Firefighter Suffers Heart Attack After Participating in a Parade – New York

Executive Summary

On August 22, 2015, a 40-year-old male volunteer fire fighter (FF) responded with an assistant chief to aide in command of a fire at an assisted living facility. On arrival, he found the fire had been extinguished. He departed to a neighboring town and marched approximately 1 mile in a parade. Approximately 90 minutes after completing the parade, the FF became unresponsive when being driven back to the fire station by another Fire Department (FD) member. The driver proceeded directly to a nearby ambulance station. Cardiopulmonary resuscitation (CPR) was initiated. Following placement of an automated external defibrillator, three shocks were provided. The FF was transported to the hospital emergency department (ED) where his EKG indicated a heart attack. Despite advance care he was pronounced dead at 2305 hours.

The death certificate and autopsy listed atherosclerotic coronary heart disease as the immediate cause of death. Cardiomegaly and obesity were identified as significant conditions contributing to death. The autopsy revealed severe stenosis in the left anterior descending coronary artery, cardiomegaly, and left ventricular hypertrophy. NIOSH investigators concluded that the physical stress of participating in a parade on a warm summer day may have triggered his heart attack.

Key Recommendation

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

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Introduction

On August 22, 2015, a 40-year-old FF suffered a heart attack after marching in a parade. The U.S. Fire Administration notified NIOSH of this fatality on August 24, 2015. NIOSH contacted the affected FD on May 20, 2016 to initiate the investigation. On June 6, 2016, a contractor for the NIOSH Fire Fighter Fatality Prevention and Investigation Program (the NIOSH investigator) conducted an on-site investigation of the incident.

During the investigation, NIOSH personnel interviewed the following people:
- Fire Chief
- Chair of the Board of Fire Commissioners
- Chair of the Health and Safety Committee
- Ex-chief (current firefighter) who was driving the FF home from the parade

NIOSH personnel reviewed the following documents:
- FD standard operating guidelines
- FD annual report for 2015
- FD incident report
- FD injury/illness investigation report
- FD medical evaluation records
- Emergency medical service (ambulance) report
- Hospital ED records
- Death certificate
- Autopsy report

Investigation

On August 22, 2015, at 1653 hours, a 40-year-old male volunteer FF was dispatched to a fire at an assisted living facility. The FF was the ex-chief of the FD and was assigned to assist the incident commander. The FF arrived on scene at approximately 1659 hours. It was a mostly cloudy, warm summer day (82.9 °F, 41% humidity, winds out of the north at 9.2 mph) [Weather Channel 2016]. The fire was reported under control at 1702 hours. Staff at the assisted care facility had extinguished the fire before the FD arrived. The FF cleared the scene at 1710 hours and he and another FD member drove approximately 19 miles to a neighboring town to participate in a parade. The parade started at approximately 1800 hours (82.9 °F, 42% humidity, winds out of the north at 5.8 mph) [Weather Channel 2016]. The parade route was approximately 1 mile and took 30–40 minutes to complete. Following the parade, members of the FD mingled and ate while they were waiting for parade winners to be announced. Shortly after 2130 hours, the FF and another FD member left the parade ground to return to their FD. As they left, the FF was joking in his normal manner. Within a few blocks, as the firefighters were talking, the FF suddenly made a snoring-type sound and became unresponsive. The

FD member who was driving drove immediately to an ambulance station three blocks way and summoned help from emergency medical services (EMS) personnel. The FD member and emergency medical technician (EMT) at the station removed the FF from the vehicle and began CPR. The EMT notified EMS dispatch that additional help was needed as the ambulance and full crew were on another call. An automated external defibrillator was placed on the FF and the FF was defibrillated. At 2141 hours, an ambulance crew arrived and began care. The FF was not breathing and the cardiac monitor revealed pulseless electrical activity. An endotracheal tube was inserted and oxygen was provided via bag valve mask. An intraosseous line was established and cardiac medications were administered. The FF was defibrillated and after approximately 15 minutes of advanced life support he regained a spontaneous pulse. The ambulance departed the station at 2208 hours and arrived at the ED at 2219 hours.

The FF was admitted to the ED with a blood pressure of 128/87 millimeters of mercury (mmHg) (normal resting systolic is 90-119 mmHg and normal resting diastolic is 60-79 mmHg), heart rate of 141 beats per minute (normal resting is 60–100 beats per minute), respiratory rate of 18 breaths per minute (normal resting is 6–12 breaths per minute), and oxygen saturation of 97% (normal resting is 94–100%). The FF was in atrial fibrillation. The prehospital electrocardiogram (EKG) and repeat EKG in hospital revealed that the FF had an acute inferior wall myocardial infarction (heart attack). As the FF was being prepared for transport to the catheterization laboratory he went into a ventricular tachycardia and ventricular fibrillation. The FF received multiple rounds of cardiac medication and he was defibrillated without a change in status. At 2242 hours the EKG revealed pulseless electrical activity. CPR continued until 2305 hours with no change in status; the FF was pronounced dead.

Medical Findings

The death certificate and autopsy, completed by the County Medical Examiner, listed atherosclerotic coronary artery disease as the cause of death and noted cardiomegaly and obesity as contributing conditions. The autopsy revealed advanced atherosclerosis with multifocal stenosis of 90% in the left anterior descending coronary artery and 75% stenosis in the circumflex and right coronary arteries, cardiomegaly (580 grams), and left ventricular hypertrophy (1.8 cm). See Appendix A for a more detailed description of autopsy findings.

The FF had a history of hypertension and high cholesterol. He received periodic medical evaluations by the FD. As early as 2008 (the first date electronic records were available) it was noted that he had hypertension that was being treated with three medications (beta blocker, ACE inhibitor, antidiuretic). Measured blood pressure during his periodic medical evaluations showed that his blood pressure was well controlled. At his last medical exam, in March 2015, his blood pressure was 122/90 mmHg (normal systolic < 120 mmHg and normal diastolic < 80 mmHg). Although records show that the FF had elevated total cholesterol, low density lipoprotein cholesterol and triglycerides; and low high density lipoprotein cholesterol since 2008, he did not begin medication for his lipid disorder until 2015. At his last exam in 2015, laboratory tests found that the FF had total cholesterol of 228 mg/dL (desirable < 200 mg/dL), low density lipoprotein cholesterol of 164 mg/dL (optimal < 100 mg/dL), high density lipoprotein cholesterol of 33 mg/dL (normal > 40 mg/dL), and triglycerides of 156 mg/dL (normal < 150 mg/dL) [NCEP 2002]. The FF was cleared for full firefighting duty.

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The FF was a former cigarette smoker who quit in 2005 but reported social smoking in the recent 2 years. He reported a family history of hypertension and diabetes mellitus. At his last medical evaluation, he was 72 inches tall and weighed 280 pounds, giving him a body mass index of 30.0 kilograms per meters squared [CDC 2015].

Fire Department

At the time of the NIOSH investigation, the FD consisted of approximately 80 uniformed personnel working out of two fire stations. It served a population of approximately 17,000 in a geographic area of 4 square miles. In 2015, the FD responded to over 390 incidents, including 315 fire calls and 78 rescue and emergency medical calls.

Employment and Training

A person may apply to join the FD at 18 years of age or the department's cadet program at 17 years of age with parent's permission. Applicants are provided with a full orientation to the FD and expectations of firefighters. Applicants complete a Physical Agility Test to help them understand the physical requirements of being a firefighter. Applicants must pass a medical evaluation and a background check followed by an interview before being accepted as members. Once a person is accepted as a member of the FD, they are considered a probationary firefighter until they complete training requirements for Certified Firefighter I at the County Training Center or 1 year of service – whichever is longer. Additionally, all members must attend in-house training provided by the FD. The FF had been with the FD since 1991 and had served as a Lieutenant, Captain, Assistant Chief, Chief, and Ex-Chief.

Preplacement Medical Evaluation

The fire district requires preplacement medical evaluations for all applicants. Evaluations are conducted by a contract occupational medical group for the fire district. Components of this evaluation include the following:

- Complete medical history
- Physical examination (height, weight, blood pressure, pulse, and respiratory rate)
- Complete blood count with lipid panel
- Urinalysis
- Urine drug screen
- Audiogram
- Vision test
- Respirator use questionnaire
- Spirometry
- Resting EKG

Periodic medical evaluations are provided annually to all members at the fire station and contain the same components listed above except that a drug screen is not performed on all FFs. Once the medical evaluation is complete, the contracted health care provider makes a determination regarding medical

clearance for firefighting duties and forwards this decision to the FD office. The FF joined the FD in 1991 and received annual medical evaluations by a contract occupational medicine group. His last medical evaluation was in March 2015, when he was cleared for full firefighting duty.

Wellness/Fitness Programs

The FD does not have a comprehensive wellness/fitness program as recommended by the IAFF/IAFC Wellness Fitness Initiative [IAFF, IAFC 2008]. However, the FD has an exercise room and a contracted Fitness Director who can create personalized fitness programs for members. There is no evidence that the FF availed himself of this program.

Discussion

Sudden Cardiac Events

In the United States, atherosclerotic coronary heart disease is the most common risk factor for cardiac arrest and sudden cardiac death [Meyerburg and Castellanos 2008]. Risk factors for its development are grouped into non-modifiable and modifiable. Non-modifiable risk factors include age older than 45, male gender, and family history of coronary artery disease. Modifiable risk factors include diabetes mellitus, smoking, high blood pressure, high blood cholesterol, and obesity/physical inactivity [AHA 2016; NHLBI 2016]. The FF had long-standing hypertension, which was controlled with medication. The FF also had high cholesterol for which he recently began medications but his lipid profile remained abnormal. At autopsy the FF was found to have severe coronary artery atherosclerosis and structural heart changes including cardiomegaly (enlarged heart) and left ventricular hypertrophy (increased ventricular wall thickness).

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades [Libby 2013]. However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion. Heart attacks (myocardial infarctions) typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply. This sudden blockage is primarily due to blood clots (thromboses) forming on top of atherosclerotic plaques [Libby 2013]. 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 FF had an EKG that indicated an inferior wall myocardial infarction.

Firefighting and Sudden Cardiac Death

Heart attacks and sudden cardiac death can be triggered by heavy physical exertion [Mittleman 1993; Willich 1993; Albert et al. 2000]. Among fire fighters, sudden cardiac events have been associated with or triggered by 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 had responded to a fire alarm in an assisted living facility as an aide to the assistant chief earlier in the afternoon. He also walked approximately 1 mile in a parade on a warm summer day. This exertion may have his triggered the heart attack.

Occupational Medical Standards for Structural Fire Fighters

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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* [NFPA 2013]. This voluntary industry standard provides the components of a preplacement and annual medical evaluation and medical fitness for duty criteria. The FF had yearly medical evaluations and had been treated for hypertension for many years.

Cardiomegaly
The autopsy revealed cardiomegaly. Cardiomegaly is associated with long-term hypertension, obesity and CHD. The FF had a history of hypertension and obesity and probably had ischemia due to his underlying CHD. Cardiomegaly increases the risk for a primary cardiac arrhythmia and sudden cardiac death [Levy et al. 1990].

Recommendation

Recommendation #1: Phase in a mandatory comprehensive wellness and fitness program for fire fighters.

Discussion: Guidance for fire department wellness/fitness programs to reduce risk factors for cardiovascular disease and improve cardiovascular capacity is found in the IAFF/IAFC *Fire Service Joint Labor Management Wellness/Fitness Initiative*, the U.S. Fire Administration *Health and Wellness Guide for the Volunteer Fire and Emergency Services*, in *Firefighter Fitness: A Health and Wellness Guide*, and in NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters* [IAFF, IAFC 2008; USFA 2009; Schneider 2010; NFPA 2015]. 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 heart 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 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 non-occupational healthcare costs [Kuehl et al. 2013]. The FD has a voluntary wellness/fitness program. Nonetheless, NIOSH recommends a mandatory wellness/fitness program to ensure all members receive the benefits of a wellness/fitness program.

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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. Denise L. Smith, Ph.D, led the investigation and coauthored the report. Dr. Smith is professor of Health and Exercise Sciences, and Director of the First Responder Health and Safety Laboratory at Skidmore College. She is a member of the NFPA Technical Committee on Occupational Safety and Health. Dr. Smith was working as a contractor with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component during this investigation.

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Appendix A
Autopsy Findings

- Atherosclerotic Cardiovascular Disease
  - 90% stenosis in the left anterior descending and first diagonal coronary arteries
  - 75% stenosis in the circumflex and right coronary arteries
- Cardiomegaly (heart weighed 580 grams; predicted normal weight is 441 grams [ranges between 334 and 582 grams as a function of sex, age, and body weight]) [Silver and Silver 2001]
- Cardiac Hypertrophy
  - Left ventricular wall – 1.8 cm
    - Normal at autopsy is 0.76–0.88 cm [Colucci and Braunwald 1997]
    - Normal by echocardiographic measurement is 0.6–1.0 cm [Connolly and Oh 2012]
  - Right ventricular wall – 0.5 cm
    - Normal at autopsy is 0.2–0.7 cm with an average of 0.35–0.39 cm [Hutchins and Anaya 1973; Murphy et al. 1988]
    - Normal by echocardiography 0.7–2.3 cm [Armstrong and Feigenbaum 2001]
- Microscopic examination
    - Advanced atherosclerosis.
- Normal cardiac valves
- No evidence of a pulmonary embolus (blood clot in the lung arteries)
- Negative blood test for drugs of abuse

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