



## Fire Chief Suffers Fatal Heart Attack At Vehicle Fire – Indiana

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### Executive Summary

On November 7, 2016, at 2352 hours a 58-year-old male volunteer Fire Chief (FC) responded to a tractor trailer truck fire and served as Incident Commander. After the fire was knocked down, the FC suddenly collapsed as he was talking with the driver of the truck. An ambulance was dispatched at 0002 hours. Fire Service personnel on scene initiated cardiopulmonary resuscitation and a police officer retrieved an AED (automated external defibrillator) from his patrol car and provided several shocks. The ambulance arrived on scene at 0018 hours and initiated advanced cardiac life support, which was continued en route to the hospital emergency department (ED). Hospital ED personnel continued resuscitation efforts unsuccessfully for approximately 20 minutes. The FC was pronounced dead on November 8 at 0117 hours.

The medical examiner's report listed the immediate cause of death as acute myocardial infarction (heart attack). The autopsy report documented an acute thrombosis in the left anterior descending coronary artery. NIOSH investigators concluded that the physical/emotional stress of the emergency response may have triggered the cardiovascular event.

The FC had several risk factors for coronary artery disease and heart attack. In addition to male sex, age over 45 years, and family history, he was a smoker [AHA 2016; NHLBI 2016].

### Key Recommendations

- *Ensure that all fire fighters receive an annual medical evaluation consistent with National Fire Protection Association (NFPA) 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments.*
- *Ensure fire fighters are cleared for 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 an annual physical performance (physical ability) evaluation.*

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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](http://www.cdc.gov/niosh/fire) or call toll free 1-800-CDC-INFO (1-800-232-4636).

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### **Introduction**

On November 7, 2016, at 2352 hours a 58-year-old male volunteer Fire Chief (the “FC”) responded to a tractor trailer truck fire and served as Incident Commander. The FC collapsed on scene 16 minutes later after suffering a major heart attack. The U.S. Fire Administration notified NIOSH of this fatality on November 8, 2016. NIOSH contacted the affected fire department (FD) on November 10, 2016, and again on June 7, 2017, to gather additional information and to initiate the investigation. On June 16, 2017, 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, the NIOSH investigator interviewed the following people:

- Fire Chief
- Assistant Fire Chief
- Fire fighter who drove the Rescue Truck
- Daughter of the FC

The NIOSH investigator reviewed the following documents:

- FD incident report
- Emergency medical service (ambulance) report
- Hospital emergency department (ED) records
- Death certificate
- Autopsy report

### **Investigation**

On November 7, 2016, at 2352 hours a 58-year-old male volunteer FC was notified of a tractor trailer truck fire on the exit ramp of a major interstate. The FC responded to his fire station, made assignments for responding personnel and apparatus, and rode to the scene in the passenger seat of the Rescue Truck. The FC left the Fire Station at 2356 hours. After they traveled a few blocks, the Driver asked the FC if he was going to radio dispatch that they were en route because the FC typically did this just as they were leaving the station. The FC responded affirmatively and then made the radio transmission. The Driver asked the FC if everything was okay and he responded that he was fine, just not feeling well. At the time, the Driver thought it was probably because they had just been awakened

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for the call. The FC arrived on scene at 0002 hours (the next day) and assumed incident command; he directed fire suppression activities and helped identify hot spots once the main fire was extinguished. After the fire was under control, the FC walked back behind the fire apparatus to where the truck driver was standing. The FC began talking to the driver then suddenly collapsed. The driver of the truck called for help and department members ran approximately 100 feet to find the FC supine on the ground. Emergency Medical Services trained fire fighters assessed the FC, found him to be unconscious and pulseless, and began chest compressions. An AED was retrieved from the police officer's vehicle and was attached to the FC. Based on the instructions provided by the AED, multiple shocks were delivered prior to the arrival of the ambulance. Emergency Medical Services personnel provided ventilation via a bag-valve mask. An ambulance arrived on scene at 0037 hours. The FC was unresponsive, pulseless, and exhibiting agonal breathing. The FC's bunker pants were removed and he was placed on a long board. The AED advised that a shock be given and another shock was delivered. The FC was loaded into the ambulance which departed the scene at 0042 hours.

En route to the hospital, the initial rhythm check showed ventricular fibrillation and manual defibrillation was performed. Paramedics gained intraosseous access and provided multiple rounds of cardiac medications. Paramedics tried to intubate the FC but were unsuccessful. The FC was defibrillated four times during transport. The ambulance arrived at the ED at 0058 hours.

The initial cardiac rhythm at the ED was asystole. The rhythm changed to pulseless electrical activity at 0108 hours and remained so until the FC's death. The FC was intubated at the hospital and received additional rounds of cardiac medications. At 0115 hours, a cardiac ultrasound was performed and no meaningful cardiac movement was noted. At 0117 hours, resuscitation efforts were discontinued and the FC was pronounced dead.

### **Medical Findings**

The Medical Examiner's report identified the cause of death as acute myocardial infarction. A thrombus was found in the left anterior descending coronary artery. There was also severe coronary arteriosclerosis and moderate aortic arteriosclerosis. The FC also had cardiac enlargement (540 grams), severe left ventricular hypertrophy (LVH, 2.4 centimeters), and myocardial fibrosis. See Appendix A for a more detailed description of autopsy findings.

The FC regularly engaged in physical work (such as flooring and carpentry). He had not seen a physician in many years and was taking no medications other than aspirin. He had a family history of coronary artery disease and was a smoker. According to family, he was 70 inches tall and based on hospital ED records he was 176 pounds, giving him a BMI (body mass index) of 25.3 kilograms per meter squared ( $\text{kg}/\text{m}^2$ ) [NHLBI no date].

### **Fire Department**

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At the time of the NIOSH investigation, the FD consisted of approximately 20 uniformed personnel operating out of a single fire station. It served a population of approximately 3,500 in a geographic area of 225 square miles. In 2016, the FD responded to approximately 100 calls.

### **Employment and Training**

Applicants must be at least 21 years of age, possess a valid state driver's license, have a high school diploma or equivalent, and complete an application. The Fire Chief reviews applications and the membership votes on new members. The new member is on probation for 1 year. The FC had been with the FD for 27 years and had been Chief of the Department for 3 years.

### **Medical Evaluation/Wellness and Fitness Programs**

The FD does not require preplacement medical evaluations for applicants or for members. Members are not required to provide medical clearance following a serious injury or illness. When members join the FD, they are required to provide a note from their physician stating that they are cleared to wear self-contained breathing apparatus (SCBA). The FD does not offer a comprehensive wellness/fitness program as recommended by the IAFF/IAFC Wellness Fitness Initiative [IAFF, IAFC 2008].

### **Discussion**

#### **Sudden Cardiac Events**

In the United States, atherosclerotic coronary heart disease (coronary artery disease) is the most common risk factor for cardiac arrest and sudden cardiac death [Meyerburg and Castellanos 2008]. Risk for its development is grouped into non-modifiable and modifiable risk factors. 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 (hypertension), unhealthy blood cholesterol levels, and obesity/physical inactivity [AHA 2016; NHLBI 2016]. The FC was male, over 45, had a family history of cardiovascular disease, and was a smoker.

#### **Coronary Artery Disease**

Coronary artery disease refers to atherosclerotic plaque in the coronary arteries and the complications of the plaque. 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. Plaque buildup that restricts blood flow and prevents sufficient oxygen delivery to the myocardium is called ischemia, and can cause chest pain (angina), particularly with exertion. Heart attacks or 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 a ruptured atherosclerotic plaque [Libby 2013]. Heart attacks and sudden cardiac death can be triggered by heavy physical exertion [Albert et al. 2000; Mittleman et al. 1993; Willich et al. 1993], including snow shoveling [Franklin et al. 2001] and fire fighting activity, including an alarm response [Kales et

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al. 2003; Kales et al. 2007; NIOSH 2007].

Establishing the occurrence of an acute heart attack requires any of the following: characteristic electrocardiogram changes, elevated cardiac enzymes, or coronary artery thrombus/plaque rupture. In this case, the FF had a coronary thrombus in a main coronary artery (left anterior descending coronary artery) at autopsy confirming a heart attack.

### **Left Ventricular Hypertrophy/Cardiomegaly**

LVH (thickening of the heart's left ventricle) is a common finding among individuals with long-standing high blood pressure, a heart valve problem, obesity, or cardiac ischemia [Cramariuc and Gerdt 2016; Cuspidi et al. 2014; Korre et al. 2016; Siegel 1997; Tavora et al. 2012]. LVH and cardiomegaly (an enlarged heart) are both structural heart changes that increase the risk for arrhythmias and sudden cardiac death [Chatterjee et al. 2014; Kahan and Bergfeldt 2007; Spirito et al. 2009; Tavora et al. 2012]. The FC had cardiomegaly and severe LVH.

### **Occupational Medical Standards for Structural Fire Fighters**

Nearly half of all fire fighter duty-related deaths are caused by sudden cardiac death. Firefighting results in multiple cardiovascular changes that could lead to plaque rupture or arrhythmogenic changes in individuals with underlying cardiovascular disease [Smith et al. 2016]. Research on fatalities have found that autopsies have shown atherosclerosis in a majority of fatality cases [Geibe et al. 2008; Kales et al. 2003]. To reduce the risk of sudden cardiac events or other incapacitating conditions among fire fighters, the NFPA developed 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments* [NFPA 2013a]. Regarding screening asymptomatic fire fighters for coronary artery disease, NFPA 1582 recommends basing this decision on presence of risk factors for the disease. For fire fighters (such as the FC) with two non-modifiable risk factors (male sex and age >45 years), the presence of just one additional risk factor (e.g., hypertension, high cholesterol, diabetes, or smoking) is enough to recommend screening with a symptom-limiting exercise stress test [NFPA 2013a].

The FD did not require medical evaluations for candidates or members, and the FC rarely saw a physician. Although his blood pressure, cholesterol level, and diabetes status were not known, the FC was a smoker. With the presence of this risk factor in a male over age 45, an exercise stress test would have been recommended according to NFPA 1582 guidance [NFPA 2013a].

## **Recommendations**

***Recommendation #1: Ensure that all fire fighters 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 2013a]. These evaluations are performed to determine a fire fighter's medical



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ability to perform duties without presenting a significant risk to the safety and health of themselves or others. This medical evaluation should be consistent with the requirements of NFPA 1582.

***Recommendation #2: Ensure fire fighters are cleared for 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.***

Discussion: According to NFPA 1582, the FD should require that physicians are familiar with the physical demands of fire fighting and the risks that fire fighters encounter and should guide, direct, and advise members with regard to their health, fitness, and suitability for duty [NFPA 2013a]. The physician should review job descriptions and essential job tasks required for all FD positions to understand the physiological and psychological demands of fire fighting and the environmental conditions under which fire fighters perform, as well as the personal protective equipment they must wear during various types of emergency operations.

***Recommendation #3: 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 NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters*, 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*, and in *Firefighter Fitness: A Health and Wellness Guide* [IAFF, IAFC 2008; NFPA 2015; Schneider 2010; USFA 2009]. 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 [Aldana 2001; Stein et al. 2000]. Health promotion programs for fire fighters 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 FD has does not have exercise equipment available to members and does not have a wellness/fitness program. Given the FD's structure and budget limitations, helpful resources for starting a program may include the *Heart-Healthy Firefighter Program* developed by the National Volunteer Fire Council [NVFC, no date] and the *Health and Wellness Guide for the Volunteer Fire and Emergency Services* [USFA 2009].

***Recommendation #4: Perform an annual physical performance (physical ability) evaluation.***

Discussion: NFPA 1500 recommends fire department 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 2013b]. This is recommended to ensure fire fighters are physically capable of performing the essential job tasks of structural fire fighting. The physical ability test could be incorporated into the FD's training program.

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### **Investigator Information**

This incident was investigated by the NIOSH Fire Fighter 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 Exercise Sciences, and Director of the First Responder Health and Safety Laboratory at Skidmore College, where she was recently awarded 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 Fire Fighter Fatality Investigation and Prevention Program, Cardiac and Medical LODD Investigations Team, during this investigation. Wendi Dick, MD, MSPH, provided medical consultation and contributed to the report. Dr. Dick is Lead for the Cardiac and Medical LODD Investigations Team in Cincinnati.

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### **Appendix A Autopsy Findings**

- Coronary artery disease
  - Generalized severe calcified arteriosclerotic plaque
    - Left circumflex is 25% narrowed by plaque
    - Left main artery is 76%-100% narrowed by calcified plaque
    - Left anterior descending artery is 76%-100% narrowed by calcified plaque
    - Right coronary artery is 25% narrowed by plaque
  - Thrombus in left anterior descending artery
  - Lateral left ventricular softening and mottling of the myocardium due to recent myocardial infarction/necrosis
- Structural heart disease
  - Cardiomegaly (heart weighed 540 grams; predicted normal weight is 375 grams [ranges between 284 and 495 grams as a function of sex and body weight] [Silver and Silver 2001])
  - Severe left ventricular hypertrophy (left ventricular thickness – 2.4 centimeters [cm]; normal at autopsy is 0.76 to 0.88 cm) [Colucci and Braunwald 1997]
- Microscopic
  - Left ventricular myocardial fibrosis
- Normal cardiac valves
- No evidence of a pulmonary embolus (blood clot in the lung arteries)
- Blood analysis negative for drugs of abuse

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