



Death in the line of duty...

NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

A summary of a NIOSH fire fighter fatality investigation

September, 2013

Airport Fire Fighter Suffers Sudden Cardiac Death While Performing Airport Runway Check – Alabama

Executive Summary

On January 8, 2013, at 0700 hours, a 33-year-old male career airport fire fighter (“FF”) began a 12-hour overtime shift. During the day the FF and a crew member performed standby during a structural fire suppression system test, checked the apparatus equipment, and pressure washed the apparatus bay and both trucks assigned to the station. At approximately 1715 hours, the FF and a crew member checked for animals, debris, and inoperable lights on the runway. After spotting a deer near the runway, the FF exited the truck and prepared to shoot the deer. As he aimed the rifle, the FF suddenly collapsed (1736 hours).

The crew member notified dispatch to request an ambulance and then began cardiopulmonary resuscitation. After the ambulance arrived 11 minutes later, intubation was performed and a cardiac monitor was placed. The FF had a heart rhythm of ventricular fibrillation; three shocks were administered, an intravenous line was inserted, and cardiac resuscitation medications were administered. Advanced life support by the ambulance personnel continued during transport to the local hospital emergency department (ED). Inside the ED, advanced life support continued for an additional 8 minutes with no change in the FF’s clinical condition. At 1820 hours the FF was declared dead, and resuscitation efforts were discontinued.

The death certificate and the autopsy report, both completed by the state medical examiner, listed “cardiac dysrhythmia due to systemic sarcoidosis with cardiac involvement” as the cause of death. Prior to his sudden cardiac death, the FF was

asymptomatic; he had not been diagnosed with sarcoidosis. NIOSH investigators concluded that the FF’s sarcoidosis triggered a cardiac arrhythmia that resulted in sudden cardiac death.

NIOSH investigators offer the following recommendations to address general safety and health issues, but it is unclear if these recommendations would have prevented the death of this fire fighter.

Provide preplacement and annual medical evaluations to all fire fighters in accordance with NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments. The preplacement medical evaluation should include a baseline chest x-ray.

Ensure that fire fighters are cleared for return to 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.

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

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

Provide fire fighters with medical clearance to wear a self-contained breathing apparatus as part of the fire department’s medical evaluation program.

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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

On January 8, 2013, a 33-year-old male career fire fighter suffered sudden cardiac death during an airport runway check. NIOSH contacted the affected fire department (FD) on January 29, 2013, to gather additional information, and on January 31, 2013, to initiate the investigation. On February 19, 2013, a safety and occupational health specialist from the NIOSH Fire Fighter Fatality Prevention and Investigation Program investigated the incident.

During the investigation, NIOSH personnel interviewed the following people:

- Airport fire chief
- City fire chief
- Fire fighter's family

NIOSH personnel reviewed the following documents:

- FD standard operating procedures
- FD annual report for 2012
- FD incident report
- Emergency medical service (ambulance) report
- Hospital ED records
- Death certificate
- Autopsy report
- Primary care physician records

Investigative Results

Incident. On January 6, 2013, the FF worked a 24-hour shift (0700 hours to 0700 hours) serving as a captain in a municipal FD. During that shift, there were no emergency responses. On January 7, 2013, the FF reported to duty at his second job as a fire fighter for the local airport. While working this second 24-hour shift, the FF assisted the municipal FD at a structure fire (1107 hours). At the fire scene, the FF, in full turnout gear, climbed an extension ladder to perform fire suppression

with a 1³/₄-inch hoseline. He continued with fire suppression tasks until 1300 hours when the fire was declared under control, and all units cleared the scene. The FF returned to the airport fire station where no additional emergency responses occurred during the remainder of his shift.

On January 8, 2013, the FF continued working at the airport FD for a 12-hour overtime shift (0700 hours to 1900 hours). During this overtime shift the FF and a crew member (1) were on standby for a fire suppression system pump test (0850–0950 hours), (2) performed an equipment check and took some equipment to a storage building (1000–1215 hours), and (3) pressure-washed the station bay and fire apparatus, which involved unloading and reloading equipment (1300–1500 hours).

At 1715 hours, the FF and a crew member drove to the runway to check for debris, animals, and inoperable lights. They spotted a deer at the far end of the runway. The crew member stopped the vehicle as the FF retrieved a rifle and prepared to shoot the deer. As the FF aimed the rifle, he collapsed. The crew member had covered his ears in anticipation of a rifle shot. He did not hear the rifle shot but did hear the rifle fall to the ground. He found the FF collapsed next to the vehicle.

The crew member notified dispatch of the incident (1736 hours) and requested an ambulance. The crew member assessed the FF and found him to be unresponsive with sporadic shallow breaths. He soon became pulseless, and cardiopulmonary resuscitation was begun.

The ambulance arrived on scene 11 minutes later at 1747 hours, and advanced life support began. The FF was intubated, and tube placement was

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Investigative Results (cont.)

verified by capnography [Neumar et al. 2010]. A cardiac monitor showed ventricular fibrillation; one defibrillation (shock) was administered with no change in the FF's clinical status. An intravenous line was placed, and cardiac resuscitation medications were administered. Two additional shocks were administered, and his heart rhythm reverted to asystole (no heart beat). The ambulance departed the scene at 1800 hours en route to the hospital's ED. The ambulance arrived at the ED at 1811 hours, and advanced life support continued for an additional 8 minutes until 1820 hours, when the FF was pronounced dead, and resuscitation efforts were discontinued.

Medical Findings. The death certificate and the autopsy report, both completed by the state medical examiner, listed "cardiac dysrhythmia due to systemic sarcoidosis with cardiac involvement" as the cause of death. Specific findings from the autopsy are listed in Appendix A.

The FF was 75 inches tall and weighed 290 pounds, giving him a body mass index of 36.2 kilograms per meter squared. A body mass index > 30.0 kilograms per meter squared is considered obese [CDC 2011]. The FF was diagnosed with hypertension in 2002 and hyperlipidemia in 2011. He was prescribed a blood pressure lowering medication to control hypertension and dietary manipulation and exercise to control hyperlipidemia. His last blood lipid test in October 2012 included normal levels of cholesterol (164 milligrams per deciliter [mg/dL]) and triglycerides (93 mg/dL), a low HDL of 39 mg/dL (normal is > 39 mg/dL), and an elevated LDL level of 106 mg/dL (normal is 0–99 mg/dL). His last blood pressure reading in November 2012 was 146/90 millimeters of mercury. The FF had never complained of cardiac symptoms and was not known to have sarcoidosis prior to this incident.

Description of the Fire Department

At the time of the NIOSH investigation, the airport FD consisted of one fire station with 10 full-time career uniformed personnel. The FD maintained three personnel on-duty Monday to Saturday and served a geographic area of 614 acres.

Employment and Training. The airport FD requires new fire fighter applicants to be 18 years of age; have a valid state driver's license; be certified as Aircraft Rescue Fire Fighter, Fire Fighter I and II, Apparatus Operator, and Emergency Medical Technician; pass an interview; and pass a background check prior to being hired. Additional training occurs at the fire station. The new hire is placed on probation for 6 months, working one of three 24-hour shifts. The FF was certified as Aircraft Rescue Fire Fighter, Fire Fighter 2, Apparatus Operator, Emergency Medical Technician, Fire Officer I, Fire Investigator, Fire Service Instructor II, Fire Inspector I, and Technical Rescue. He had 3 years airport fire fighting experience and 13 years fire fighting experience at the municipal FD including 7 years as a volunteer and 6 years as a career fire fighter.

Preplacement and Annual Medical Evaluations.

The airport FD does not require preplacement or annual medical evaluations. Airport fire fighters typically obtain medical clearance at their other fire service jobs. The municipal FD requires preplacement medical evaluations but no annual medical evaluations. However, the preplacement medical evaluation did not include a chest x-ray. Medical clearance to wear a respirator is not required. Members injured on duty must be evaluated by the member's primary care physician who forwards his or her determination for return-to-duty to the FD. Members who become ill on- or off-duty may be required to be cleared

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Description of the FD (cont.)

for return-to-work, depending on the nature and extent of the illness.

Health and Wellness Programs. The airport FD does not have a wellness/fitness program and exercise equipment is not available in the fire station. No annual physical ability test is required. The FF did not participate in an exercise program.

Discussion

Sarcoidosis. Sarcoidosis is a chronic, multisystem disorder of unknown etiology [Newman et al. 1997; ATS 1999; Iannuzzi et al. 2007; Hamzeh 2011]. It is characterized by the accumulation of inflammatory cells into lesions known as “non-caseating granulomas.” These granulomas can disrupt the structure and function of any organ; the lung and intrathoracic lymph nodes are most commonly involved. The clinical course of the disease is variable, ranging from acute onset of respiratory symptoms, to a chronic disease with symptoms that wax and wane over decades.

The characteristic histologic (microscopic) lesions, noncaseating granulomas, are required for a diagnosis of sarcoidosis. However, noncaseating granulomas can also be found in other diseases such as tuberculosis, fungal infections, metal-induced lung disease, vasculitis, and some malignancies. Thus, the diagnosis of sarcoidosis must be made by a combination of clinical, radiographic (x-rays, gallium scans, etc.), and histologic findings [Newman et al. 1997; ATS 1999; Iannuzzi et al. 2007; Hamzeh 2011]. It is unclear if the FF had a chest x-ray during his city preplacement medical evaluation or at any other time. These records, if in existence, were not available to NIOSH at the time of this investigation.

Sarcoidosis usually presents with respiratory symptoms, but some cases are asymptomatic and the diagnosis is suggested following unrelated medical testing such as a chest x-ray [Baughman and Lower 2008]. About 5% of sarcoidosis patients have known cardiac involvement, while another 20% have unknown cardiac involvement discovered at autopsy [Iannuzzi et al. 2007]. Sarcoidosis patients with cardiac involvement are at increased risk of sudden death primarily from sarcoid lesions invading the heart muscle and disrupting the conduction system [Matsui et al. 1976; Roberts et al. 1977; Abeler 1979; Fleming 1985; Zenker 1995; Mitchell et al. 1997]. As this case exemplifies, sudden cardiac death can be the first manifestation of cardiac sarcoidosis [McDougall et al. 1994; Veinot and Johnston 1998; Byard et al. 2008].

The incidence and prevalence of sarcoidosis in the United States vary by race, sex, and age. African Americans, women, and people ages 30–39 years are at highest risk [Henke et al. 1986; Rybicki et al. 1997; Rybicki and Iannuzzi 2007]. Although the cause of sarcoidosis is unknown, research has focused on genetics and environmental, occupational, and infectious factors.

Two studies have reported that fire fighters are at increased risk of sarcoidosis, presumably from their exposure to toxins in smoke or exposure to communicable diseases while performing their duties as first responders [Kern et al. 1993; Prezant et al. 1999]. However, it is difficult to draw definitive conclusions from these studies because of differences in how cases were identified and defined and age differences between the study and comparison groups.

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Discussion (cont.)

The first study investigated three cases of sarcoidosis among 10 white fire fighters who trained together as apprentices [Kern et al. 1993]. A questionnaire survey of 1,282 active and retired male fire fighters and police officers from the same city, followed by a medical evaluation, found one additional case for an overall prevalence of 312 per 100,000. This is higher than the general population point prevalence of 17 per 100,000 for whites and 64 per 100,000 for African Americans [Robins et al. 1962].

The second study was a longitudinal study of newly diagnosed cases among New York City fire fighters between 1985 and 1998. It used chest x-rays taken during periodic wellness medical evaluations and counted only biopsy-proven cases [Prezant et al. 1999]. An annual incident rate of 12.9 cases per 100,000 among white fire fighters was found. This rate is higher than the incident rate of age-adjusted biopsy proven cases of sarcoidosis in white males (5.9 per 100,000 per year) or of age-adjusted biopsy and clinical cases of sarcoidosis in white males (9.6 per 100,000 per year) [Rybicki et al. 1997].

After the World Trade Center attack in 2001, the incidence of sarcoidosis or “sarcoid-like” granulomatous pulmonary disease increased among the New York fire department’s rescue workers [Izbicki et al. 2007]. It is unclear whether this finding is due to increased surveillance of this highly exposed group or to exposures that occurred during the response.

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 2013a]. This voluntary industry standard provides the components of a preplacement and annual medical evaluation and medical fitness for duty criteria. It is unclear if any of the recommended components of the medical evaluations such as annual medical history, medical examination, electrocardiogram, spirometry, and baseline chest x-ray would have detected this fire fighter’s underlying sarcoidosis.

Recommendations

NIOSH investigators offer the following recommendations to address general safety and health issues, but it is unclear if these recommendations would have prevented the death of this fire fighter.

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. The preplacement medical evaluation should include a baseline chest x-ray.

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 [IAFF, IAFC 2008; NFPA 2013a]. 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. To ensure improved health and safety of candidates and members, and to ensure continuity of medical evaluations, it is recommended the FD

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Recommendations (cont.)

comply with this recommendation. Applying this recommendation involves economic repercussions and may be particularly difficult for smaller fire departments to implement. The FD is not legally required to follow the NFPA standard or the IAFF/IAFC initiative.

To overcome the financial obstacle of medical evaluations, the FD could urge current members to get annual medical clearances from their private physicians. Another option is having the annual medical evaluations completed by paramedics and emergency medical technicians from the local ambulance service (vital signs, height, weight, visual acuity, and EKG). This information could then be provided to a community physician, perhaps volunteering his or her time, who could review the data and provide medical clearance or further evaluation, if needed. The more extensive portions of the medical evaluations could be performed by a private physician at the fire fighter's expense, personal or through insurance, provided by a physician volunteer, or paid for by the FD, city, or state. Sharing the financial responsibility for these evaluations between fire fighters, the FD, the city, the state, and physician volunteers may reduce the negative financial impact on recruiting and retaining needed fire fighters.

Ensure the preplacement medical evaluation includes a baseline chest x-ray. If a chest x-ray had been performed, perhaps the FF's sarcoidosis could have been identified and he would be referred for further medical treatment.

Recommendation #2: Ensure that fire fighters are cleared for return to 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.

Guidance regarding medical evaluations and examinations for structural fire fighters can be found in NFPA 1582 and in the IAFF/IAFC Fire Service Joint Labor Management Wellness/Fitness Initiative [IAFF, IAFC 2008; NFPA 2013a]. According to these guidelines, the FD should have an officially designated physician who is responsible for guiding, directing, and advising the members with regard to their health, fitness, and suitability for duty. The physician should review job descriptions and essential job tasks required for all FD positions and ranks to understand the physiological and psychological demands of fire fighters and the environmental conditions under which they must perform, as well as the personal protective equipment they must wear during various types of emergency operations. The FD currently uses the member's personal physician to clear fire fighters injured on duty or who miss work because of a lengthy illness. The extent of these physicians' knowledge of the fire fighting duties of their patients is unknown.

Recommendation #3: Phase in a mandatory 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 is 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]. Worksite health

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Recommendations (cont.)

promotion programs have been shown to be cost effective by increasing productivity, reducing absenteeism, and reducing the number of work-related injuries and lost work days [Chapman 2005; Mills et al. 2007; Pelletier 2009; Baicker et al. 2010]. Fire service health promotion programs have been shown to reduce CAD risk factors and improve fitness levels, with mandatory programs showing the most benefit [Dempsey et al. 2002; Womack et al. 2005; Blevins et al. 2006]. A study conducted by the Oregon Health and Science University reported a savings of more than \$1 million for each of four large fire departments implementing the IAFF/IAFC wellness/fitness program compared to four large fire departments not implementing a program. These savings were primarily due to a reduction of occupational injury/illness claims with additional savings expected from reduced future nonoccupational healthcare costs [Kuehl 2013].

The FD does not currently have a wellness/fitness program. NIOSH recommends a formal, mandatory wellness/fitness program to ensure all members receive the benefits of a health promotion program.

Recommendation #4: Perform a preplacement and an annual physical performance (physical ability) evaluation for all members.

NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, requires the FD to develop physical performance requirements for candidates and members who engage in emergency operations [NFPA 2013b]. Members who engage in emergency operations must be annually qualified (physical ability test) as meeting these physical performance standards for structural fire fighters [NFPA 2013b]. This could

be incorporated into the annual task-level training program.

Recommendation #5: Provide fire fighters with medical clearance to wear SCBA as part of the fire department's medical evaluation program.

The Occupational Safety and Health Administration (OSHA) revised respiratory protection standard requires employers to provide medical evaluations and clearance for employees using respiratory protection [29 CFR 1910.134]. These clearance evaluations are required for private industry employees and public employees in states operating OSHA-approved state plans. Because federal OSHA rules apply in Alabama [OSHA 2012], the FD is not required to ensure all members have been medically cleared to wear an SCBA. However, we recommend voluntary compliance with this recommendation to improve fire fighter health and safety.

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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).

Appendix A

Autopsy Findings

- Systemic sarcoidosis
 - Multiple relatively homogenous lesions (measuring up to 50 millimeters) involving several areas of the heart (right ventricle, left ventricle, and interventricular septum)
 - Microscopic evidence of extensive noncaseating granulomas (hyaline fibrosis, multinucleated giant cells, and minimal chronic inflammatory cell infiltration) in the heart, liver, spleen, and pulmonary hilar lymph nodes.
- Cardiomegaly (enlarged heart; heart weighed 650 grams; predicted normal weight is 450 grams as a function of sex, age, and body weight) [Silver and Silver 2001]
- Minimal coronary artery atherosclerosis
 - 10% focal narrowing of the left main coronary artery
 - 20% focal narrowing of the left anterior descending coronary artery
 - 20% narrowing of the circumflex coronary artery
 - 10% focal narrowing of the right coronary artery
- Normal cardiac valves
- No evidence of a pulmonary embolus (blood clot in the lung arteries)
- Enlarged spleen
- Drug and alcohol blood levels negative

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