



Lieutenant Suffers a Stroke Following Training and Dies – New York

Executive Summary

On January 10, 2011, a 26-year-old male volunteer lieutenant (LT) participated in annual training designed to increase confidence with the breathing apparatus. Approximately two and a half hours after completing 16 minutes of strenuous self-contained breathing apparatus (SCBA) training, the LT complained of not feeling well. He was evaluated by fellow fire fighters who noted very high blood pressure. A paramedic was summoned to transport the LT to the emergency department (ED) where he was admitted to the hospital for dizziness and headache. Overnight his condition deteriorated and it became clear he was having a stroke. Despite care in the hospital, the FF died on January 12, 2011. The death certificate and autopsy listed “cerebellar infarct due to vertebral artery thrombosis” as the cause of death. The NIOSH investigators concluded that the LT’s death was likely due to an ischemic stroke due to a congenital abnormality in the brain’s vascular system and possibly triggered by the heavy physical exertion required by the training. The following recommendations would not have prevented this LT’s death. However, NIOSH investigators offer these recommendations to address general safety and health issues:

Provide preplacement and annual medical evaluations to all fire fighters in accordance with NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments.

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

Introduction & Methods

On January 12, 2011, a 26-year-old male LT died after suffering a stroke. The LT initially complained of headache and dizziness after departmental training on January 10, 2011. NIOSH was notified of this fatality on January 14, 2011, by the United States Fire Administration. NIOSH contacted the affected department January 14, 2011, and again on October 2, 2011, to obtain further information and to initiate the investigation. On October 24, 2011, a member of the NIOSH Fire Fighter Fatality Investigation Team traveled to New York to conduct an on-site investigation of the incident.

During the investigation, NIOSH personnel interviewed the following people:

- Fire Chief
- Assistant Chief
- Crew members
- Paramedic
- Medical examiner
- LT’s sister

NIOSH personnel reviewed the following documents:

- Fire District (FD) incident report
- FD training records
- Occupational medical records
- Ambulance report
- Hospital records
- Death certificate
- Autopsy report

Lieutenant Suffers a Stroke Following Training and Dies – New York

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).

Lieutenant Suffers a Stroke Following Training and Dies – New York

Investigative Results

Incident. On January 10, 2011, the LT and department members met at the fire station for annual Self-Contained Breathing Apparatus (SCBA) testing. The testing was essentially a physical agility test performed while wearing SCBA firefighters simulate fireground fire suppression tasks. The SCBA course was set up in the main hall of the fire station.

The SCBA training began at 1900 hours. Departmental members arrived for training, gathered their personal protective equipment (PPE) and reported to the training officer. The LT and three other fire department members were the first crew to participate in the drill. Members were briefed on the tasks and then vital signs were obtained (the LT's vital signs were HR = 118 beats per minute [bpm]; BP = 148/88 millimeters of mercury [mmHg]). Firefighters then donned their PPE (helmet, turnout gear, boots, gloves) and SCBA (with a 45-minute air tank) weighing a total of approximately 50 lbs. The LT and his crew entered the course at 1934 hours.

The course included: (a) crawling through a 15 foot limited space tube (24 inches in diameter), (b) performing a low crawl under tables, (c) "duck walking" for approximately 15 feet to check for potential hazards, (d) negotiating through a simulated wall breach (16 inches by 48 inches), (e) locating a victim (dummy), (f) assessing and extricating the victim, (g) removing the victim through wall breach, (h) dragging the victim 30 feet, and (i) removing the victim through a simulated first floor window. After the victim was located, one of the crew member's low air alarm began sounding. It was decided that this member and the LT, who was second lowest on air, would exit the course. These two individuals went back through the wall

breach, crawled approximately 30 feet and then exited the course using the first floor window simulator. The LT exited the course at 1950 hours after approximately 16 minutes on the course.

Immediately after exiting the course, SCBA and turnout coats were removed and the LT and his partner were sent to a rehabilitation station. A set of vital signs were obtained when the LT entered rehabilitation (HR = 139 bpm; BP = 160/92 mmHg). He was then provided with fluids and given the opportunity to rest and recover. After 10 minutes in rehabilitation another set of vitals were obtained (HR = 85 bpm; BP = 138/80 mmHg). The LT was released from rehabilitation and rejoined the training, where he provided encouragement to other participating members. The LT showed no signs of distress during or after completing the course.

After everyone had completed the training (approximately 2200 hours) members began cleaning up the station. The LT was asked to help and stated that he didn't feel well. The LT complained of a headache, dizziness and nausea. He sat down and other members trained in emergency medical services (EMS) began an evaluation. Another set of vital signs were obtained (HR = 115 bpm; BP = 168/117 mmHg). A paramedic (FD member) was called to the station to transport the LT to the ED. At 2230 hours another set of vital signs was obtained by the paramedic (HR = 95 bpm; BP = 177/112 mmHg). En route to the hospital the paramedic noted that the LT's diaphoresis had resolved and that heart rate and blood pressure had decreased. The paramedic recorded a final set of vitals at 2258 hours (HR = 92 bpm; BP = 152/92 mmHg).

Lieutenant Suffers a Stroke Following Training and Dies – New York

Investigative Results (cont.)

The LT arrived at the ED at 2306 hours. Initial examination revealed that the LT was hypertensive (blood pressures in the 150s over 50-90s) and presented with dizziness and light-headedness. At 2340 he complained of nausea and was vomiting. He denied blurred vision and was alert and fully oriented. He was able to walk without assistance and his speech was normal. He was provided with medication to address the nausea and reported feeling better. Upon evaluation in the early morning hours of January 11, 2011, the LT was resting comfortably in a darkened room. However, he had mild slurring of his words and initially had difficulty naming the month. An initial computerized tomography (CT) scan of the brain revealed no abnormalities. He was admitted to the hospital for acute altered mental status and dizziness.

At 0620 hours it was noted that the LT had further change in mental status with lethargy and uncontrolled hypertension. Shortly thereafter uncontrolled seizure activity was noted and the LT was intubated. A follow-up head CT scan suggested of new ischemic changes but no hemorrhage. The LT was diagnosed with status epilepticus (uncontrolled seizure) and acute respiratory failure. The LT's third head CT scan showed signs of a stroke and a magnetic resonating imaging (MRI) study the evening of January 11th diagnosed a thrombus (blood clot) throughout the basilar artery with extensive cerebral and cerebellar ischemia. An electroencephalogram (EEG) performed on the morning of January 12, 2011, indicated that the LT had no brain activity. A neurology evaluation later that day showed no clinical evidence of brain stem function. Repeat testing confirmed brain death criteria and at 1035 hours the LT was declared dead.

Medical Findings. The death certificate and autopsy (completed by the chief medical examiner) listed “cerebellar infarct due to vertebral artery thrombosis” as the cause of death. The autopsy findings included “blood clots (thrombus) in the vertebral artery and basilar artery, extensive swelling and herniation of tissue, and an abnormal distribution of vessels within the cerebellum”. The LT was 70.5 inches tall and weighed 336 pounds, giving him a body mass index (BMI) of 47.5 kilograms per square meter (kg/m²). A BMI of 30 kg/m² or greater is considered obese [CDC 2011]. The autopsy noted morbid obesity as a significant condition.

The LT had his last medical examination on November 19, 2009. This was the LT's preplacement medical evaluation performed by an occupational medicine clinic. The ECG and respiratory testing done with the examination were normal. The LT indicated that he had no history of cardiovascular disease on his health history form. The LT was cleared for interior attack and general firefighting duties. Medical records indicate that he was counseled to address lifestyle factors due to elevated blood pressure (132/78 mmHg).

Description of the Fire District

At the time of the NIOSH investigation, this volunteer FD consisted of two fire stations with 65 uniformed personnel. It served a population of approximately 7,500 residents in a geographical area of approximately 1 square mile.

Membership and Training. The FD requires new fire fighter applicants to be 18 years of age and live within the fire district or adjoining fire districts. Applicants must pass a background check

Lieutenant Suffers a Stroke Following Training and Dies – New York

Description of the FD (cont.)

and an interview by the investigating committee. New members are then voted on by the fire company. The new member must attend meetings and departmental training. The new members are put on “probation” for one year after which they become full members. The LT had been a member of the department for approximately 1.5 years and had been promoted to the rank of lieutenant within the past month.

Preplacement and Periodic Medical Evaluations.

The FD requires preplacement medical evaluations for all applicants and periodic (annual) evaluations for all continuing members. Components of the preplacement and periodic medical evaluations are the same and include the following:

- Complete medical history
- Physical examination (including vital signs)
- Urinalysis
- Pulmonary function test
- Resting electrocardiogram (EKG)
- Hearing (whisper) test
- Vision screen

The evaluations are performed by an occupational medicine clinic under a contract with the FD. Once an evaluation is complete, the physician makes a determination regarding medical clearance for fire fighting duties and wearing an SCBA. These determinations are then forwarded to the FD. As mentioned earlier, the LT had his preplacement medical evaluation on November 19, 2009, and was cleared for fire fighting duties. He was due for a periodic evaluation in November of 2010 but this evaluation was not performed prior to the SCBA training.

Members injured on duty must be evaluated by the FD contract physician or their own physician. The physician makes the determination regarding return to duty. In addition to the medical evaluation, an annual SCBA face piece fit test is required by the FD.

Discussion

Stroke. A stroke is defined as the sudden development of a focal neurological deficit [Spraycar 1995]. Stroke (cerebrovascular disease) is the third leading cause of death and accounts for about 130,000 deaths each year in the United States [Goldstein et al. 2011]. The American Heart Association (AHA) identifies sixteen risk factors for stroke [AHA/ASA 2006]. This includes five factors over which the individual has no control (increasing age [over age 55], male gender, race [African Americans have a higher risk of death from stroke than Caucasians], family history, and prior stroke or heart attack). The AHA has also identified eleven risk factors that are modifiable or can be controlled (high blood pressure, cigarette smoking, diabetes mellitus, carotid or other artery disease, peripheral artery disease, atrial fibrillation, heart disease, sickle cell disease, high cholesterol, physical inactivity and obesity).

Strokes are broadly grouped into two types: ischemic (reduced blood flow due to an obstruction within a blood vessel) and hemorrhagic (a ruptured blood vessel) [Smith et al. 2005]. Ischemic strokes are three times more common than hemorrhagic strokes [Sacco et al. 1997]. While the risk factors for both types are generally the same, they differ with regard to cholesterol. Several studies have suggested that high cholesterol levels are associated with ischemic strokes but are protective for hemorrhagic strokes [Iso et al. 1989; Yano

Lieutenant Suffers a Stroke Following Training and Dies – New York

Discussion (cont.)

et al. 1989; Hebert et al. 1997; Eastern Stroke and Coronary Heart Disease Collaborative Research Group 1998; Warlow 1998]. The LT had three non-modifiable risk factors (male gender, African American, family history) and two known modifiable risk factors (obesity and physical inactivity) for a stroke. The LT had an ischemic stroke caused by thrombosis in the vertebral and basilar arteries. This caused a decrease or blockage of blood flow to the cerebrum and cerebellum. Also noted on the autopsy report was an abnormal distribution of arteries in the cerebellum. It is likely that this congenital abnormality played a significant role in causing the stroke.

Physical Activity and Stroke. The association between lack of physical activity and ischemic heart disease is well established [Pate et al. 1995; Fletcher et al. 1996; Lee et al. 2003]. Given that most strokes are ischemic and that ischemic strokes and ischemic heart disease share a common pathophysiology, the association between the lack of physical activity and strokes is not surprising [Lee and Paffenbarger Jr 1998; Batty and Lee 2002]. Studies have also established a link between lack of physical activity and hemorrhagic strokes [Thrift et al. 2002; Wendel-Vos et al. 2004;]. A meta-analysis has reported that moderately active individuals had a 20% lower risk and highly active individuals had a 27% lower risk of stroke than low-active individuals [Lee et al, 2003].

The relationship between stroke and physical activity has been describe by some authors as a “U”-shaped association (lack of physical activity or very heavy physical activity is associated with increased risk for a stroke, while moderate physical activity is protective) [Lee and Paffenbarger Jr

1998; Thrift et al. 2002]. One possible explanation for this finding is that heavy physical exertion may “trigger” a stroke, as with heart attacks (acute myocardial infarctions) [Mittleman et al. 1993; Willich et al. 1993; Albert et al. 2000]. This seems plausible from a pathophysiological perspective because blood pressure rises during heavy physical exertion [Taylor and Beller 1998], and elevated blood pressure could trigger plaque rupture (ischemic stroke due to a thrombus) or blood vessel wall rupture (hemorrhagic stroke).

Firefighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations [Gledhill and Jamnik 1992]. Firefighting activities are strenuous and often require fire fighters to work at near maximal heart rates for long periods. Even when energy costs are moderate (as measured by oxygen consumption) and work is performed in a thermoneutral environment, heart rates may be high (over 170 bpm), owing to the insulative properties of the personal protective clothing [Smith et al. 1995]. The LT performed SCBA training while wearing full bunker gear and SCBA weighing about 50 pounds. This is considered a heavy level of physical exertion [American Industrial Hygiene Association 1971; Gledhill and Jamnik 1992;].

Given this information, NIOSH investigators conclude that this LT suffered an ischemic stroke due to thrombosis in the basilar and vertebral arteries, most likely due to congenital abnormalities, and possibly triggered by the heavy physical exertion required by the training drills.

Lieutenant Suffers a Stroke Following Training and Dies – New York

Recommendations

The following recommendations would not have prevented this LT's death. However, NIOSH investigators offer these recommendations to address general safety and health issues:

Recommendation #1: Provide preplacement and annual medical evaluations to all fire fighters in accordance with NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments.

Guidance regarding the content and frequency of these medical evaluations can be found in NFPA 1582 and in the International Association of Fire Fighters (IAFF)/International Association of Fire Chiefs (IAFC) Fire Service Joint Labor Management Wellness/Fitness Initiative [NFPA 2007a; IAFF, IAFC 2008]. These evaluations are performed to determine fire fighters' medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others. To ensure improved health and safety of candidates and members, and to ensure continuity of medical evaluations, it is recommended the FD comply with this recommendation. However, the FD is not legally required to follow the NFPA standard or the IAFF/IAFC initiative.

Recommendation #2: Phase in a mandatory comprehensive wellness and fitness program for fire fighters.

Guidance for fire department wellness/fitness programs to reduce risk factors for cardiovascular disease and improve cardiovascular capacity is found in NFPA 1583, Standard on Health-Related Fitness Programs for Fire Fighters, the IAFF/IAFC Fire Service Joint Labor Management Wellness/Fitness Initiative, and in Firefighter Fitness: A Health

and Wellness Guide [IAFF, IAFC 2008; NFPA 2008; 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 [Stein et al. 2000; Aldana 2001]. Fire service health promotion programs have been shown to reduce CAD 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 nonoccupational healthcare costs [Kuehl 2007]. The FD currently has a voluntary wellness/fitness program. NIOSH recommends a formal, mandatory wellness/fitness program to ensure all members receive the benefits of a health promotion program. During exercise time, employees should be taken out of service to ensure uninterrupted participation.

Lieutenant Suffers a Stroke Following Training and Dies – New York

References

- AHA/ASA (American Heart Association/American Stroke Association) [2006]. Stroke risk factors. [http://www.strokeassociation.org/STROKE-ORG/AboutStroke/UnderstandingRisk/Understanding-Risk_UCM_308539_SubHomePage.jsp]. Date accessed: December 2011.
- Albert CM, Mittleman MA, Chae CU, Lee MI, Hennekens CH, Manson JE [2000]. Triggering of sudden death from cardiac causes by vigorous exertion. *N Engl J Med* 343(19):1355-1361.
- Aldana SG [2001]. Financial impact of health promotion programs: a comprehensive review of the literature. *Am J Health Promot* 15:296-320.
- American Industrial Hygiene Association [1971]. Ergonomics guide to assessment of metabolic and cardiac costs of physical work. *Am Ind Hyg Assoc J* 32:560-564.
- Batty GD, Lee IM [2002]. Physical activity for preventing strokes. *Brit Med Journal* 325:350-351.
- 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.
- CDC (Centers for Disease Control and Prevention) [2011]. BMI Body Mass Index. [<http://www.cdc.gov/healthyweight/assessing/bmi/>]. Date accessed: December 2011.
- 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.
- Eastern Stroke and Coronary Heart Disease Collaborative Research Group [1998]. Blood pressure, cholesterol, and stroke in eastern Asia. *Lancet* 352:1801-1807.
- Fletcher GF, Balady GJ, Blair SN, Blumenthal J, Caspersen C, Chaitman B, Epstein S, Sivarajan Froelicher ES, Froelicher VF, Pina IL, Pollock ML [1996]. Statement on exercise: benefits and recommendations for physical activity programs for all Americans: a statement for health professionals by the Committee on Exercise and Cardiac Rehabilitation of the Council on Clinical Cardiology, American Heart Association. *Circulation* 94:857-862.
- Gledhill N, Jamnik VK [1992]. Characterization of the physical demands of firefighting. *Can J Spt Sci* 17(3):207-213.
- Goldstein LB, Bushnell CD, Adams RJ, Appel LJ, Braun LT, Chaturvedi S, Creager MA, Culebras A, Eckel RH, Hart RG, Hinchey JA, Howard VJ, Jauch EC, Levine SR, Meschia JF, Moore WS, Nixon JV, Pearson TA [2011]. Guidelines for the primary prevention of stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke* 42:517-584.
- Hebert PR, Gaziano JM, Chan KS, Hennekens CH [1997]. Cholesterol lowering with statin drugs, risk of stroke, and total mortality. An overview of randomized trials. *JAMA* 278:313-321.
- IAFF, IAFC [2008]. The fire service joint labor management wellness/fitness initiative. 3rd ed. Washington, DC: International Association of Fire Fighters, International Association of Fire Chiefs.

Lieutenant Suffers a Stroke Following Training and Dies – New York

References (cont.)

- Iso H, Jacobs DR Jr., Wentworth D, Neaton JD, Cohen JD, The MRFIT Research Group [1989]. Serum cholesterol levels and six-year mortality from stroke in 350,977 men screened for the Multiple Risk Factor Intervention Trial. *N Engl J Med* 320:904-910.
- Kuehl K [2007]. Economic impact of the wellness fitness initiative. Presentation at the 2007 John P. Redmond Symposium in Chicago, IL on October 23, 2007.
- Lee CD, Folsom AR, Blair SN [2003]. Physical activity and stroke risk: a meta-analysis. *Stroke* 34:2475-2482.
- Lee IM, Paffenbarger RS Jr. [1998]. Physical activity and stroke incidence. The Harvard Alumni health study. *Stroke* 29:2049-2054.
- Mittleman MA, Maclure M, Tofler GH, Sherwood JB, Goldberg RJ, Muller JE [1993]. Triggering of acute myocardial infarction by heavy physical exertion. *N Engl J Med* 329:1677-1683.
- NFPA [2007a]. Standard on comprehensive occupational medical program for fire departments. Quincy, MA: National Fire Protection Association. NFPA 1582.
- NFPA [2007b]. Standard on fire department occupational safety and health program. Quincy, MA: National Fire Protection Association. NFPA 1500.
- NFPA [2008]. Standard on health-related fitness programs for fire fighters. Quincy, MA: National Fire Protection Association. NFPA 1583.
- Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, Buchner D, Ettinger W, Heath GW, King AC, Kriska A, Leon AS, Marcus BH, Morris J, Paffenbarger RS, Patrick K, Pollock ML, Rippe JM, Sallis J, Wilmore JH [1995]. Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 273:402-407.
- Sacco RL, Benjamin EJ, Broderick JP, Dyken M, Easton JD, Feinberg WM, Goldstein LB, Gorelick PB, Howard G, Kittner SJ, Manolio TA, Whisnant JP, Wolf PA [1997]. Risk factors. *Stroke* 28:1507-1517.
- Schneider EL [2010]. Firefighter fitness: a health and wellness guide. New York: Nova Science Publishers.
- Smith DL, Petruzzello SJ, Kramer JM, Warner SE, Bone BG, Misner JE [1995]. Selected physiological and psychobiological responses to physical activity in different configurations of firefighting gear. *Ergonomics* 38(10):2065-2077.
- Smith WS, Johnston SC, Easton JD [2005]. Cerebrovascular diseases. In: Kasper DL, Fauci AS, Longo DL, Braunwald E, Hauser SL, Jameson JL, eds. *Harrison's principles of internal medicine*. 16th ed. New York: McGraw-Hill, pp. 2372-2393.
- Spraycar M, ed. [1995]. *Stedman's medical dictionary*. 26th ed. Baltimore, MD: Williams & Wilkins, p. 1688.

Lieutenant Suffers a Stroke Following Training and Dies – New York

References (cont.)

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* 42:1148-1155.

Taylor AJ, Beller GA [1998]. Postexercise systolic blood pressure response: clinical application to the assessment of ischemic heart disease. *Am Fam Physician* 58:1257-1260.

Thrift AG, Donnan GA, McNeil JJ [2002]. Reduced risk of intracerebral hemorrhage with dynamic recreational exercise but not with heavy work activity. *Stroke* 33:559-564.

Warlow CP [1998]. Epidemiology of stroke. *Lancet* 352(suppl III):1-4.

Wendel-Vos GCW, Schuit AJ, Feskens EJM, Boshuizen HC, Verschuren WMM, Saris WHM, Kromhout D [2004]. Physical activity and stroke. A meta-analysis of observational data. *Int J of Epidemiol* 33:787-798. Willich SN, Lewis M, Lowel H, Arntz HR, Schubert F, Schroder R [1993]. Physical exertion as a trigger of acute myocardial infarction. *N Engl J Med* 329:1684-1690.

Willich SN, Lewis M, Lowel H, Arntz HR, Schubert F, Schroder R [1993]. Physical exertion as a trigger of acute myocardial infarction. *N Engl J Med* 329:1684-1690.

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.

Yano K, Reed DM, MacLean CJ [1989]. Serum cholesterol and hemorrhagic stroke in the Honolulu Heart Program. *Stroke* 20:1460-1465.

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 was working as a contractor with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component during this investigation. Thomas Hales, MD, MPH, provided medical consultation and coauthored the report. Dr. Hales is a member of the NFPA Technical Committee on Occupational Safety and Health, and Vice Chair of the Public Safety Medicine Section of the American College of Occupational and Environmental Medicine (ACOEM).