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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 *December 2009*

Fire Fighter Trainee With an Atrial Septal Aneurysm Collapses and Dies During Debris Fire Operations – Pennsylvania

SUMMARY

On July 6, 2009, a 28-year-old male volunteer fire fighter trainee (the Trainee) responded to a debris fire. At the scene, he assisted in stretching a 1¾-inch handline as other fire fighters extinguished the fire. The Trainee reported to the driver/operator that he had a severe headache and difficulty breathing. As the driver/operator called for the Fire Chief, the Trainee collapsed. Crew members assessed the Trainee, began cardiopulmonary resuscitation (CPR), and called an ambulance. Despite advanced life support on-scene and during transport to the local hospital's emergency department (ED), the Trainee died. The death certificate, completed by the coroner, and the autopsy, completed by the forensic pathologist, listed "atrial septal aneurysm" as the cause of death. NIOSH investigators conclude that the Trainee's underlying medical condition, possibly triggered by the physical exertion involved in responding to the call and stretching the fire hose, caused his death.

Given the cause of death, it is unlikely Fire Department (FD) policies or procedures could have prevented the death of this Trainee. Therefore, the following recommendations address general health and safety issues to reduce the risk of on-the-job cardiovascular events among fire fighters at this and other fire departments across the country.

- ***Provide preplacement and annual medical evaluations to all fire fighters.***
- ***Perform a preplacement and an annual physical performance (physical ability) evaluation.***
- ***Ensure 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 comprehensive wellness and fitness program for fire fighters.***
- ***Provide fire fighters with medical clearance to wear self-contained breathing apparatus (SCBA) as part of the Fire Department's medical evaluation program.***

INTRODUCTION & METHODS

On July 6, 2009, a 28-year-old male volunteer fire fighter trainee died after suffering an atrial septal aneurysm (ASA) while working at a debris fire. NIOSH was notified of this fatality on July 6, 2009, by the U.S. Fire Administration. NIOSH contacted the affected FD on July 17, 2009, to gather additional information, and on October 14, 2009, to initiate the investiga-

tion. On October 19, 2009, a safety and occupational health specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Pennsylvania to conduct an on-site investigation of the incident.

- Fire Chief
- Trainee's Spouse

NIOSH personnel reviewed the following documents:

- FD training records
- FD annual report for 2008
- FD incident report
- Police investigation report
- Emergency medical service (ambulance) incident report
- Hospital ED records
- Death certificate
- Autopsy report
- Primary care provider medical records

RESULTS OF INVESTIGATION

Incident. On July 6, 2009, the FD was dispatched at 0354 hours to a vacant lot where debris from a demolished house was burning and was threatening a dwelling. One engine, one brush truck, and 13 personnel responded, arriving on the scene at about 0401 hours. Situational assessment revealed the fire could be extinguished with a single 1¾-inch handline. The Trainee assisted with stretching the handline and stood by while other fire fighters extinguished the fire. As fire fighters began checking for hot spots, the Trainee spoke with the driver/operator and reported that he had a severe headache and difficulty breathing. As the driver/operator called for the Fire Chief to walk over to their location, the Trainee collapsed (0406 hours). Fire fighters assessed the Trainee and found him unresponsive, not breathing, and without a pulse. They began CPR as the Fire Chief called for an ambulance.

The ambulance, dispatched at 0408 hours, responded at 0412 hours, and arrived on the scene at 0420 hours. Paramedics found the Trainee unresponsive, not breathing, pulseless, with CPR in progress. A cardiac monitor attached to the Trainee's chest revealed asystole (no heart beat). Advanced life support, including intravenous line placement and cardiac resuscitation medications, was administered. Intubation was attempted but could not be performed because the Trainee was vomiting. The ambulance departed the scene at 0432 hours en route to the hospital's ED.

En route to the ED, the Trainee's clinical condition did not improve. CPR continued as the ambulance arrived at the ED at 0439 hours. The ED's attending physician came outside to meet the ambulance. At this point the Trainee had been in cardiac arrest for over 30 minutes.

After assessing the Trainee and consulting with the paramedics, the physician pronounced the Trainee dead and resuscitation efforts were discontinued.

Medical Findings. The death certificate, completed by the coroner, and the autopsy, completed by the forensic pathologist, listed "atrial septal aneurysm" as the cause of death. Specific findings from the autopsy are listed in Appendix A.

The Trainee was 72 inches tall and weighed 182 pounds, giving him a normal body mass index (BMI) of 24.7 kilograms per meters squared (kg/m2) [CDC 2008]. Visits to his primary care physician were for noncardiac conditions such as colds and sinusitis. The Trainee had no other medical conditions but had a headache the day before his death.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the volunteer FD consisted of one fire station with 37 uniformed personnel that served 4,500 residents in a geographic area of 25 square miles. In 2008, the FD responded to 63 calls.

Membership and Training. The FD requires new fire fighter applicants to complete an application, be 18 years of age (14 years of age for a junior fire fighter), and be physically capable of performing the position duties. Members must complete the State Fire Fighter Essentials course prior to performing interior structural fire fighting. The FD also required the completion of National Incident Management System (NIMS) 100, 300, and 700 within 1 year of joining the FD. Officers must also complete NIMS 300 and 400. Members are required to attend meetings, monthly training, and other FD events. The Trainee was not certified as a Fire Fighter but was in fire fighter training with 8 months of fire fighting experience.

Pre-placement and Periodic Medical Evaluations. The FD does not require preplacement or periodic (annual) medical evaluations for members. An annual SCBA facepiece fit test is required for fire fighters, but SCBA medical clearance is not required. Members injured on duty must be evaluated by their primary care physician who makes the final determination regarding returning the fire fighter to duty.

Health and Wellness Programs. The FD does not have a formal wellness/fitness program, and no exercise equipment is available in the fire station. No annual physical ability test is required.

DISCUSSION

Atrial Septal Aneurysm (ASA). An aneurysm of the interatrial septum is a localized deformity of the upper chambers (atria) of the heart [Olivares-Reyes et al. 1997]. It is thought to arise when an increased pressure gradient between the left and right atria produces a bulging septal shift toward the low-pressure side. This bulging, however, has also been found in patients with normal atrial pressures, suggesting a congenital etiology at least in some patients [Mügge et al. 1995].

ASA is a relatively rare, usually asymptomatic condition. It is diagnosed by echocardiogram, although more commonly it is identified at autopsy as an unexpected finding [Mügge et al. 1995]. In this case, the Trainee was asymptomatic, and his ASA was unexpected and found at autopsy.

ASA can be an isolated abnormality but is more frequently associated with other structural cardiac abnormalities, including mitral valve prolapse, atrial septal defects, cadiomegaly, and dilated ventricular cavity [Mügge et al. 1995; Shirani et al. 1995; Olivares-Reyes et al. 1997]. It is not clear if the ASA is the result of these other cardiac abnormalities or causes these abnormalities. The Trainee had an atrial septal defect, left ventricular hypertrophy, and left ventricular dilatation identified at autopsy, yet he had normal heart valves and heart weight.

ASA is associated with both atrial and ventricular arrhythmias. Using 24-hour cardiac (Holter) monitoring, ASA patients were found to have significantly more runs of ventricular tachycardia (a life threatening arrhythmia) than controls [Morelli et al. 1995]. It is unclear if these life threatening arrhythmias are because of the ASA or to the other structural cardiac abnormalities frequently associated with ASA [Schneider et al. 1999].

At autopsy the Trainee had left ventricular hypertrophy, a condition associated with 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 (hypertension), a heart valve problem, or chronic cardiac ischemia (coronary artery disease) [Siegel 1997]. The Trainee was not known to be hypertensive, have a heart valve problem, or have chronic cardiac ischemia; therefore, one could associate his left ventricular hypertrophy with the ASA.

Just prior to his sudden death, the Trainee assisted in stretching a hoseline at a debris fire, which is considered light physical activity [AIHA 1971; Gledhill and Jamnik 1992]. Given the Trainee's underlying atrial septal defect, ASA, and left ventricular hypertrophy, it is possible the physical stress of responding to the emergency call and stretching the hoseline could have triggered an arrhythmia that caused the Trainee's sudden cardiac death.

RECOMMENDATIONS

Given the cause of death, it is unlikely FD policies or procedures could have prevented the death of this Trainee. Therefore, the following recommendations address general health and safety issues to reduce the risk of on-the-job cardiovascular events among fire fighters at this and other fire departments across the country.

Recommendation #1: Provide preplacement and annual medical evaluations to all fire fighters.

Guidance regarding the content and frequency of these medical evaluations can be found in NFPA 1582 and in the International Associa-

tion of Fire Fighters (IAFF)/International Association of Fire Chiefs (IAFC) Fire Service Joint Labor Management Wellness/Fitness Initiative [IAFF, IAFC 2007; 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 or this initiative. Applying this recommendation involves economic repercussions and may be particularly difficult for small volunteer fire departments to implement.

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 (EMTs) from the local EMS (vital signs, height, weight, visual acuity, and electrocardiogram [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.

Recommendation #2: Perform a preplacement and an annual physical performance (physical ability) evaluation.

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. Members who engage in emergency operations must be annually qualified (physical ability test) as meeting these physical performance standards for structural fire fighters [NFPA 2007b].

Recommendation #3: 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 [NFPA 2007] and in the IAFF/IAFC Fire Service Joint Labor Management Wellness/Fitness Initiative [IAFF, IAFC 2007]. 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. This recommendation is made based on review of the FD health and medical programs.

Recommendation #4: 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 is found in NFPA 1583, Standard on Health-Related Fitness Programs for Fire Fighters, and the IAFF/IAFC Fire Service Joint Labor Management Wellness/Fitness Initiative, and in the National Volunteer Fire Council (NVFC)'s Health and Wellness Guide [IAFF, IAFC 2007; USFA 2004; NFPA 2008]. Worksite health 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 [Stein et al. 2000; Aldana 2001]. Fire service health promotion programs have been shown to reduce coronary artery disease 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 recent 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 2007].

Given the FD's structure, the NVFC program might be the most appropriate model [USFA 2004]. NIOSH recommends a formal, structured wellness/fitness program to ensure all members receive the benefits of a health promotion 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[1] 1910.134]. These clearance evaluations are required for private industry employees and public employees in States operating OSHA-approved State plans [OSHA 2009]. Pennsylvania does not operate an OSHA-approved State plan. However, we recommend voluntary compliance with this standard.

[1]*Code of Federal Regulations.* See CFR in references.

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Appendix A

Autopsy Findings

- Atrial septal aneurysm (fossa ovalis) 2.8 x 3.0 centimeters

  Atrial septal defect

- Left ventricular hypertrophy

  Left ventricular wall thickened (1.2 cm; normal by autopsy is 0.76–0.88 cm [Colucci and Braunwald 1997]; normal by echocardiographic measurement is 0.6–1.1 cm) [Armstrong and Feigenbaum 2001]

  Microscopic evidence of myocyte nuclear hypertrophy

- Normal heart weight
- No evidence of coronary artery disease
- No evidence of a thrombus (blood clot) in the coronary arteries
- Normal cardiac valves
- No evidence of a pulmonary embolus (blood clot in the lung arteries)
- Blood tests for drugs and alcohol were negative

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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 Heath, and Vice-Chair of the Public Safety Medicine Section of the American College of Occupational and Environmental Medicine (ACOEM).