1000 FREDERICK LANE, MORGANTOWN, WV 26508 • 304.285.5916

46-Year-Old Sergeant Suffers Fatal Cardiac Event at Station – Michigan

Executive Summary

On August 2, 2020, a 46-year-old male career Sergeant (SGT) suffered a sudden cardiac arrest while taking a meal break during his police shift as part of his public safety job. Another officer found him pulseless and non-responsive on the kitchen floor at approximately 2300 hours, called dispatch, and initiated cardiopulmonary resuscitation (CPR). Other officers assisted with resuscitation efforts until paramedics arrived and provided advanced cardiac life support. The ambulance arrived at the emergency department (ED) at 2332 hours. At 2348 resuscitation efforts were deemed unsuccessful and the SGT was pronounced dead.

The Medical Examiner's report listed hypertensive and arteriosclerotic heart disease as the underlying causes of death. Pulmonary hypertension and obesity were listed as contributing factors. The autopsy report noted an enlarged heart (weight of 658 grams), ventricular wall hypertrophy, and significant coronary artery atherosclerosis (50%–70%) in the three main coronary arteries. There was no evidence of acute thrombus or of myocardial scarring. The SGT had cardiac risk factors including a medical history of obstructive hypertrophic cardiomyopathy, hypertension, and elevated lipid levels along with being a prior smoker. National Institute for Occupational Safety and Health (NIOSH) investigators concluded that the SGT suffered a sudden cardiac arrest due to arrhythmias resulting from his underlying cardiac disease.

The SGT's public safety job required him to work split shifts as both a firefighter and a police officer. On the day he died, he was on a 24-hour shift which required him to work the first 8 hours as a firefighter and the second 8 hours as a police officer. The SGT suffered his cardiac arrest 7 hours after completing the portion of his shift worked as a firefighter. Since his death occurred within 24 hours of his last actions as a firefighter, it is considered to be a firefighter line of duty death.

Key Recommendations

NIOSH investigators offer the following recommendations to prevent similar fatal events, and to address general health and safety issues among firefighters at this and other fire departments across the country.

Key Recommendation 1: Ensure that all firefighters receive an annual medical evaluation consistent with National Fire Protection Association (NFPA) 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments

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Key Recommendation 2: Ensure firefighters are cleared for duty by a physician knowledgeable about the physical demands of firefighting, the personal protective equipment used by firefighters, and the various components of NFPA 1582

Key Recommendation 3: Phase in a mandatory comprehensive wellness and fitness program for firefighters.

For further information, visit the program Web site at www.cdc.gov/niosh/fire or call toll free 1-800-CDC-INFO (1-800-232-4636).

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Introduction

On August 2, 2020, a 46-year-old male career public safety officer who was working a split shift (8 hours firefighter, 8 hours police officer, 8 hours firefighter) suffered sudden cardiac death while preparing a light meal toward the end of his police officer tour. The U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this fatality on August 8, 2020. NIOSH contacted the affected public safety department on September 15, 2020 to gather initial information. In June of 2021, a contractor for the NIOSH Firefighter Fatality Investigation and Prevention Program (the NIOSH investigator) conducted a series of phone calls and reviewed records of the incident.

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

- *Union President and Departmental Point of Contact*
- *Medical Examiner*

The NIOSH investigator reviewed the following documents:

- *Incident reports for calls on preceding shift days*
- *Police report*
- *Emergency medical service (ambulance) report*
- *Hospital emergency department (ED) records*
- *Death certificate*
- *Autopsy report*

Fire Department

This career public safety department has 1 station with 24 uniformed members who are cross-trained in fire, police, and first response. The department serves a population of approximately 5,000.

The FD requires preplacement medical evaluations for applicants. The evaluations are performed by a clinic that provides medical evaluations on a contract basis. Components of the medical evaluation include the following:

- *Complete medical history*

- *Physical examination (height, weight, blood pressure, pulse, and respiratory rate)*
- *Complete blood count*
- *Urinalysis*
- *Urine drug screen*
- *Audiogram*
- *Vision test*
- *Respirator use questionnaire*
- *Spirometry*
- *Resting electrocardiogram (EKG)*
- *Chest X-ray*

The department does not require annual medical evaluations for members. Members are required to provide medical clearance from a personal physician or the occupational clinic that contracts with the City after a serious injury. The department may require medical clearance if a safety officer misses more than three shift days. Respiratory fit test testing is performed annually by specially trained members of the department.

The department does not offer a comprehensive wellness/fitness program as recommended by the International Association of Firefighters//International Association of Fire Chiefs Wellness Fitness Initiative [IAFF and IAFC 2018]. The department maintains a workout space that includes aerobic and strength training equipment and encourages safety officers to use the facilities. One of the safety officers had formal training in fitness and nutrition and is available to assist other safety officers. There is an employee health program that provides programming for wellness and offers discounts to local gyms.

Investigation

On August 2, 2020, a public safety officer (SGT) began his 24-hour shift. His shift was divided into three eight-hour segments; he was scheduled to work as a firefighter from 0800–1600 hours, a police officer from 1600–2400 hours, and a firefighter from 2400–0800. During the first four hours of his first 8-hour firefighting shift, the SGT served as Shift Commander. He spent his time in the office doing office work and reports. At approximately 1200 hours he had a conversation with the oncoming Lieutenant about shift operations and the lieutenant later reported that there was nothing out of the ordinary about the SGTs appearance or behavior. Just after 1300 hours, the SGT and another firefighter were dispatched in an engine to assist with removing a tree that was blocking the roadway. Another firefighter operated the chainsaw and the SGT and a third member of the department cleared the tree from the roadway. They cleared the call at 1322 hours and returned to the station and put the engine back in service.

At approximately 1500 hours, the SGT began to clean up and change for duty as a police officer. At 1554 hours, just minutes before his police patrol was to begin, the department received a 911 hang-up, and the SGT went to the address to determine if there was an emergency. He found no emergency and

continued to patrol the city. At 1715 hours the SGT returned to the station to have dinner with his shift. Nothing out of the ordinary was noted. At 1814, the SGT and another officer were dispatched to assist an elderly man who had fallen and could not get back into his wheelchair. Throughout the rest of the evening, the SGT patrolled the city in his departmental vehicle, responded to a call for a citizen assist, and assisted another officer on two traffic stops. At 2240 hours he returned to the station.

At 2301 hours, another officer entered the kitchen and found the SGT pulseless and unresponsive on the floor of the kitchen. There was a bowl of soup and glass of water sitting on the counter suggesting the SGT had returned for a light meal. The officer that found the SGT radioed dispatch that there was an officer down and requested medical assistance. The officer initiated cardiopulmonary resuscitation (CPR) and called dispatch to request an ambulance. The shift commander was notified by dispatch and went to the kitchen to assist with CPR. Other officers were notified by dispatch and returned to the station to assist with care. An automated external defibrillator (AED) was attached to the SGT, but no shock was advised or administered at this time.

An Advanced Life Support (ALS) ambulance arrived on scene at 2310 hours and initiated advanced cardiac life support protocols. The SGT remained unresponsive, and his heart was in asystole. An intravenous line was established, and epinephrine was administered. The airway was secured with a Combitube® (a double lumen airway device useful with blind insertion that some emergency medical technicians (EMTs) are certified to use. One tube blocks the esophagus ensuring an open airway via the second tube in the trachea). The heart rhythm changed to ventricular fibrillation and the SGT was manually defibrillated four times before arrival at the ED. The SGT received multiple rounds of epinephrine and a single dose of amiodarone.

The ambulance arrived at the ED at 2332 hours with the SGT still in ventricular fibrillation. The SGT remained unresponsive, and his pupils were fixed and dilated. He received additional rounds of epinephrine and other cardiac medications. A bedside ultrasound was performed that revealed that there was no heart movement. At 2348 hours the SGT was pronounced dead.

Medical Findings

The SGT was hired by this FD in June 2005. He had been diagnosed in 2006 with obstructive hypertrophic cardiomyopathy (an enlargement of the heart that interfered with blood flow from the left ventricle into the aorta), hypertension, and hyperlipidemia, and saw his physician regularly. It is unclear if this had been disclosed to the department. As part of his ongoing medical care, in June of 2020, his physician ordered a resting echocardiogram (ECG), an exercise stress test, and a 24-hour ECG (also known as a Holter monitor evaluation). The ECG showed severe septal hypertrophy (1.7 centimeters [cm]) and moderate ventricular wall hypertrophy (1.3 cm) but with normal ejection fraction and no wall motion abnormalities. The SGT performed an exercise stress test using the Bruce protocol. He exercised for 10 minutes (estimated 10.2 metabolic equivalents [METs]) before reaching volitional fatigue (when the protocol was ended). The ECG at rest showed a deep T-wave inversion (consistent with hypertrophic cardiomyopathy). The 24-hour Holter monitor showed some premature atrial and ventricular contractions but were not considered to be clinically significant. The SGT was a former smoker. Records indicate that he worked with his physician to try to control his blood pressure and hyperlipidemia through diet and exercise and was compliant with his medication. He was 5’7” and weighed 230 pounds (lbs.) giving him a BMI of 36.

The medical examiner's report identified (1) hypertensive and atherosclerotic cardiovascular disease which was evidenced by cardiomegaly, concentric left ventricular hypertrophy, moderate arteriolonephrosclerosis (atherosclerosis in the kidneys), severe coronary atherosclerosis, aortic atherosclerosis, and myocardial bridging (a coronary artery that "tunnels" under heart muscle); (2) pulmonary hypertension (atherosclerosis in pulmonary arteries, right ventricular hypertrophy), and (3) obesity as factors contributing to the SGT's death. The heart weighed 658 grams. The left ventricular wall thickness was 2.5 cm, the septal thickness was 1.8 cm, and the right ventricular wall thickness was 0.5 cm. They myocardium was red-brown and firm with no evidence of prior myocardial injury. The coronary arteries had significant atherosclerotic plaque leading to 50% narrowing of the left anterior descending artery, 45% narrowing of the left circumflex artery, and 70% narrowing of the right coronary artery. There was no evidence of an intracoronary thrombus. The medical examiner did not conclude that the SGT had hypertrophic cardiomyopathy but, in an interview, she indicated that nothing she found in the autopsy was inconsistent with that diagnosis.

Discussion

Hypertrophic Cardiomyopathy and Sudden Cardiac Events

Hypertrophic cardiomyopathies affect approximately 1/500 people and are characterized by enlargement of some structures of the heart that is unexplained by other factors such as hypertension or aortic stenosis [Cooper et al. 2017]. Hypertrophic cardiomyopathies increase the risk of fatal arrhythmias and sudden cardiac death.

Hypertensive Heart Disease

Interactions between genetic factors and hemodynamic factors cause hypertensive heart disease in individuals with arterial hypertension [Diamond and Phillips 2005]. Hypertensive heart disease includes anatomical and functional changes to the heart and vessels as a consequence of long-standing hypertension. Left ventricular hypertrophy (LVH), due to myocyte enlargement with or without fibrosis, is a reflection of hypertensive end-organ damage. This can lead to increased ventricular mass, abnormal perfusion, congestive heart failure, and arrhythmias [Prisant 2005]. Increased heart mass is a predisposition to fatal arrhythmias [Kahan and Bergfeldt 2005; Tavora et al. 2012].

Myocardial Bridging

At autopsy, the SGT had evidence of myocardial bridging in the LAD (left anterior descending) coronary artery. Myocardial bridging is a congenital anomaly in which a portion of a coronary artery (usually the LAD) tunnels under the myocardium, creating a "bridge" of heart muscle overlying the coronary artery [Lee and Chen 2015]. Myocardial bridging is relatively common, having been reported in 40% to 80% of autopsy cases [Mohlenkamp et al. 2002]. Compression of the coronary artery occurs during systole (as the heart muscle contracts) and sometimes extends into diastole (relaxation). Myocardial bridging has been associated with coronary artery spasm, ischemia, and sudden cardiac death [Alegria et al. 2005; Lee and Chen 2015]. Autopsy and intravascular ultrasound studies have shown that the proximal segment of the "tunneled" coronary artery is prone to developing atherosclerosis, likely due to altered blood flow patterns in this area [Corban et al. 2014]. Myocardial bridging is more common in individuals with hypertrophic cardiomyopathy with a prevalence as high as 30% [Alegria et al. 2005; Basso et al. 2009].

Occupational Medical Standards for Structural Firefighters

Nearly half of all firefighter duty-related deaths are caused by sudden cardiac death. Firefighting results in multiple cardiovascular changes, including high heart rates and blood pressure that could lead to plaque rupture or arrhythmogenic changes (due to ischemia) in individuals with underlying cardiovascular disease [Smith et al. 2016]. Research relying on autopsy data found that approximately 80% of firefighters who suffered duty-related sudden cardiac deaths had atherosclerosis and/or cardiomegaly [Smith et al. 2018]. The high percentage of atherosclerosis and enlarged heart size was also found among young firefighters (< 45 yrs.) who had died due to duty-related sudden cardiac events [Yang et al. 2013]. To reduce the risk of sudden cardiac events or other incapacitating conditions among firefighters, the NFPA developed 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments* [NFPA 2018]. Guidance in the 1582 Standard recommends annual risk assessment of all firefighters ≥ 40 years old with a "Heart Risk Calculator" that takes into account age, sex, blood pressure, smoking status, etc., to estimate 10-year risk of sudden cardiac events or stroke [ACC/AHA 2018; NFPA 2018]. The SGT did not have an occupational medical evaluation, but NFPA 1582 indicates that obstructive hypertrophic cardiomyopathy can compromise the member's ability to safely perform as part of a team where sudden incapacitation could result in mission failure. The SGT was compliant with medication to help relax the heart and help it function efficiently. However, he did not achieve the 12 METs recommended (minimum cardiorespiratory fitness) to ensure that individuals with cardiac disease can safely perform firefighting activity.

NIOSH offers the following recommendations to help reduce the risk of sudden cardiac events among firefighters at this and other fire departments across the country.

Recommendations

Recommendation #1: Ensure that all firefighters receive an annual medical evaluation consistent with NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments.

Discussion: Guidance regarding the content and frequency of these medical evaluations can be found in NFPA 1582 [NFPA 2018]. These evaluations are performed to determine a firefighter's medical ability to perform duties without presenting a significant risk to the safety and health of himself/herself or others. This medical evaluation should be consistent with the requirements of NFPA 1582. In this case the SGT did not have a medical evaluation consistent with this standard and it is unclear if he would have been cleared for duty if that standard was applied.

Recommendation #2: Ensure firefighters are cleared for duty by a physician knowledgeable about the physical demands of firefighting, the personal protective equipment used by firefighters, and the various components of NFPA 1582.

Discussion: According to NFPA 1582, the department should require that physicians are familiar with the physical demands of firefighting and the risks that firefighters encounter and should guide, direct, and advise members with regard to their health, fitness, and suitability for duty [NFPA 2018]. The physician should review job descriptions and essential job tasks required for all positions to understand the physiological and psychological demands of firefighting and the environmental conditions under which firefighters perform, as well as the personal protective equipment they must wear during various

types of emergency operations. The SGT was being treated for his cardiovascular conditions, but it is unclear if the physician was familiar with the physical demands of firefighting.

Recommendation #3: Phase in a mandatory comprehensive wellness and fitness program for firefighters.

Discussion: 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 Firefighters* [NFPA 2015], the *IAFF/IAFC Fire Service Joint Labor Management Wellness/Fitness Initiative (WFI)* [IAFF and IAFC 2018], and *Firefighter Fitness: A Health and Wellness Guide* [Schneider 2010]. 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 workdays [Aldana 2001; Stein et al. 2000]. Health promotion programs for firefighters have been shown to reduce coronary heart disease risk factors and improve fitness levels, with mandatory programs showing the most benefit [Blevins et al. 2006; Dempsey et al. 2002; Womack et al. 2005]. The department has exercise equipment available to personnel but does not have a formal wellness/fitness program. NIOSH recommends that all firefighters have access to a well-structured health and wellness program such as the IAFF/IAFC WFI.

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Investigator Information

This incident was investigated by the NIOSH Firefighter Fatality Investigation and Prevention Program, Cardiac and Medical Line-of-Duty Deaths (LODD) Investigations Team, located in Cincinnati, Ohio. Denise L. Smith, Ph.D., led the investigation and authored the report. Dr. Smith is Professor of Health and Human Physiological Sciences and Director of the First Responder Health and Safety Laboratory at Skidmore College, where she holds the Tisch Family Distinguished

Professorship. She is also a member of the NFPA Technical Committee on Occupational Safety and Health. Dr. Smith was working as a contractor with the NIOSH Firefighter Fatality Investigation and Prevention Program, Cardiac and Medical LODD Investigations Team, during this investigation. Judith Eisenberg, MD, MS, provided medical consultation and contributed to the report. Dr. Eisenberg is Lead for the Cardiac and Medical LODD Investigations Team in Cincinnati.

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Appendix A
Autopsy Findings

Structural

- Cardiomegaly (heart weighed 658 grams)
- Left ventricular hypertrophy (left ventricular thickness of 2.5 cm)
- Interventricular septum thickness (1.8 cm)
- Right ventricular thickness (0.5 cm)
- No evidence of previous injury/scarring

Coronary arteries

- Significant atherosclerotic narrowing of coronary arteries
    - Left anterior descending (50%)
    - Left circumflex (45%)
    - Right coronary artery (70%)
- No evidence of intracoronary thrombus
- Myocardial bridging of inferior portion of left anterior descending artery
- No evidence of a pulmonary embolus (blood clot in the lung arteries)

Blood analysis

- Negative for drugs of abuse

Author's Discussion:

Predicted normal heart weight 399 grams (ranges between 302 and 526 grams as a function of sex and body weight), according to research in Silver and Silver [2001].

Left ventricular thickness of 2.5 cm is very high on the basis of postmortem studies by Kitzman et al. [1988] (normal range 1.07 cm–1.39 cm, average 1.23 cm).

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