



31-Year-Old Fire Fighter Suffers a Seizure at Fire Department Training and Dies of Sudden Cardiac Arrest—New Jersey

Executive Summary

On October 23, 2017, at 1900 hours a 31-year-old male volunteer fire fighter (FF) began a regularly scheduled weekly training session. The training was held at the county fire training center and was focused on automobile extrication. Minutes after the hands-on training began, the FF began having a seizure. An ambulance was dispatched at 2021 hours and arrived on scene at 2035 hours. The FF was loaded into the ambulance and en route to the hospital emergency department (ED) he suffered a cardiac arrest. Advanced cardiac life support (ACLS) was initiated in the ambulance and continued in the hospital ED. Efforts to revive the FF were unsuccessful and the FF was pronounced dead at 2256 hours.

The death certificate listed the cause of death as “cardiac arrest.” No autopsy was performed. The FF’s past medical history was significant for epilepsy and smoking. NIOSH investigators concluded the seizure suffered by the FF may have played a role in precipitating his sudden cardiac event.

Key Recommendations

NIOSH offers the following recommendations to reduce the risk of sudden cardiovascular events and other incapacitating conditions among fire fighters at this and other fire departments across the country.

- 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.

In addition, NIOSH offers the following recommendation:

- Perform autopsies on all on-duty fire fighter fatalities.

31-Year-Old Fire Fighter Suffers a Seizure at Fire Department Training and Dies of Sudden Cardiac Arrest—New Jersey

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).



31-Year-Old Fire Fighter Suffers a Seizure at Fire Department Training and Dies of Sudden Cardiac Arrest—New Jersey

Introduction

On October 23, 2017, at 1900 hours a 31-year-old male volunteer FF reported for weekly training. After traveling to the county fire training center and receiving a classroom briefing, the FF and other department members retrieved tools from the apparatus and began training. Within two minutes of beginning the training, the FF had a seizure. While being transported to the hospital, the FF suffered a cardiac arrest. Attempts to revive him were unsuccessful. The U.S. Fire Administration notified NIOSH of this fatality on October 25, 2017. NIOSH contacted the affected FD on October 27, 2017, and again on March 31, 2018, to gather additional information and to initiate the investigation. On April 9, 2018, a contractor for the NIOSH Fire Fighter Fatality Investigation and Prevention Program (the NIOSH investigator) conducted an on-site investigation of the incident.

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

- Fire Chief (who was Assistant Chief at the time of the incident)
- Captain (who was Fire Chief at the time of the incident)
- Father of the FF

The NIOSH investigator reviewed the following documents:

- FD incident report
- County training academy incident report
- Fire Marshall report
- Emergency medical service (ambulance) report
- Emergency medical service (EMS) report for ALS unit that intercepted the basic life support (BLS) unit
- Hospital ED records
- Primary care physician records
- Death certificate

Investigation

On October 23, 2017, at 1900 hours a 31-year-old male volunteer FF reported to his fire station for weekly training. The FF and other department members then traveled approximately 20 miles to the county training academy for hands-on automobile extrication training. The training was the second day

31-Year-Old Fire Fighter Suffers a Seizure at Fire Department Training and Dies of Sudden Cardiac Arrest—New Jersey

of a two-part series on automobile extrication. The first session had been classroom training and this night was scheduled to be hands-on training, where personnel practiced using tools and following procedures and then performed a simulated drill. The FF and department members arrived at the training academy at 1930 hours and reported to the classroom, where they signed in, reviewed the scenario, and developed a plan for the evening drill. The group then went to the fireground where there were two cars positioned for an automobile extrication drill. It was a humid evening, with an ambient temperature of 68°F, relative humidity of 83%, and a wind speed of 8 miles per hour [Weather Channel no date]. The chief of the department and instructors discussed the tools that would be used and then the FF and other department members removed extrication tools from the apparatus (an engine and utility truck) and placed them in proximity to the automobiles.

After preparations were completed, at approximately 2020 hours, the FF was working with the Chief, who was serving as incident command. As the FF began the drill, the FF stepped back from the car and started shaking. The Chief recognized that the FF was beginning to have a seizure, put his arm on the FF's shoulder, and spoke to the FF. He then reached around the FF and helped him to the ground. As the Chief attended to the FF, an instructor called for an ambulance. As the seizure continued, the Chief noticed a small amount of blood from the right side of the mouth. Oxygen was provided by mask until the ambulance arrived.

The ambulance was dispatched at 2021 hours and arrived on scene at 2028 hours. The FF was placed on a stretcher and loaded into the ambulance. Oxygen was administered via mask. Attempts to obtain vital signs were unsuccessful due to seizure activity. At 2035 hours, the ambulance was intercepted by an ALS unit and paramedics took over care. Paramedics found the FF unconscious, unresponsive, and actively seizing in a full-body tonic-clonic seizure. At approximately 2041 hours, paramedics administered Ativan® (lorazepam) (2 milligrams) and seizure activity decreased but the FF continued to have difficulty breathing. Medical command gave orders for another dose of Ativan, and at approximately 2044 hours, a third dose of Ativan was administered. Approximately two minutes later, around 2046 hours, the FF went into cardiac arrest and cardiopulmonary resuscitation (CPR) was initiated. The cardiac monitor indicated that the FF was in asystole. The FF remained unresponsive but his heart rhythm did briefly return to a sinus rhythm before returning to asystole. The FF was successfully intubated on the second attempt with placement of the endotracheal tube (ETT) verified by auscultation, misting in the tube, direct visualization, and end-tidal CO₂. Intravenous (IV) access was gained in the left antecubital vein and four rounds of epinephrine were administered en route to the hospital. The ambulance arrived at the hospital at 2058 hours and patient care was transferred to ED staff.

In the ED, the rhythm remained asystole. The FF was placed on a ventilator. The initial bedside echocardiogram revealed minimal ventricular wall motion. At 2107 hours, CPR was paused which showed the absence of a femoral pulse. CPR was resumed. Cardiac medications were administered, including epinephrine and amiodarone. At 2111 hours, a second ultrasound revealed no cardiac wall motion. At 2113 hours, CPR was paused and the FF had a return of circulation (carotid and femoral pulses). At 2122 hours, the FF's rhythm reverted to asystole. CPR was again initiated. A central line

31-Year-Old Fire Fighter Suffers a Seizure at Fire Department Training and Dies of Sudden Cardiac Arrest—New Jersey

was obtained to administer medications. At 2128 hours, the FF regained a pulse. Additional cardiac medications were given. At 2132 hours, the FF's heart rate began to decrease and CPR was again initiated. At 2133 hours, the FF again became asystolic. Additional cardiac medications were given and a cardiac pacer was set. At 2148 hours, a bedside ultrasound was positive for cardiac activity but blood pressure was only 51/20 millimeters of mercury (mmHg). One minute later, the blood pressure was 105/37 mmHg.

Around 2150 hours, a decision was made to transfer the FF to a more advanced medical center. However, before he could be transferred his condition deteriorated. At 2243 hours, his heart rate was 60 beats per minute and his blood pressure was 76/38 mmHg. At 2248 hours, the pacer was shut off and the rhythm was asystole. CPR was again initiated and cardiac medications were administered. At 2256 hours, more than two hours after his initial cardiac arrest, it was determined that resuscitation efforts were futile, and the FF was pronounced dead.

During the ED treatment, multiple tests were performed, including a CT of the spine which showed no evidence of acute fracture or dislocation; a CT of the brain which showed only a small amount of fluid in the sinuses; a CT of the chest which showed no enlargement of the heart, no thoracic aneurysm or dissection, and mild respiratory changes; and a CT of the abdomen and pelvis which showed mild vascular calcification but no traumatic injuries. The FF's prior pertinent medical records were reviewed. The FF was last seen in the ED for abdominal pain in December of 2013.

Medical Findings

The death certificate listed the cause of death as cardiac arrest. Because the FF had a witnessed cardiac arrest, and the cause of death was known, an autopsy was not performed.

The FF was diagnosed with epilepsy at 16 years of age. He was diagnosed with localization-related (focal) (partial) symptomatic epilepsy and epileptic syndromes with simple partial seizures, not intractable, without status epilepticus, and took anti-seizure medication and worked with his primary care physician to find the proper dosage to limit his seizures and control tremors. The FF was currently taking Lamictal® and Depakote® and his family reported good compliance with medications. The FF had no other known medical conditions. The FF saw his physician in June 2017 and reported that his last seizure was approximately 6 weeks prior. At this time, the physician began working with the FF to change his medication and gave him a note saying that he could not participate as a fire fighter for 90 days. The FF complied with the 90-day period and then returned to participation with the FD. The FF returned to the physician's office one week later for a follow-up. At this visit, the FF had a blood pressure of 120/80 mmHg (normal resting systolic is 90–119 mmHg and normal resting diastolic is 60–79 mmHg). The FF had no other significant medical issues. The FF did not regularly engage in physical activity. He was a smoker and was 72 inches tall and weighed 198 pounds, giving him a body mass index (BMI) of 26.9 kilograms per meter squared (BMI > 25 is considered overweight) [NHLBI no date].

31-Year-Old Fire Fighter Suffers a Seizure at Fire Department Training and Dies of Sudden Cardiac Arrest—New Jersey

Fire Department

At the time of the NIOSH investigation, the FD consisted of approximately 45 uniformed personnel operating out of a single fire station. It served a population of approximately 10,000 in a geographic area of just over two square miles.

Employment and Training

Applicants must be at least 18 years of age, complete an application, and pass a background check to join the FD. Once applicants pass the background check, they are voted on by the town council.

Preplacement/Periodic/Return to Work Medical Evaluations

The FD requires preplacement medical evaluations for applicants. Medical evaluations are completed by the applicant's primary care physician who must provide a written note certifying that the applicant is in good health. The FD does not require medical evaluations for members. The FD does provide annual testing ("fit testing") for self-contained breathing apparatus (SCBA) use. Members are required to provide medical clearance from their own physician following a serious injury or illness. The FF joined the FD in 2006. He was not cleared for SCBA use, interior fire fighting, use of ladders, or driving due to his epilepsy.

Wellness/Fitness Programs

The FD does not offer a comprehensive wellness/fitness program.

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 [Myerburg 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 FF was a smoker.

The Pathophysiology of Sudden Cardiac Arrest/Death

Sudden cardiac death may be caused by a heart attack (myocardial infarction) or a fatal arrhythmia (disruption in the electrical signal of the heart) that causes the heart to stop beating (cardiac arrest). The FF was being treated by EMS personnel when he experienced a sudden cardiac arrest.

Sudden cardiac arrest/death can also result from non-cardiac causes, particularly in younger persons (e.g., < 35 years old). Some of the more common non-cardiac causes include pulmonary embolism, asthma, severe infection, cerebral hemorrhage, and epilepsy [Puranik et al. 2005; Vaartjes 2009].

31-Year-Old Fire Fighter Suffers a Seizure at Fire Department Training and Dies of Sudden Cardiac Arrest—New Jersey

Epilepsy

Epilepsy is a neurological disease that causes recurrent seizures due to abnormal electrical activity in the brain. Epilepsy is usually diagnosed when a person has had two or more seizures that were unprovoked (not secondary to fever, concussion, electrolyte imbalance, alcohol withdrawal, etc.) [Fisher et al. 2014]. It is not understood why the brains of persons with epilepsy are more susceptible to seizures.

Epilepsy and Sudden Death

Individuals with epilepsy are at increased risk of sudden cardiac arrest and have a significantly worse survival rate than the general population [Bardai et al. 2012; Stecker et al. 2013]. It is not known why individuals with epilepsy are at increased risk of cardiac arrest, but there is evidence that epilepsy may lead to changes in cardiac electrophysiology, including QTc prolongation and early repolarization pattern [Bardai et al. 2015; Lamberts et al. 2015].

Sudden unexpected death in epilepsy (SUDEP) describes death in a patient with epilepsy that occurs after a seizure in most cases, usually a generalized tonic-clonic seizure (grand mal seizure) [Devinsky 2011]. Documenting the incidence of SUDEP is difficult because there are varying definitions, it does not have a code in the current International Classification of Diseases (ICD) list, and it is often under recognized by medical examiners, coroners, and clinicians who complete death certificates [Ryvlin and Cascino 2017; Tomson et al. 2008]. A systematic review of studies investigating the incidence of SUDEP in the general population found that the cumulative risk of SUDEP was related to the age of the individual and the age at the onset of epilepsy [Thurman et al. 2014]. Based on this analysis, an individual who is 30 years of age and was diagnosed at 15 years of age has approximately a 3% cumulative risk of SUDEP. The underlying mechanism of death in SUDEP is difficult to determine and may be multifactorial; possible explanations involve seizure-induced cardiac, respiratory, or neurologic (“cerebral shutdown”) causes [Devinsky 2011; Tolstykh and Cavazos 2013]. In this case, the FF had a witnessed cardiac arrest while he was being treated by EMS. To reduce the risk of SUDEP the current recommendations are to focus on prevention through control of seizures, including medication and counseling on lifestyle [Devinsky 2011].

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 relying on autopsy data suggests that the majority of fire fighter duty-related sudden cardiac deaths have coronary atherosclerosis, cardiomegaly/left ventricular hypertrophy, or both conditions [Geibe et al. 2008; Kales et al. 2003; Yang et al. 2013]. 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 2018].

NFPA 1582 addresses epilepsy in Chapter 6.17 (Neurological Disorders) for candidates and Chapter 9.13.6 (Single Unprovoked Seizure and Epileptic Conditions) for fire fighters [NFPA 2018].

31-Year-Old Fire Fighter Suffers a Seizure at Fire Department Training and Dies of Sudden Cardiac Arrest—New Jersey

According to this guidance, candidates with epilepsy would not meet medical requirements to enter fire fighting training (Category A medical condition) unless a list of specific criteria is met, to include no seizures in the past 10 years [NFPA 2018]. For fire fighters, epilepsy would compromise the ability to safely perform a number of job tasks, such as wearing SCBA, operating from heights, critical problem-solving in hazardous environments, operating fire apparatus or other emergency vehicles, etc. [NFPA 2018]. NFPA 1582 advises the physician to report applicable limitations to the fire department unless the fire fighter meets a number of certain criteria, which includes no seizures for the past 10 years [NFPA 2018].

The FD did not require medical evaluations for members. However, the FD was aware that the FF had a seizure disorder and the FF was not cleared to perform several essential job tasks, including wearing SCBA, entering a burning building, operating on a ladder or roof, or driving an apparatus.

NIOSH offers the following recommendations to reduce the risk of heart attacks, sudden cardiac arrest, and other incapacitating conditions among fire fighters at this and other fire departments across the country.

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 2018]. These evaluations are performed to determine a fire fighter's medical 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 2018]. 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*

31-Year-Old Fire Fighter Suffers a Seizure at Fire Department Training and Dies of Sudden Cardiac Arrest—New Jersey

Health-Related Fitness Programs for Fire Fighters [NFPA 2015], the *IAFF/IAFC Fire Service Joint Labor Management Wellness/Fitness Initiative (WFI)* [IAFF and IAFC 2018], the U.S. Fire Administration *Health and Wellness Guide for the Volunteer Fire and Emergency Services* [USFA 2009], and in *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 work days [Aldana 2001; Stein et al. 2001]. 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].

Given the FD's structure and budget limitations, helpful resources for starting a program 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].

In addition, NIOSH offers the following recommendation:

Recommendation #4: Perform autopsies on all on-duty fire fighter fatalities.

Discussion: The U.S. Fire Administration recommends that an autopsy is obtained for each fire fighter fatality that occurs while on duty. Obtaining this information can serve the following purposes, as outlined in the *Firefighter Autopsy Protocol* [USFA 2008]:

1. To better understand the causes of fire fighter deaths so that these findings can contribute to improved fire fighter health and safety equipment, procedures, and standards
2. To help determine survivors' eligibility for death benefits through the federal government's Public Safety Officer Benefits Program, as well as state and local programs
3. To address increased attention to the study of deaths among active/retired fire fighters that could be occupationally related.

References

AHA [2016]. Understand your risks to prevent a heart attack. Dallas, TX: American Heart Association, http://www.heart.org/HEARTORG/Conditions/HeartAttack/UnderstandYourRiskofHeartAttack/Understand-Your-Risk-of-Heart-Attack_UCM_002040_Article.jsp.

Aldana SG [2001]. Financial impact of health promotion programs: a comprehensive review of the literature. *Am J Health Promot* 15(5):296–320, <http://dx.doi.org/10.4278/0890-1171-15.5.296>.

Bardai A, Lamberts RJ, Blom MT, Spanjaart AM, Berdowski J, van der Staal SR, Brouwer HJ, Koster RW, Sander JW, Thijs RD, Tan HL [2012]. Epilepsy is a risk factor for sudden cardiac arrest in the general population. *PloS One* 7(8):e42749, <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0042749>.

31-Year-Old Fire Fighter Suffers a Seizure at Fire Department Training and Dies of Sudden Cardiac Arrest—New Jersey

Bardai A, Blom MT, van Noord C, Verhamme KM, Sturkenboom MC, Tan HL [2015]. Sudden cardiac death is associated both with epilepsy and with use of antiepileptic medications. *Heart* 101(1):17–22, <http://heart.bmj.com/content/101/1/17.long>.

Blevins JS, Bounds R, Armstrong E, Coast JR [2006]. Health and fitness programming for fire fighters: does it produce results? *Med Sci Sports Exerc* 38(5):S454.

Dempsey WL, Stevens SR, Snell CR [2002]. Changes in physical performance and medical measures following a mandatory firefighter wellness program. *Med Sci Sports Exerc* 34(5):S258.

Devinsky O [2011]. Sudden, unexpected death in epilepsy. *N Engl J Med* 365(19):1801–1811, <http://dx.doi.org/10.1056/NEJMra1010481>.

Geibe JR, Holder J, Peeples L, Kinney AM, Burress JW, Kales SN [2008]. Predictors of on-duty coronary events in male firefighters in the United States. *Am J Cardiol* 101(5):585–589, <http://dx.doi.org/10.1016/j.amjcard.2007.10.017>.

Fisher RS, Acevedo C, Arzimanoglou A, Bogacz A, Cross JH, Elger CE, Engel J Jr, Forsgren L, French JA, Glynn M, Hesdorffer DC, Lee BI, Mathern GW, Moshé SL, Perucca E, Scheffer IE, Tomson T, Watanabe M, Wiebe S [2014]. ILAE official report: practical clinical definition of epilepsy. *Epilepsia* 55(4):475–482, <http://dx.doi.org/10.1111/epi.12550>.

IAFF, IAFC [2018]. The fire service joint labor management wellness/fitness initiative. 3rd ed. Washington, DC: International Association of Fire Fighters; Fairfax, VA: International Association of Fire Chiefs, <https://www.iafc.org/topics-and-tools/safety-health/wellness-fitness-task-force/wellness-fitness-program-summary>.

Kales SN, Soteriades ES, Christoudias SG, Christiani DC [2003]. Firefighters and on-duty deaths from coronary heart disease: a case-control study. *Environ Health* 2(1):14, <https://dx.doi.org/10.1186%2F1476-069X-2-14>.

Lamberts RJ, Blom MT, Novy J, Belluzzo M, Seldenrijk A, Penninx BW, Sander JW, Tan HL, Thijs RD [2015]. Increased prevalence of ECG markers for sudden cardiac arrest in refractory epilepsy. *J Neurol Neurosurg Psychiatry* 86(3):309–313, <http://jnnp.bmj.com/content/86/3/309.long>.

Myerburg RJ, Castellanos A [2008]. Cardiovascular collapse, cardiac arrest, and sudden cardiac death. In: Fauci AS, Braunwald E, Kasper DL, Hauser SL, Longo DL, Jameson JL, Loscalzo J, eds. *Harrison's principles of internal medicine*. 17th ed. New York: McGraw-Hill.

NFPA [2015]. Standard on health-related fitness programs for fire fighters, NFPA 1583. Quincy, MA: National Fire Protection Association.

NFPA [2018]. Standard on comprehensive occupational medical program for fire departments, NFPA 1582. Quincy, MA: National Fire Protection Association.

NHLBI [2016]. Who is at risk for coronary heart disease? Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, National Heart, Lung, and Blood Institute, <http://www.nhlbi.nih.gov/health/health-topics/topics/cad/atrisk.html>.

31-Year-Old Fire Fighter Suffers a Seizure at Fire Department Training and Dies of Sudden Cardiac Arrest—New Jersey

NHLBI [no date]. Calculate your body mass index. Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, National Heart, Lung, and Blood Institute, https://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmi-m.htm.

NVFC [no date]. Heart-healthy firefighter program. Greenbelt, MD: National Volunteer Fire Council, <http://www.healthy-firefighter.org/about-the-heart-healthy-firefighter-program>.

Puranik R, Chow CK, Duflou JA, Kilborn MJ, McGuire MA [2005]. Sudden death in the young. *Heart Rhythm* 2(12):1277–1282, <https://doi.org/10.1016/j.hrthm.2005.09.008>.

Ryvlin P, Cascino GD [2017]. Sudden unexpected death in epilepsy patients is often misdiagnosed as sudden cardiac death. *Neurology* 89(9):878–879, <http://n.neurology.org/content/89/9/878>.

Schneider EL [2010]. Firefighter fitness: a health and wellness guide. New York: Nova Science Publishers.

Smith DL, DeBlois JP, Kales SN, Horn GP [2016]. Cardiovascular strain of firefighting and the risk of sudden cardiac events. *Exerc Sport Sci Rev* 44(3):90–97, <http://dx.doi.org/10.1249/JES.0000000000000081>.

Stecker EC, Reinier K, Uy-Evanado A, Teodorescu C, Chugh H, Gunson K, Jui J, Chugh SS [2013]. Relationship between seizure episode and sudden cardiac arrest in patients with epilepsy: a community-based study. *Circ Arrhythm Electrophysiol* 6(5):912–916, <http://circep.ahajournals.org/content/6/5/912.long>.

Stein AD, Shakour SK, Zuidema RA [2000]. Financial incentives, participation in employer-sponsored health promotion, and changes in employee health and productivity: HealthPlus health quotient program. *J Occup Environ Med* 42(12):1148–1155, <https://insights.ovid.com/pubmed?pmid=11125677>.

Thurman DJ, Hesdorffer DC, French JA [2014]. Sudden unexpected death in epilepsy: assessing the public health burden. *Epilepsia* 55(10):1479–1485, <https://onlinelibrary.wiley.com/doi/abs/10.1111/epi.12666>.

Tolstykh GP, Cavazos JE [2013]. Potential mechanisms of sudden unexpected death in epilepsy. *Epilepsy Behav* 26(3):410–414, <http://dx.doi.org/10.1016/j.yebeh.2012.09.017>.

Tomson T, Nashef L, Ryvlin P [2008]. Sudden unexpected death in epilepsy: current knowledge and future directions. *Lancet Neurol* 7(11):1021–1031, <https://www.sciencedirect.com/science/article/pii/S1474442208702023?via%3Dihub>.

USFA [2008]. Firefighter autopsy protocol. Emmitsburg, MD: Federal Emergency Management Agency, United States Fire Administration, https://www.usfa.fema.gov/downloads/pdf/publications/firefighter_autopsy_protocol.pdf#:~:text=he%20firefighter%20Autopsy%20Protocol%20has%20been%20extensively%20revised,autopsies%20.%20As%20stated%20in%20the%20report%2C%20it.

USFA [2009]. Health and wellness guide for the volunteer fire and emergency services. Emmitsburg, MD: Federal Emergency Management Agency, United States Fire Administration, Publication No. FA-321, <https://www.nvfc.org/wp-content/uploads/2015/09/HealthWellnessGuide-2009.pdf>.

31-Year-Old Fire Fighter Suffers a Seizure at Fire Department Training and Dies of Sudden Cardiac Arrest—New Jersey

Vaartjes I, Hendrix A, Hertogh EM, Grobbee DE, Doevendans PA, Mosterd A, Bots ML [2009]. Sudden death in persons younger than 40 years of age: incidence and causes. *Eur J Cardiovasc Prev Rehabil* 16(5):592–596, <http://dx.doi.org/doi:10.1097/HJR.0b013e32832d555b>.

Weather Channel [no date]. Historical weather. Weather Underground, The Weather Company, <http://www.wunderground.com/history>.

Womack JW, Humbarger CD, Green JS, Crouse SF [2005]. Coronary artery disease risk factors in firefighters: effectiveness of a one-year voluntary health and wellness program. *Med Sci Sports Exerc* 37(5):S385.

Yang J, Teehan D, Farioli A, Baur DM, Smith D, Kales SN [2013]. Sudden cardiac death among firefighters \leq 45 years of age in the United States. *Am J Cardiol* 112(12):1962–1967, <http://dx.doi.org/10.1016/j.amjcard.2013.08.029>.

Investigator Information

This incident was investigated by the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiac/Medical Line-of-Duty Death (LODD) Component, within the Division of Surveillance, Hazard Evaluations, and Field Studies, located in Cincinnati, Ohio. Denise L. Smith, PhD, led the investigation and authored the report. Dr. Smith is Tisch Distinguished Professor of Health and Exercise Sciences and Director of the First Responder Health and Safety Laboratory at Skidmore College in Saratoga Springs, New York. She is also a member of the NFPA Technical Committee on Fire Service Occupational Safety and Health. Dr. Smith was working as a contractor for NIOSH during this investigation. Wendi Dick, MD, MSPH, provided medical consultation and contributed to the report. Dr. Dick is Medical Officer for the Cardiac/Medical LODD Component at NIOSH.

Additional Information

NIOSH has investigated other medical LODDs in fire fighters with seizure disorder. Below are links to these reports.

[F2007-05](#)

Sep 21, 2006: 38-year-old volunteer fire fighter/emergency medical technician (FF/EMT) suffers sudden death 2 hours after completing vehicle extrication training - New York. [PDF](#)

[F2007-04](#)

Dec 07, 2006: 25-year-old fire fighter dies during the night after responding to a structure fire - Pennsylvania. [PDF](#)

[F2006-18](#)

Mar 31, 2006: 34-year-old FF/EMT suffers sudden death while on-duty - South Carolina. [PDF](#)

[F2002-27](#)

May 16, 2001: 30-year-old fire fighter dies during the night at fire station - Missouri. [PDF](#)

The reports can also be accessed via <https://www.cdc.gov/niosh/fire/investigations/investigations.html>.

31-Year-Old Fire Fighter Suffers a Seizure at Fire Department Training and Dies of Sudden Cardiac Arrest—New Jersey

Disclaimer

Mention of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health (NIOSH). In addition, citations to websites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these websites. All web addresses referenced in this document were accessible as of the publication date.