found to have obstructive sleep apnea and was prescribed a CPAP unit. The National Fire Protection Association (NFPA) cautions that obstructive sleep apnea that leads to hypoxemia (decrease in oxygen saturation) or hypercapnic disorder (elevated carbon dioxide with serum PCO₂ ≥ 45 millimeters of mercury) compromises a member's ability to safely perform fire fighting tasks, wear a self-contained breathing apparatus, climb stairs while wearing fire protective ensemble, wear a fire protective ensemble, advance charged hose lines, and function as an integral component of a team. Although obstructive sleep apnea increases the risk of sudden cardiac events, given the LT's successful CPAP treatment, sleep apnea alone would not necessitate job restrictions. [Ancoli-Isreal et al. 2008].

NFPA 1582 warns that certain classes of cardiac medications could affect a member's ability to safely perform their essential job tasks. The issue of concern with beta-blockers is a sudden increase in heart rate during an emergency response, and the potential to exacerbate heat stress. Given the LT's longstanding use of these medications without problems, their use in this case would not, by itself, necessitate job restrictions.

The LT had a history of ventricular arrhythmias documented during an exercise stress test in 2002. The NFPA cautions that a history of ventricular ectopy might compromise a member's ability to function as an integral component of a team [NFPA 2007a]. NFPA lists the following items to consider when evaluating a fire fighter with a history of ventricular arrhythmias:

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1. A history of ventricular arrhythmias including ventricular tachycardia or ventricular fibrillation poses significant risk for life-threatening sudden incapacitation in the presence of structural abnormalities, functional abnormalities, or ectopy that occurs during exercise.
 2. A history of ventricular ectopy might pose a significant risk for life-threatening sudden incapacitation if structural or ischemic heart disease is present or if ventricular ectopy increases during exercise.
 3. Holter monitoring (24-hour ECG recording) might show ventricular ectopy but should show no evidence of ventricular arrhythmias.
 4. Echocardiograph must show normal function and no evidence of structural abnormalities.
 5. Stress testing off cardiac medications must show no evidence for ischemia, ventricular tachycardia, or ventricular fibrillation.
 6. Premature ventricular contractions (PVCs) should resolve with increasing levels of exercise up to 12 METS.
- tool to evaluate a fire fighter's aerobic capacity. Maximal (e.g., symptom-limiting) stress tests with imaging should be used for fire fighters with the following conditions:
- abnormal screening submaximal tests
 - cardiac symptoms
 - known coronary artery disease
 - two or more risk factors for CAD (in men older than 45 and women older than 55)

The LT's last echocardiogram in 2009 was normal, however, no subsequent stress tests were conducted either on or off medications. Recommendations for conducting stress tests vary by organization. The following paragraphs summarize these positions.

National Fire Protection Association (NFPA) 1582, a voluntary industry standard, recommends an exercise stress test be performed "as clinically indicated by history or symptoms" and refers the reader to Appendix A [NFPA 2007a]. Items in Appendix A are not standard requirements, but are provided for "informational purposes only." Appendix A recommends using submaximal (85% of predicted heart rate) stress tests as a screening

Risk factors are defined as hypercholesterolemia (total cholesterol greater than 240 milligrams per deciliter), hypertension (diastolic blood pressure greater than 90 mm of mercury), smoking, diabetes mellitus, or family history of premature CAD (heart attack or sudden cardiac death in a first-degree relative less than 60 years old).

The American College of Cardiology/American Heart Association (ACC/AHA) has also published exercise testing guidelines [Gibbons et al. 2002]. The ACC/AHA guideline states that the evidence to conduct stress tests in asymptomatic individuals with diabetes mellitus is "Class IIa" which is defined as "conflicting evidence and/or a divergence of opinion about the usefulness/efficacy but the weight of the evidence/opinion is in favor." The ACC/AHA guideline states the evidence is "less well established" (Class IIb) for the following groups:

- persons with multiple risk factors (defined similarly to those listed by the NFPA)
- asymptomatic men older than 45 years and women older than 55 years:
 - who are sedentary and plan to start vigorous exercise
 - who are involved in occupations in which impairment might jeopardize public safety (e.g., fire fighters)

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Discussion (cont.)

- who are at high risk for coronary artery disease due to other diseases (e.g., peripheral vascular disease and chronic renal failure)

The U.S. Department of Transportation (DOT) provides guidance for those seeking medical certification for a commercial drivers' license. An expert medical panel recommended exercise tolerance tests (stress tests) for asymptomatic "high risk" drivers [Blumenthal et al. 2007]. The panel defines high risk drivers as those with any of the following:

- diabetes mellitus
- peripheral vascular disease
- age 45 and above with multiple risk factors for coronary heart disease
- Framingham risk score predicting a 20% coronary heart disease event risk over the next 10 years

The U.S. Preventive Services Task Force (USPSTF) does not recommend stress tests for asymptomatic individuals at low risk for coronary heart disease events. For individuals at increased risk for coronary heart disease events, the USPSTF found "insufficient evidence to recommend for or against routine screening with EKG, exercise tolerance test, or electron beam computerized tomography scanning..." Rather, they recommend the diagnosis and treatment of modifiable risk factors (hypertension, high cholesterol, smoking, and diabetes) [USPSTF 2004]. The USPSTF does note that "For people in certain occupations, such as pilots, and heavy equipment operators (for whom sudden incapacitation or sudden death may endanger the safety of others), consideration other than the health benefit to the individual patient may influence the decision to screen for coronary heart disease."

Recommendations

NIOSH investigators offer the following recommendations to address general safety and health issues. Had some of these recommended programs been implemented, specifically incorporating exercise stress tests into the Fire Department's medical evaluation program, perhaps the FF's death could have been prevented.

Recommendation #1: Institute a policy for conducting exercise stress tests based on a member's coronary heart disease risk profile.

NFPA 1582, the IAFF/IAFC Fire Service Joint Labor Management Wellness/Fitness Initiative, and the ACC/AHA provide guidance as to exercise stress testing programs. [IAFF, IAFC 2008; Gibbons et al. 2002; NFPA 2007a]. The discussion section of this report summarizes the positions of several organizations regarding exercise stress tests in asymptomatic individuals. When an exercise stress test is indicated, consider including imaging studies to improve the test's sensitivity as recommended in NFPA 1582.

Recommendation #2: Phase in a comprehensive wellness and fitness program for fire fighters.

Guidance for fire department wellness/fitness programs to reduce risk factors for cardiovascular disease and improve cardiovascular capacity can be found in NFPA 1583, Standard on Health-Related Fitness Programs for Fire Fighters, the IAFF/IAFC Fire Service Joint Labor Management Wellness/Fitness Initiative, and in Firefighter Fitness: A Health and Wellness Guide [IAFF, IAFC 2008; NFPA 2008; Schneider 2010]. Fire department health promotion programs have been shown to reduce CAD risk factors and improve fitness levels, with mandatory programs showing the

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Recommendations (cont.)

most benefit [Dempsey et al. 2002; Womack et al. 2005; Blevins et al. 2006]. The FD has a voluntary wellness/fitness program. However, NIOSH recommends a formal, structured wellness/fitness program to ensure all members receive the benefits of a health promotion program. In addition, during exercise time, employees should be taken out of service to ensure uninterrupted member participation.

Recommendation #3: Ensure fire fighters are cleared for return to duty by a healthcare provider knowledgeable about the physical demands of fire fighting, the personal protective equipment used by fire fighters, and the various components of National Fire Protection Association (NFPA) 1582.

NFPA 1582 recommends that physicians knowledgeable about the physical demands of fire fighting, the personal protective equipment used by fire fighters, and the various components of NFPA 1582 be the final reviewing health care provider regarding return to work issues [NFPA 2007a].

The LT was medically cleared to wear a respirator, however, the FD did not require, and was not provided, medical clearance from the LT's personal physicians.

Recommendation #4: Provide an annual medical evaluation to all fire fighters.

Guidance regarding the content and frequency of these medical evaluations can be found in NFPA 1582 [NFPA 2007a]. 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. However, the FD is not legally required to follow this standard. Applying this recommenda-

tion involves economic repercussions and may be difficult to implement.

Recommendation #5: Perform an annual physical performance (physical ability) evaluation for all members.

Although the FD conducts incumbent physical agility assessments, it is unclear if these are performed annually. NFPA 1500 recommends FD members who engage in emergency operations be annually evaluated and certified by the FD as having met the physical performance requirements identified in paragraph 10.2.3 of the standard [NFPA 2007b]. This is recommended to ensure fire fighters are physically capable of performing the essential job tasks of structural fire fighting. Recommendation #6: Perform an autopsy on all on-duty fire fighter fatalities.

In 2008, the USFA published the Firefighter Autopsy Protocol [USFA 2008]. With this publication, the USFA hopes to provide "a more thorough documentation of the causes of firefighter deaths for three purposes:

1. to advance the analysis of the causes of firefighter deaths to aid in the development of improved firefighter health and safety equipment, procedures, and standards;
2. to help determine eligibility for death benefits under the Federal government's Public Safety Officer Benefits Program, as well as state and local programs; and
3. to address an increasing interest in the study of deaths that could be related to occupational illnesses among firefighters, both active and retired."

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Investigator Information

This incident was investigated by the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component located in Cincinnati, Ohio. Clara Sue Ross, MD, led the investigation and coauthored the report. Dr. Ross is a board-certified occupational medicine physician. She was working as a contractor with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component during this investigation. Thomas Hales, MD, MPH, provided medical consultation and coauthored 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).