2015
02

Death in the line of duty...

NIOSH Fire Fighter Fatality Investigation and Prevention Program

A summary of a NIOSH fire fighter fatality investigation

July 31, 2015

Fire Fighter Suffers Heart Attack During Training and Later Dies - Kansas

Executive Summary

On January 22, 2015, a 49-year-old male career fire fighter (FF) participated in air management training during his 24-hour shift as part of the fire department (FD) respiratory protection program. The FF, wearing full turnout gear and self-contained breathing apparatus (SCBA) (on-air) completed one evolution lasting about 10 minutes without incident. After removing his SCBA and turnout gear, he sat on the engine's tailboard and told his battalion chief (BC) that he "was just a little winded." About 5 minutes later, the FF stated "his chest was hurting." Dispatch was notified as crewmembers noted the FF's clammy skin and a weak and irregular pulse. An electrocardiogram (EKG) revealed changes consistent with an acute myocardial infarction (heart attack), and the FF was transported to the local hospital's emergency department (ED). In the ED, an acute heart attack was confirmed and the FF was taken emergently to the cardiac catheterization lab for coronary angiography and angioplasty. While in the cardiac catheterization lab, the FF suffered cardiac arrest. Despite resuscitation efforts for over 20 minutes, the FF died at 2145 hours.

The death certificate listed "MI [myocardial infarction] – acute due to "occlusion of LAD [left anterior descending] on cath [catheterization]" as the cause of death. Due to findings in the cardiac catheterization lab, no autopsy was performed. Given the FF's underlying heart disease, NIOSH investigators concluded that the physical stress of the air management training triggered his heart attack, which resulted in his sudden cardiac death.

Key Recommendations

- *Provide annual medical evaluations to all fire fighters consistent with NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments, to identify fire fighters with risk factors for coronary heart disease (CHD)*
- *Perform symptom-limiting exercise stress tests (ESTs) on firefighters at increased risk for CHD and sudden cardiac events.*

The following recommendations would not have prevented the FF's death, but NIOSH investigators include them to address general safety and health issues:

- *Discontinue routine ESTs on asymptomatic fire fighters with no risk factors for CHD*
- *Perform candidate and member physical ability evaluations*
- *Discontinue routine protein specific antigen (PSA) testing*
- *Conduct annual respirator fit testing*
- *Install diesel exhaust source capture systems in fire stations.*

Fire Fighter Suffers Heart Attack During Training and Later Dies - Kansas

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).

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Introduction

On January 22, 2015, a 49-year-old male career FF suffered a heart attack while performing air management training. NIOSH was notified of this fatality on January 23, 2015, by the U.S. Fire Administration. NIOSH contacted the affected FD on January 26, 2015, to gather additional information and to initiate the investigation. On February 2, 2015, a safety and occupational health specialist from the NIOSH Fire Fighter Fatality Prevention and Investigation Program conducted an on-site investigation of the incident.

During the investigation, NIOSH personnel interviewed the following people:

- Fire Chief
- BC of the FF's shift
- Crewmembers
- City Human Resources Director
- FF's spouse

NIOSH personnel reviewed the following documents:

- FD standard operating guidelines
- FD annual report for 2014
- Emergency medical service (ambulance) report
- Hospital ED records
- Hospital cardiac catheterization lab records
- Death certificate
- FD medical evaluation records
- Primary care physician records

Investigation

On January 22, 2015, the FF arrived for duty at about 0745 hours for his 24-hour shift at his fire station, beginning at 0800 hours. Daily temperatures ranged from -7° Fahrenheit to 4° Fahrenheit [NOAA 2015]. At 0813 hours, the FD was dispatched to a motor vehicle crash with injuries. At the scene, the FF assisted with preparing the injured person for ambulance transport and then returned to the station at 0900 hours. At the station, the FF performed truck and equipment checks for an hour, then studied for a firefighter exam. At 1105 hours, the FD was dispatched to another motor vehicle crash, but this incident had no injuries. At the scene, the FF assisted with applying absorbent to the vehicle's fluid spill, then returned with his crew to the station. After eating lunch, the FF continued to study for the exam until 1600 hours when he refueled the engine and purchased food for dinner. From 1730 hours to 1830 hours, the crew prepared and ate dinner.

At 1900 hours, air management training began. Components of the training are listed in Appendix A. The fifteen crewmembers in attendance were grouped into two groups of seven with the BC as the supervisor. The FF was in the second group which began the course at about 1930 hours. He completed the course once, then walked down the stairs to begin a second evolution per the training protocol. While the FF crossed the training room floor, the BC excused the FF from finishing the training because the FF stated he was short of breath. The FF walked up to the engine bay and removed his personal protective equipment with the assistance of the BC. When resting on the Engine's tailboard, the FF stated "I'm fine, just a little winded." The FF had his blood pressure taken by a crewmember (no reading was documented but the FF stated the reading was good). The FF then walked outside to "cool off." A few minutes later crewmembers checked up on the FF, who was lying on his bed stating "my chest is hurting."

The BC notified Dispatch (2009 hours), as crewmembers obtained vital signs. The FF's skin was clammy, his pulse was weak and irregular, and his blood pressure was 138/90 millimeters of mercury (mmHg) (normal). At 2013 hours, ambulance paramedics arrived and found the FF lying on his bed, alert and oriented, but complaining of chest pain and shortness of breath. A cardiac monitor revealed an irregular sinus rhythm. Oxygen was administered via a non-rebreather mask and an intravenous line was placed. A 12-lead EKG revealed ST-elevation in leads II, III, and aVF (augmented vector foot [left foot]); a finding consistent with an acute heart attack. The FF was moved to a stretcher and given oral aspirin. The ambulance departed the scene en route to the hospital's ED at 2027 hours.

The ambulance arrived at the ED at 2038 hours. An EKG revealed acute ST-elevation, and subsequent blood testing revealed an elevated troponin I level of 0.410 nanograms per milliliter (normal is <0.030), both confirmatory tests for an acute heart attack. At 2115 hours, the FF was taken emergently to the cardiac catheterization lab where coronary angiography revealed a totally occluded left anterior descending coronary artery. While preparing for coronary intervention, the FF developed ventricular fibrillation and cardiopulmonary arrest. CPR was initiated and defibrillation re-established a heart rhythm. As the team prepared for angioplasty again, the FF's heart rhythm reverted to ventricular fibrillation. After several unsuccessful defibrillations, a balloon was advanced into his left anterior descending coronary artery to re-establish blood flow. This, however, failed to stabilize his heart rhythm. Despite continued advanced life support measures, the FF's heart rhythm reverted to asystole and there was no cardiac movement, spontaneous respirations, or neurologic activity. At 2145 hours, the FF was pronounced dead and resuscitation efforts were discontinued.

Medical Findings

The death certificate listed "MI [myocardial infarction] – acute due to "occlusion of LAD [left anterior descending] on cath [catheterization]" as the cause of death. Due to the findings in the cardiac catheterization lab, no autopsy was performed. The FF had the following medical conditions:

Hypertension - first diagnosed in 2004 and began prescription anti-hypertensive medication in 2004. His last clinic blood pressure reading on December 23, 2014 was 132/98 mmHg.

Type 2 diabetes mellitus – first diagnosed in 2004 and began oral medications in 2004. His most recent blood glucose reading on October 11, 2014 was 160 milligrams per deciliter (mg/dL) (normal is 70-99 mg/dL) and his hemoglobin A1c blood level was 8.1% (normal is <5.7%).

Smoking – the FF smoked about 5 to 10 cigarettes (¼ to ½ pack) per day.

Dyslipidemia – first diagnosed in 2005 and prescribed a lipid-lowering medication in 2005. His most recent (October 11, 2014) readings included a blood cholesterol level of 201 mg/dL (normal is < 200 mg/dL), a triglyceride blood level of 287 mg/dL (normal is <150 mg/dL), a low density lipoprotein blood level of 109 mg/dL (normal is <100 mg/dL), a high density lipoprotein (HDL) blood level of 35 mg/dL (normal is 30-70 mg/dL), and a cholesterol/HDL ratio of 5.7 (normal is < 4.9).

Metabolic syndrome – the FF had four of the five conditions defining metabolic syndrome: hypertriglyceridemia, low HDL-C (< 40 mg/dL), hypertension (> 135/85), and elevated fasting glucose (> 110 mg/dL) [NFPA 2013a].

Family history of CHD – The FF's father passed away at age 51 due to heart disease.

Borderline obesity – The FF was 76 inches tall and weighed 250 pounds, giving him a body mass index of 30.4 kilograms per meters squared [CDC 2014]. Diet and exercise had been recommended by his primary care physician and the FD-contracted physician.

As part of the FD's medical program (discussed below), the FF underwent an annual EST in September 2014, 4 months prior to his death. This test was performed by a cardiologist and conducted on a treadmill using the Bruce protocol with EKG and blood pressure monitoring. The FF exercised for 7 minutes 17 seconds achieving 10.1 metabolic equivalents (METs) and 85% of his maximal predicted heart rate (146 beats per minute), stopping due to fatigue and dyspnea. The FF had stage II hypertension (183/99 mmHg) prior to starting the test and had a hypertensive response to exercise (peak systolic blood pressure of 210 mmHg) [Mundal et al. 1996]. His EKG tracing showed no clear signs of ischemia (1 millimeter horizontal ST-segment depression), however he did have arrhythmias (premature ventricular contractions with left bundle branch block morphology, and couplets). Although these findings were unchanged from 2013, the cardiologist was concerned about possible ischemia and recommended repeating the EST with perfusion imaging. Medical records available to the NIOSH investigator did not indicate that this test was performed. The FF was counseled on the findings and mailed copies of the findings along with follow-up recommendations.

Fire Department

At the time of the NIOSH investigation, the FD consisted of two fire stations with 33 career uniformed personnel and additional paid-on-call personnel. The FD served 37,100 residents in a geographic area of 1,320 square miles. In 2014, the FD responded to 843 incidents: 153 fire calls, 240 rescue/emergency medical calls, 130 hazardous condition calls, 157 false alarms, 129 good intent calls, and 34 other calls.

Employment, Membership, Training, and Experience

The FD requires new fire fighter applicants to be 21 years of age, have a valid state driver's license, a high school diploma or general education diploma (GED), Fire Fighter I certification, pass a written test, and pass an interview prior to being offered a conditional job offer. The candidate must pass a driving record check, a preplacement medical evaluation (components described below), employment and reference verifications, completion of reasonable accommodation, a urine drug screen, and a background check prior to being hired. The new member then enters the fire fighter academy as a recruit. Academy training consists of standard operating guideline reviews, job tasks, SCBA, and turnout gear, apparatus equipment and placement, radio procedures, hose and ladder operations, EMS vehicle and equipment orientation, hazardous materials trailer review, live fire training with each shift, and company inspections. The FF was certified as a Fire Fighter I, Emergency Medical Technician-Basic, Apparatus Operator, Fire Investigator, Fire Instructor, Fire Inspector, Wildland Fire Fighter, Hazardous Materials Technician, Airport Fire Fighter, and Incident Safety Officer. He had 19 years of fire fighting experience including 16 career years**.**

Preplacement and Annual Medical Evaluations/Return to Work Medical Evaluations

The FD requires preplacement medical evaluations for all applicants. Components of this evaluation include the following:

- Complete medical history
- Physical examination (including vital signs – height, weight, blood pressure, pulse, and respirations)
- Vision test (Snellen and color blind test)
- Audiogram
- Spirometry
- Resting EKG
- Urine drug screen
- Urinalysis
- Blood tests (complete blood count and lipid panel)
- Chest x-ray (baseline)
- Either a PSA test or rectal exam

The medical evaluation is performed by a contracted physician. Once this evaluation is complete, the physician makes a determination regarding medical clearance for fire fighting duties and forwards this decision to the City Human Resources Office. The FF had a baseline medical evaluation when he joined the FD in 1998, however, the evaluation at this time was only a questionnaire and a limited physical examination.

Periodic (biannual) medical evaluations are required for all members. The components are the same as the preplacement medical evaluation except:

- a urine drug screen is not performed,

- an EKG is performed every other year for members < age 40, and every year for members ≥ 40
- annual EST are required beginning at age 41.

The FF had annual medical evaluations beginning in 2011, but for unclear reasons an EST was not performed in 2011 or in 2012. Medical clearance to wear a respirator is required. Members injured on duty or who become ill must be evaluated by a City-contracted physician who forwards his or her determination for return-to-duty to the City.

Wellness/Fitness Programs

The FD has a mandatory wellness/fitness program, and exercise equipment is available in the fire stations. Members are required to exercise for 45 minutes on each shift. The FF participated in the FD's Wellness Innovations and Nursing Services program and the wellness/fitness program by walking vigorously and lifting weights on each shift. Annual physical ability tests are not required for candidates or members.

DISCUSSION

Sudden Cardiac Events

In the United States, atherosclerotic CHD is the most common risk factor for cardiac arrest and sudden cardiac death [Meyerburg and Castellanos 2008]. Risk factors for its development are grouped into non-modifiable and modifiable. Non-modifiable risk factors include age older than 45, male gender, and family history of coronary artery disease. Modifiable risk factors include diabetes mellitus, smoking, high blood pressure, high blood cholesterol, and obesity/physical inactivity [NHLBI 2014a; AHA 2015]. The FF had all three non-modifiable risk factors and all five modifiable CHD risk factors, and severe CHD was found during his cardiac catheterization.

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades [Libby 2013]. However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion. Heart attacks (myocardial infarctions) typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply. This sudden blockage is primarily due to blood clots (thromboses) forming on top of atherosclerotic plaques [Libby 2013]. Establishing a recent (acute) heart attack requires any of the following: characteristic EKG changes, elevated cardiac enzymes, or coronary artery thrombus. In this case, the FF's cardiac enzyme was elevated, his EKG revealed an acute heart attack, and a thrombus was found during his cardiac catheterization.

Physiological Stress of Firefighting

Heart attacks and sudden cardiac death can be triggered by heavy physical exertion [Mittleman 1993; Willich 1993; Albert et al. 2000]. Among fire fighters, sudden cardiac events have been associated with/triggered by alarm response, fire suppression, and heavy exertion during training (including physical fitness training) [Kales et al. 2003; Kales et al. 2007; NIOSH 2007]. The FF's activities including a 10-minute air management training evolution while wearing full turnout gear and SCBA

(on-air). This activity expended about 12 metabolic equivalents, which is considered heavy physical activity [Gledhill and Jamnik 1992; Ainsworth et al. 2011]. The heart attack that preceded the FF's sudden cardiac death was probably triggered by the physical exertion of air management training.

Occupational Medical Standards for Structural Fire Fighters

To reduce the risk of sudden cardiac arrest or other incapacitating medical conditions among fire fighters, the National Fire Protection Association (NFPA) developed NFPA 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments* [NFPA 2013a]. This voluntary industry standard provides the components of a preplacement and annual medical evaluation and medical fitness for duty criteria. The FF had several conditions addressed by NFPA 1582: 1) hypertension, 2) type 2 diabetes mellitus, 3) smoking, 4) metabolic syndrome, and 5) cardiac arrhythmias.

Hypertension. NFPA 1582 suggests that members with stage I hypertension be referred to their primary care physician to ensure that their blood pressure is controlled and to determine whether screening for end organ damage is indicated [NFPA 2013a]. The FF's hypertension was diagnosed in 2004, and he was prescribed a blood pressure-lowering medication at the same time. His most recent blood pressure readings were slightly elevated, but earlier readings in 2014 revealed Stage II hypertension (168/98 mmHg, 162/94 mmHg, and 174/106 mmHg).

NFPA considers that Stage II hypertension (systolic greater than or equal to 160 mmHg or diastolic greater than or equal to 100 mmHg) or end organ damage (retinopathy, nephropathy, neuropathy, or vascular/cardiac complications) compromises the member's ability to safely perform essential job tasks such as the following:

(1) wearing personal protective ensemble and SCBA, performing fire fighting tasks (hoseline operations, extensive crawling, lifting and carrying heavy objects, ventilating roofs or walls using power or hand tools, forcible entry, etc.), rescue operations, and other emergency response actions under stressful conditions, including working in extremely hot or cold environments for prolonged time periods;

(2) wearing fire protective ensemble that is encapsulating and insulated, which will result in significant fluid loss that frequently progresses to clinical dehydration and can elevate core temperature to levels exceeding 102.2ºF;

(3) wearing personal protective ensemble and SCBA, advancing water-filled hoselines up to 2½-inches in diameter from fire apparatus to occupancy [approximately 150-feet], which can involve negotiating multiple flights of stairs, ladders, and other obstacles;

(4) unpredictable emergency requirements for prolonged periods of extreme physical exertion without benefit of warm-up, scheduled rest periods, meals, access to medication(s), or hydration; and

(5) functioning as an integral component of a team, where sudden incapacitation of a member can result in mission failure or in risk of injury or death to civilians or other team members. Therefore, according to NFPA 1582, the FF should not have been medically cleared for unrestricted fire fighting due to his persistent hypertension [NFPA 2013a].

Diabetes Mellitus. NFPA 1582 provides guidance for fire department physicians to follow when treating diabetic fire fighters [NFPA 2013a]. The standard states that fire fighters with diabetes mellitus that is controlled by diet, exercise, or oral hypoglycemic agents should be restricted from duty unless the member meets all of the following criteria:

(1) If on oral hypoglycemic agents, has had no episodes of severe hypoglycemia (defined as requiring assistance of another in the preceding year)

(2) Has achieved a stable blood glucose as evidenced by HA_1C level less than 8 during the prior 3-month period

(3) Has a dilated retinal exam by a qualified ophthalmologist or optometrist that shows no higher grade of diabetic retinopathy than microaneurysms

(4) Has normal renal function on the basis of a calculated creatinine clearance greater than 60 milliliters per minute and absence of proteinuria

(5) Has no autonomic or peripheral neuropathy

(6) Has normal cardiac function without evidence of myocardial ischemia on cardiac stress testing (to at least 12 METs) by EKG and cardiac imaging [NFPA 2013a]

The FF had diabetes mellitus, had not consistently achieved the recommended HA_1C level, and had not achieved a 12 MET EST in 2014 (the EST did not include an imaging study). Therefore, according to NFPA 1582, he should have been restricted from fire fighting duties due to his diabetes mellitus.

Smoking. NFPA 1582 considers tobacco use to be a Category A condition (where allowed by law) for fire fighter candidates. A Category A medical condition is "a medical condition that would preclude a person from performing as a member in a training or emergency operational environment by presenting a significant risk to the safety and health of the person or others [NFPA 2013a].

Metabolic Syndrome. Metabolic syndrome is associated with reduced aerobic capacity and increased risk for cardiovascular ischemic disease, diabetes, and hypertension. NFPA 1582 recommends members with metabolic syndrome undergo an imaging EST. If the results are abnormal or the member is unable to achieve an aerobic capacity of 12 METs, the member should be given restrictions due to their inability to safely perform many essential job tasks [NFPA 2013a]. The FF did not have an imaging EST.

Arrhythmias. NFPA 1582 states that "PVCs should resolve with increasing exercise up to 12 METs" [NFPA 2013a]. The FF had increasing PVCs, including some couplets, with exercise. Therefore, according to NFPA 1582, the FF should have been restricted due to inability to safely perform as an integral component of a team, where sudden incapacitation of a member can result in mission failure or in risk of injury or death to civilians or other team members [NFPA 2013a].

Recommendations

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

Discussion: 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* [IAFF, IAFC 2008; NFPA 2013a]. 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. The FD is not legally required to follow the NFPA standard or the IAFF/IAFC guideline.

In addition, this recommendation requires significant resources and may be difficult for smaller fire departments to implement. To overcome the financial obstacle of medical evaluations, the FD could urge current members to get annual medical clearances from their private physicians through insurance, or paid for by the FD, city, or state. Sharing the financial responsibility for these evaluations between fire fighters, the FD, the city, and the state may reduce the negative financial impact on recruiting and retaining needed fire fighters.

Recommendation #2: Perform symptom-limiting ESTs on firefighters at increased risk for CHD and sudden cardiac events.

Discussion: Firefighters with multiple or severe CHD risk factors, or a high Framingham score, are at increased risk of a sudden cardiac event [AHA 2014; NHLBI 2014b]. Currently, the FD screens members for CHD risk factors and requires aerobic capacity tests but does not require symptom-limiting imaging ESTs for fire fighters at increased risk for a sudden cardiac event.

The following recommendations would not have prevented the FF's death, but NIOSH investigators include it to address general safety and health issues:

Recommendation #3: Discontinue routine exercise stress tests on asymptomatic fire fighters with no risk factors for CHD.

Discussion: NFPA 1582, the IAFF/IAFC *Fire Service Joint Labor Management Wellness/Fitness Initiative,* and the ACC/AHA recommend an exercise stress test for male fire fighters older than 45

with one or more CAD risk factors [IAFF, IAFC 2008; Gibbons et al. 2002; NFPA 2013a]. The FD currently requires EST (submaximal aerobic capacity tests) every year for all members over the age of 40. Conducting routing EST is an unnecessary expense for the fire department.

Recommendation #4: Perform candidate and member physical ability evaluations.

Discussion: NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, requires the FD to develop physical performance requirements for candidates and members who engage in emergency operations [NFPA 2013b]. Members who engage in emergency operations must be annually qualified (physical ability test) as meeting these physical performance standards for structural fire fighters [NFPA 2013b]. Once developed by the FD, this evaluation could be performed as part of the FD annual training program.

Recommendation #5: Discontinue routine PSA testing.

Discussion: Prostate cancer is the second most common cancer in men in the United States. Although prostate cancer is very common, in many cases, the cancer does not grow or cause symptoms. If it does grow, it often grows so slowly that it isn't likely to cause health problems during a man's lifetime. Therefore, only a very small number of adult men would benefit from screening.

The PSA test is commonly used to screen for prostate cancer, however the test has several limitations. For example, PSA levels may be high in men with other types of prostate problems. This is called a "false-positive" result. False-positive results cause worry and anxiety and can lead to follow-up tests that aren't needed such as needle biopsies that can cause fever, infection, bleeding, urinary problems, and pain. Second, even if biopsy finds some prostate cancer cells, currently there is no way to tell if those cells will go on to cause a problem. This means that many non-harmful cancers are diagnosed. This is called "over diagnosis." Because there is so much uncertainty about which cancers need to be treated, at present, almost all men with prostate cancer found by the PSA test get treatment with surgery, radiation, or hormone therapy. Many of these men do not need treatment because their cancer will not grow or cause health problems. This is called "overtreatment." Many treatments have complications including: 1) erectile dysfunction (impotence) from surgery, radiation therapy, or hormone therapy; 2) urinary incontinence from radiation therapy or surgery; 3) problems with bowel control from radiation therapy; and 4) a small risk of death and serious complications from surgery. Because of these limitations, all major medical organizations recommend against the routine PSA screening of asymptomatic men who are not at increased risk for prostate cancer [USPSTF 2012; AUA 2013a; AUA 2013b; AAFP 2015; ACS 2015; Wilt et al. 2015]. Rather, these organizations recommend that starting at age 50 a man should discussion the benefits and harms of the test with his physician. Because many studies suggest that fire fighters may have an increased risk of prostate cancer, this discussion could start at age 40 or 45 years [LeMasters et al. 2008; IARC 2010].

Recommendation #6: Conduct annual respirator fit testing.

Discussion: The OSHA respiratory protection standard requires employers whose employees are

required to use a respirator (e.g., an SCBA) to have a formal respiratory protection program, including annual fit testing [29 CFR 1910.134]. Each member has their own SCBA facepiece. Because Kansas does not operate an OSHA-approved state plan, the fire department is not required to follow OSHA standards [OSHA 2015]. Nevertheless, NIOSH investigators recommend voluntary compliance with this standard to ensure proper fitting personal protective equipment.

Recommendation #7: Install diesel exhaust source capture systems in fire stations.

Discussion: The exhaust from diesel engines is a complex mixture that consists of gaseous and particulate fractions. The composition varies depending on fuel and engine type, maintenance, tuning, and exhaust-stream treatment [ILO 1983; NIOSH 1988]. The gaseous fraction includes carbon dioxide, carbon monoxide, oxides of nitrogen, oxides of sulfur, and hydrocarbons. The particulate fraction (soot) of diesel exhaust is composed of microscopic cores of solid carbon (in its pure, or elemental state) onto which are adsorbed thousands of different substances [NIOSH 1988; OSHA 1988]. Most of the particles are extremely small and can reach the deep regions of the human lung when inhaled. These respirable particles are considered more hazardous than larger particles because larger particles are efficiently trapped in higher regions of the respiratory tract and removed by the body's natural mucociliary clearing process. Based on the results of human epidemiology studies, the International Agency for Research on Cancer (IARC) of the World Health Organization considers diesel exhaust emissions a human carcinogen [Attfield et al. 2012; IARC 2012]. In addition, the inhalation of fine (respirable) particulate matter has been associated with the triggering of acute myocardial infarction [Lucking et al. 2008; Mills et al. 2011].

NIOSH has stated that, "excess cancer risk for workers exposed to diesel exhaust has not yet been quantified, but the probability of developing cancer should be reduced by minimizing exposure." Therefore, NIOSH recommends reducing workers' exposures to diesel exhaust to the lowest feasible concentration [NIOSH 1988]. Steps to reduce exposures would include the following:

a). Ensure fire apparatus are inspected, tested, and maintained on a regular basis. Repair any deficiencies that are found. This will ensure proper tuning and engine efficiency and reduce generation of carbon monoxide.

b). Minimize engine idling time inside apparatus bays. While not as effective as a filtration system, limiting engine idling time reduces the diesel exhaust exposure level.

c). Control diesel exhaust emissions in fire stations by any of the following: (a) engine exhaust filters; (b) local tailpipe exhaust ventilation; or (c) dilution ventilation for equipment bays and other affected areas. Engine exhaust filters attach directly to the apparatus exhaust system and filter the emissions, while local tailpipe exhaust ventilation prevents the exhaust from entering the bay area by directing the emissions through tubing and a filter to the outdoors. Both measures prevent diesel exhaust emissions from entering the engine bay area. Providing dilution ventilation for equipment bays and isolating adjacent areas from engine exhaust products allow diesel exhaust to enter the bay and then the exhaust

is directed outside. Any diesel emissions exhausted to the outdoors should be directed away from all outdoor air intakes. I have enclosed guidelines for diesel exhaust capture and removal for your information.

d). Isolate adjacent areas from the engine exhaust products, using physical barriers and ensuring that air handling systems provide proper pressure differentials between areas.

e). Measure airborne contaminant levels for diesel emissions to assess the effectiveness of control measures. These measurements should be conducted based on the normal work hours of the employee, i.e., 8-hour, 10-hour, 24-hour shifts, etc.

f). Re-route the ventilation system air intake from the apparatus bay to another location away from any potential source of diesel exhaust.

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Investigator Information

This incident was investigated by the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component in Cincinnati, Ohio. Mr. Tommy Baldwin (MS) led the investigation and co-authored the report. Mr. Baldwin is a Safety and Occupational Health Specialist, a National Association of Fire Investigators (NAFI) Certified Fire and Explosion Investigator, an International Fire Service Accreditation Congress (IFSAC) Certified Fire Officer I, and a former Fire Chief and Emergency Medical Technician. Dr. Thomas Hales (MD, MPH) provided medical consultation and co-authored 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).

Disclaimer

Fire Fighter Suffers Heart Attack During Training and Later Dies - Kansas

Appendix A
Air Management Training

All participants in the air management training will wear full turnout gear and SCBA on-air.

1. The course will begin at the back stairs of Station 2 where the participant walks down the stairs to the basement.

2. Crawl across the training room floor to the middle stairway.

3. Walk up the stairs to the engine bay.

4. Crawl across the bay to the north side door.

5. Walk outside to the 5-inch hoseline and pull 50-feet of the hose towards themselves.

6. Walk the hose back to the starting point and set the hose down.

7. Pick up two weights and carry them to the trash container and back around three traffic cones. Set the weights down.

8. Walk to the tire and strike the tire three times with the hammer.

9. Walk around the outside of the fire station toward the south and then back to the beginning of the course on the north side.

Continue 1-9 until the participant's SCBA air supply is depleted.