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Death in the line of duty...

NIOSH
Fire Fighter Fatality Investigation and Prevention Program

A summary of a NIOSH fire fighter fatality investigation August, 2014

Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

Executive Summary

On March 7, 2014, a 51-year-old male career fire department captain ("Captain") participated in his fire department's rules of air management training. Wearing his bunker gear and self-contained breathing apparatus (SCBA), and carrying a 50-foot section of 2½-inch hoseline, the Captain and his team climbed the stairs of the drill tower to the fifth floor and returned to the ground floor. Per department protocol, the Captain repeated the tower climb with his group. Approximately 30 seconds after completing the second climb, the Captain collapsed. A nearby fire department member immediately responded and found the Captain unresponsive but with a pulse and breathing rapidly. An engine company and an ambulance response were requested via fire department radio by the member as the Captain was carried into a nearby fire apparatus bay. Cardiac monitoring in the bay revealed ventricular tachycardia (a heart rhythm incompatible with life), and cardiopulmonary resuscitation (CPR) and advanced life support (ALS) were begun. These procedures included defibrillation, delivery of cardiac resuscitation medications via the intraosseous route, and oxygen administration via bag-valve-mask. En route to the hospital's emergency department (ED), the Captain was shocked four times; the Captain's pulse returned briefly but he never regained consciousness. Inside the ED, the Captain was intubated (placement confirmed by capnography [Neumar et al. 2010]), and an electrocardiogram (EKG) revealed tracings consistent with a heart attack. The Captain was taken to the cardiac catheterization lab at 1224 hours; the procedure was complicated by intermittent cardiac arrest requiring CPR and ALS. The cardiologist found a 95% blockage of the Captain's proximal left anterior descending (LAD) coronary artery, but no obvious thrombus. Percutaneous transluminal coronary angioplasty successfully opened the blockage, and a stent was placed to keep the artery open. The Captain was never able to sustain a viable heart rhythm, pulse, or blood pressure despite the placement of a pacemaker and an intra-aortic balloon pump and extensive use of cardiac resuscitation medications. After approximately 2.5 hours of intermittent ALS and CPR, the Captain was pronounced dead (1445 hours), and resuscitation efforts were discontinued.

The death certificate and the autopsy report, completed by the state medical examiner, listed "hypertensive and atherosclerotic cardiovascular disease" as the cause of death. Given the Captain's previously unidentified coronary heart disease (CHD), NIOSH investigators concluded that the physical stress of the training probably triggered a fatal heart attack.

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

Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

Executive Summary (cont.)

Conduct exercise stress tests as part of the fire department medical evaluation program for fire fighters at increased risk for CHD.

Ensure that fire fighters are cleared for return to 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.

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

Include medical monitoring in rehabilitation programs.

Perform an annual physical performance (physical ability) evaluation for all members.

Discontinue routine screening chest x-rays for members unless clinically indicated.

Discontinue preplacement and routine screening lumbar spine x-rays unless clinically indicated.

Introduction & Methods

On March 7, 2014, a 51-year-old male career captain suffered a fatal heart attack while performing the physically demanding rules of air management training required by the fire department. NIOSH was notified of the fatality by the U.S. Fire Administration on March 10, 2014. NIOSH contacted the affected fire department on March 14, 2014, to gather additional information and on April 10, 2014, to initiate the investigation. On April 21, 2014, a safety and occupational health specialist from the NIOSH Fire Fighter Fatality Prevention and Investigation Program travelled to Alaska to investigate the incident.

During the investigation, NIOSH personnel interviewed the following people:

- Fire chief
- Assistant chief of safety and training
- Assistant chief of operations
- Deputy chief of operations
- Municipality safety manager
- Safety officer of "B" shift
- International Association of Fire Fighters local president
- Fire department accident investigation team
- Crew members
- Captain's spouse

NIOSH personnel reviewed the following documents:

- Fire department standard operating procedures
- Fire department annual report for 2012
- Fire department physician records
- Captain's primary care physician records
- Emergency medical service (ambulance) report
- Hospital ED report
- Procedure note from the catheterization lab
- Death certificate
- Autopsy report

Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

Results of Investigation

Training Description. On March 7, 2014, the fire department scheduled rules of air management training. The training was part of the department's respiratory protection program designed to determine the air consumption rate for each member performing heavy physical activity [NFPA 2013a]. The training was held at the department's training center, Tower B (Photograph 1).

Photo 1: Fire Department Training Center's Tower B
Photo by Anchorage Fire Department.

Self-Contained Breathing Apparatus Description. The SCBA used in this incident were manufactured by Draeger, model PSS 7000. The cylinders were 4,500 pounds per square inch, 45-minute carbon cylinders weighing approximately 26 pounds. The Captain's SCBA held 4,235 pounds per square inch at the start of the training.

Building Description. The training tower was a six-story type 1 fire resistive structure measuring 42 feet by 60 feet and constructed of masonry brick with concrete floors

Photo 2: Type I Training Tower
Photo by Anchorage Fire Department.

(Photograph 2). The building was equipped with a deluge sprinkler system. Several burn rooms equipped with Fireblast LP gas-fueled live fire training props were located within the building. These props were controlled from a control room or a remote computer pendant that allowed the training officer to change the intensity of the fire while observing the exercises in the burn room. None of the fuels for live fire were used during this training exercise.

Incident. The Captain arrived at his fire station at 0900 hours for his 24-hour shift. At about 1000 hours, the Captain along with his crew arrived at the fire department training center for rules of air management training. One instructor, two assistant instructors, and 18 trainees were present. Weather conditions included a temperature of 17 degrees Fahrenheit (°F), relative humidity of 65%, and wind at 8 miles per hour, giving a wind chill of 7°F [NOAA 2014].

Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

Results of Investigation (cont.)

After an hour of classroom training, the class was separated into two groups. All wore full bunker gear with SCBA on-air. Each trainee picked up a 50-foot roll of 2½-inch hoseline and proceeded into the training tower. Each trainee climbed the stairs to the fifth floor, rounded the stairs, and returned down the stairs to the ground level. After the trainees exited the tower, they returned to the entrance to repeat the five-story stair climb. During the descent of the second climb, the Captain slowed down and allowed the rest of his group to pass. He exited the building about 30 seconds after his group. After the Captain exited the tower, he walked to the center of the drill pad and collapsed.

A fire department member not participating in the training witnessed the Captain's collapse. The member summoned assistance and removed the Captain's helmet and SCBA facepiece, finding him breathing and with a pulse, but unresponsive. Crew members carried the Captain into a nearby engine bay, as a jump kit and an ambulance were requested (1146 hours). The Captain was found to be in cardiac arrest. CPR was begun, and oxygen was administered by bag-valve mask as the ambulance arrived at 1150 hours. Ambulance paramedics began ALS; cardiac monitoring showed ventricular tachycardia. Two shocks were delivered followed by the administration of intraosseous cardiac resuscitation medications. Two additional shocks were administered before the ambulance departed the scene at 1156 hours en route to the ED.

As the ambulance neared the ED, the Captain regained a pulse rate of 40 beats per minute and a blood pressure of 175/145 millimeters of mercury, but he had no spontaneous respirations and remained unconscious. The ambulance arrived at the ED at 1159 hours.

Inside the ED, the Captain was intubated with correct tube placement confirmed by capnography [Neumar et al. 2010]. An intravenous line was placed, and an EKG revealed an ST elevation indicating an acute heart attack. Shortly after ED arrival, he suffered another cardiac arrest. Over the subsequent 5 minutes, his heart rhythm fluctuated between ventricular tachycardia, ventricular fibrillation, and asystole. CPR was begun, and additional cardiac resuscitation medications were administered. He was taken to the cardiac catheterization lab at 1224 hours for emergent coronary angiography. The procedure revealed the following:

- 95% occlusion of the proximal portion of the LAD coronary artery
- 50% occlusion of the right coronary artery
- 30% occlusion of the circumflex coronary artery

The LAD blockage was successfully opened by percutaneous transluminal coronary angioplasty followed by a metal stent to keep the LAD artery open. Despite high dose pressors, a paced ventricular rhythm via a transvenous pacemaker, and an intra-aortic balloon pump, he was only able to maintain a peak systolic blood pressure of 50–60 millimeters of mercury. After approximately 2 hours and 20 minutes of

Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

Results of Investigation (cont.)

intermittent CPR and ALS in the cardiac catheterization lab, the Captain was pronounced dead at 1445 hours.

Medical Findings. The death certificate and the autopsy report, completed by the state medical examiner, listed "hypertensive and atherosclerotic cardiovascular disease" as the cause of death. Cardiac findings showed mild cardiomegaly (enlarged heart) and moderate to severe focal CHD (Appendix A).

The Captain was 70 inches tall and weighed 242 pounds at his last medical evaluation (June 2013), giving him a body mass index of 34.7 kilograms per meters squared [CDC 2011]. According to medical records, the Captain's risk factors for CHD were high blood cholesterol (diagnosed in 2002), obesity, and borderline diabetes mellitus (intermittently elevated fasting glucose since 2008). He was prescribed a cholesterol-lowering medication, nutritional supplements, diet, and exercise by his primary care physician. The Captain never complained of cardiac symptoms. The Captain passed his last fire department medical evaluation in June 2013.

Description of the Fire Department

At the time of the NIOSH investigation, the fire department consisted of 13 fire stations with 313 career uniformed personnel. It served 300,000 residents in a geographic area of 140 square miles. In 2012, the fire department responded to 32,615 incidents: 735 fire calls, 21,372 emergency medical/rescue calls, 787 hazardous conditions calls, 2,350 false alarms, and 7,371 service calls.

Membership and Training. The fire department requires new career fire fighter applicants to be 18 years of age; be a high school graduate or have the equivalent certificate; have a valid state driver's license; be certified as an emergency medical technician; and pass a background check, a written fire and police selection test, a candidate physical ability test, a committee interview, and a fire chief interview before being placed on a ranking list and given a conditional job offer. The potential new hire then must pass a preplacement medical evaluation (described below) and a psychological screening. The new member then begins the 9-week fire training academy to become trained as a fire fighter II. The new member is on probation for 18 months and works 24-hours on duty/24-hours off duty for two shifts, then works an 8-hour day.

The Captain had 19 years of fire fighting experience with this fire department. He was certified as a fire fighter II, fire officer II, apparatus driver/operator, paramedic, CPR instructor, trauma instructor, emergency medical technician instructor, fire investigator, wildland fire fighter, swift water rescue, and

Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

Description of the FD (cont.)

urban search and rescue. He had worked for 4 hours (1800 to 2200 hours) the day before his 24-hour shift began on March 7, 2014, at 0900 hours.

Preplacement and Periodic Medical Evaluations. The fire department 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 (acuity, color, peripheral fields, and depth perception)
- Audiogram
- Spirometry
- EKG
- Urinalysis
- Urine drug screen (baseline)
- Blood tests (complete blood count, lipids)
- Chest x-ray (baseline and every 3 years)
- Lumbar spine x-ray (baseline and every 3 years)
- SCBA respirator clearance
- Exercise stress test (EST) when clinically indicated
- Tuberculosis screen (annual)
- Hepatitis B and C screens (annual)

The medical evaluations are performed by a fire department-contracted physician. The physician makes a determination regarding medical clearance for fire fighting duties and forwards this decision to the fire department.

Annual medical evaluations are also required for members. The components are similar to the preplacement medical evaluation. The Captain's most recent annual medical evaluation was in June 2013. Although he had elevated glucose, hemoglobin A1c (a marker of long-term elevated blood glucose levels), and lipid levels, he was not referred to his primary care physician for follow-up, and he was cleared for unrestricted duty as a fire fighter.

Medical clearance to wear a respirator is required for suppression fire fighters. Members injured on duty or who become ill and miss three shifts must be evaluated by their primary care physician who forwards a determination for return to duty to the fire department.

Health and Wellness Programs. The fire department does not require members to participate in a wellness/fitness program; however, exercise equipment is available in the fire stations. In 2010, the fire department adopted the IAFF/IAFC Wellness/Fitness Initiative (WFI) and receives an insurance premium reduction with 90% compliance. A voluntary annual physical fitness assessment is offered through the WFI (Appendix B), but annual physical fitness assessments are not required. The Captain routinely exercised while on shift.

Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

Discussion

Atherosclerotic Coronary Heart Disease. 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 include age older than 45, male gender, family history of CAD, smoking, high blood pressure, high blood cholesterol, obesity/physical inactivity, and diabetes [NHLBI 2012; AHA 2014]. The Captain had two, possibly three, modifiable CHD risk factors (high blood cholesterol, obesity, borderline diabetes mellitus). He had moderate to severe two-vessel CHD on autopsy, despite reporting no previous episodes of chest pain (angina) and having normal annual resting EKGs.

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 (thrombosis) 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 EKG revealed an acute heart attack.

Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks and sudden cardiac death [Mittleman et al. 1993; Willich et al. 1993; Albert et al. 2000]. Heart attacks in fire fighters have been associated with alarm response, fire suppression, and heavy exertion during training (including physical fitness training) [Kales et al. 2003; Kales et al. 2007; NIOSH 2007]. The Captain, wearing full turnout gear and SCBA on-air, climbed to the fifth floor of the drill tower while carrying a 50-foot roll of 2½-inch hoseline, all weighing about 73 pounds. This activity expended about 11 metabolic equivalents, which is considered heavy physical activity [Gledhill and Jamnik 1992; Ainsworth et al. 2011].

Occupational Medical Standards for Structural Fire Fighters and Exercise Stress Test. 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 2013b]. This voluntary industry standard provides the components of a preplacement and annual medical evaluation and medical fitness for duty criteria. Recommendations for ESTs on asymptomatic individuals without known heart disease are varied. The following paragraphs summarize the positions of widely recognized organizations on this topic.

NFPA 1582, a voluntary industry standard, recommends an EST be performed "as clinically indicated by history or symptoms" and refers the reader to Appendix A [NFPA 2013b]. Items in Appendix A are not standard requirements, but are provided for "informational purposes only." Appendix A recommends using submaximal (85% of predicted heart rate) stress tests as a screening tool to evaluate a fire fighter's aerobic capacity. Maximal (i.e., symptom-limiting) stress tests with imaging should be used for fire fighters with the following conditions:

Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

Discussion (cont.)

- abnormal screening submaximal stress tests
- cardiac symptoms
- known CAD
- one or more risk factors for CAD (in men older than 45 and women older than 55)

Negative stress tests should be repeated as clinically indicated or at least every 2 to 5 years.

Risk factors are defined as hypercholesterolemia (total cholesterol greater than 240 milligrams per deciliter), hypertension (diastolic blood pressure greater than 90 millimeters of mercury), smoking, diabetes mellitus, or family history of premature CAD (heart attack or sudden cardiac death in a first-degree relative less than 60 years old). Given the Captain's age and hypercholesterolemia, NFPA 1582 recommends a symptom-limiting EST.

The ACC/AHA has also published exercise testing guidelines [Gibbons et al. 2002]. The ACC/AHA guideline states that the evidence to conduct stress tests in asymptomatic individuals is "less well established" (Class IIb) for the following groups:

- persons with multiple risk factors (defined similarly to those listed by the NFPA)
- asymptomatic men older than 45 years and women older than 55 years:
  - who are sedentary and plan to start vigorous exercise
  - who are involved in occupations in which impairment might jeopardize public safety (e.g., fire fighters)
  - who are at high risk for CAD due to other diseases (e.g., peripheral vascular disease and chronic renal failure)

Like NFPA, the above ACC/AHA criteria suggest an EST may have been appropriate for the Captain.

The U.S. Department of Transportation provides guidance for those seeking medical certification for a commercial driver's license. An expert medical panel recommended exercise tolerance tests (stress tests) for asymptomatic high risk drivers [Blumenthal et al. 2007]. The panel defines high risk drivers as those with any of the following:

- diabetes mellitus
- peripheral vascular disease
- age 45 and above with multiple risk factors for CHD
- Framingham risk score predicting a 20% CHD event risk over the next 10 years

Given the Captain's Framingham risk score of 6% the U.S. Department of Transportation would not have recommended an EST [NHLBI 2013].

The U.S. Preventive Services Task Force (USPSTF) does not recommend stress tests for asymptomatic individuals at low risk for coronary heart disease events. For individuals at increased risk for CHD events, the USPSTF found "insufficient evidence to recommend for or against routine screening with EKG, exercise tolerance test, or electron beam computerized tomography scanning…." Rather, they recommend the diagnosis and treatment of modifiable risk factors (hypertension, high cholesterol, smoking, and diabetes) [USPSTF 2004]. The USPSTF does note that "For people in certain occupations, such as pilots, and heavy equipment operators (for whom sudden incapacitation or sudden death may endanger the safety of others), consideration other than the health benefit to the individual patient may influence the decision to screen for coronary heart disease."

In summary, the Captain had an acute heart attack despite being asymptomatic. He had at least two CHD risk factors. According to NFPA 1582 and possibly the ACC/AHA, a symptom-limiting EST was indicated.

Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

Recommendations

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

Recommendation #1: Conduct exercise stress tests for fire fighters at increased risk for coronary heart disease.

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 coronary artery disease risk factors [Gibbons et al. 2002; IAFF, IAFC 2008; NFPA 2013b]. The Captain was over the age of 45 and had two, possibly three, modifiable risk factors for CHD (high blood cholesterol, obesity, borderline diabetes mellitus). A symptom-limiting exercise stress test may have identified his underlying CHD, possibly leading to further evaluation and treatment.

Recommendation #2: Ensure that fire fighters are cleared for return to 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.

Guidance regarding medical evaluations and examinations for structural fire fighters can be found in NFPA 1582 and in the IAFF/IAFC Fire Service Joint Labor Management Wellness/Fitness Initiative [IAFF, IAFC 2008; NFPA 2013b]. According to these guidelines, the fire department should have an officially designated physician who is responsible for guiding, directing, and advising the members with regard to their health, fitness, and suitability for duty. The physician should review job descriptions and essential job tasks required for all fire department positions and ranks to understand the physiological and psychological demands of fire fighters and the environmental conditions under which they must perform, as well as the personal protective equipment they must wear during various types of emergency operations. The fire department currently uses the member's personal physician to initially clear fire fighters injured on duty or who miss work because of a lengthy illness.

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

We applaud the fire department for adopting the WFI. However, the fire department operates its program on a voluntary basis. Fire service health promotion programs have been shown to reduce coronary artery disease 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; Poston et al. 2013]. A study 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 2013]. NIOSH recommends a formal, mandatory wellness/fitness program to ensure all members receive the benefits of a health promotion program.

The following recommendations would not have prevented the Captain's death, but NIOSH

Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

Recommendations (cont.)

investigators include them to address general safety and health issues.

Recommendation #4: Include medical monitoring in rehabilitation programs.

Medical monitoring should be included during physically demanding respiratory protection training [NFPA 2013a]. A model rehabilitation program can be found in NFPA 1584, Standard on the Rehabilitation Process for Members During Emergency Operations and Training Exercises [NFPA 2008]. Medical monitoring should be part of any rehabilitation program. This would consist of evaluating the symptoms, signs, and vital signs of personnel upon entry to, and discharge from, the rehabilitation program. These findings should be recorded and maintained. Symptomatic members or members with abnormal findings should receive medical monitoring and/or be evaluated for potential transport to the ED. If medical care is given, a medical report should be completed and maintained. In this incident, all participants should have had their vital signs taken prior to the physically demanding training.

Recommendation #5: Perform an annual physical performance (physical ability) evaluation.

NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, requires the fire department to develop physical performance requirements for candidates and members who engage in emergency operations [NFPA 2013c]. Members who engage in emergency operations must be annually qualified (physical ability test) as meeting these physical performance standards for structural fire fighters [NFPA 2013c]. This requirement could be incorporated into the annual task-level training program.

Recommendation #6: Discontinue routine screening chest x-rays for members, unless clinically indicated.

The fire department obtains chest x-rays during the pre-employment/pre-placement medical evaluation and every 4 years. NFPA 1582 recommends an initial baseline chest x-ray and repeat chest x-rays every 5 years or as medically indicated [NFPA 20013b]. Requiring chest x-rays every 4 years, or even every 5 years, exposes members to unnecessary radiation and is an unnecessary expense for the fire department [Tigges et al. 2004]. Routine screening chest x-rays are not recommended by the OSHA hazardous materials (hazardous waste operations and emergency response) standard, unless clinically indicated (e.g., respiratory symptoms) [NIOSH 1985; CFR 2012].

Recommendation #7: Discontinue preplacement and routine screening lumbar spine x-rays unless clinically indicated.

The fire department performs preplacement screening and lumbar spine x-rays and repeats these x-rays every 3 years in members. While these x-rays may be useful in evaluating individuals with existing problems, the American College of Radiology, American College of Occupational and Environmental Medicine, and NIOSH investigators have concluded that lumbar spine x-rays have no value as a routine screening measure to determine risk for back injuries [Present 1974; Lincoln et al. 1979; Gibson 1998]. Lumbar spine x-rays are an unnecessary radiation exposure for the individual and an unnecessary expense for the fire department.

Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

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Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

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Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

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Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

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 Heath, and Vice-Chair of the Public Safety Medicine Section of the American College of Occupational and Environmental Medicine (ACOEM).

Appendix A

Pertinent Autopsy Findings

- Coronary artery atherosclerosis
  - 75% focal narrowing of the left anterior descending coronary artery with a stent in the proximal artery
  - 50% focal narrowing of the right coronary artery
  - No focal narrowing of the left circumflex coronary artery
  - Microscopic: mild myocyte hypertrophic change
- Hypertensive heart disease
  - Mild cardiomegaly (enlarged heart; heart weighed 460 grams [g]; predicted normal weight is 410 g [ranges between 311 g and 541 g as a function of sex, age, and body weight]) [Silver and Silver 2001]
- Normal cardiac valves
- No evidence of a pulmonary embolus (blood clot in the lung arteries)
- Blood tests for drugs and alcohol were negative.

Reference

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Senior Captain Suffers Sudden Cardiac Death During Training – Alaska

Appendix B

Annual Physical Fitness Assessment

This assessment is voluntary for all members. Results are provided only to the member. Any member who fails to successfully complete the assessment is advised on fitness improvement. Failure to participate in the program or repeated failure of the assessment does not result in punitive action.

The physical fitness assessment consists of the following:

- Member must have been medically cleared within the last 12 months
- Health screen questionnaire
- Body composition: skinfold measurements
- Aerobic capacity: WFI treadmill/stepmill
- Muscular strength: hand grip, static arm, and static leg
- Muscular endurance: push-ups and prone static plank
- Flexibility: sit and reach