



## **Fire Boat Captain Suffers Sudden Cardiac Death After Winterizing Fire Boat—Michigan**

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### **Executive Summary**

On November 20, 2015, a 65-year old seasonal career fire boat captain (the “Captain”) began his 24-hour shift. He piloted the fire department’s fire boat from its’ berth at Engine 16 to its’ slip at the U.S. Coast Guard (USCG) station. For about 2½ hours, the Captain and a crewmember winterized the boat. He then gave a tour of the boat to the Executive Fire Commissioner and the Deputy Fire Commissioner. After returning to Engine 16, the Captain took a nap. About 4 hours later, crewmembers found the Captain unresponsive in his bunk. They notified Dispatch and began cardiopulmonary resuscitation (CPR). They placed an automated external defibrillator. It advised no shocks. After arriving by ambulance, paramedics placed their automated external defibrillator on the Captain. Again, no shock was advised. Paramedics inserted an oropharyngeal airway and administered oxygen via bag-valve-mask. They transported the Captain to the hospital’s emergency department (ED). Hospital staff administered advanced life support. Measures included cardiac monitoring, intubation, intravenous line placement, and cardiac resuscitation medication administration. CPR continued for 9 minutes with no positive change in the Captain’s clinical status. The attending physician pronounced the Captain dead.

The Assistant Medical Examiner completed the death certificate. It listed “arteriosclerotic cardiovascular disease” as the cause of death. No autopsy was performed. The Captain’s coronary heart disease (CHD) was undiagnosed prior to this incident.

### **Key Recommendations**

- *Provide preplacement and 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 at increased risk for CHD*
- *Perform symptom-limiting exercise stress tests (ESTs) on 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 components of NFPA 1582*

The following recommendations address general safety and health issues and would not have prevented the Captain’s death:

## **Fire Boat Captain Suffers Sudden Cardiac Death After Winterizing Fire Boat—Michigan**

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- *Perform an annual physical ability evaluation*
- *Phase in a mandatory comprehensive wellness and fitness program for fire fighters*
- *Perform an autopsy on all on-duty fire fighter fatalities.*

The National Institute for Occupational Safety and Health (NIOSH), an institute within the Centers for Disease Control and Prevention (CDC), is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. In 1998, Congress appropriated funds to NIOSH to conduct a fire fighter initiative that resulted in the NIOSH Fire Fighter Fatality Investigation and Prevention Program, which examines line-of-duty deaths or on-duty deaths of fire fighters to assist fire departments, fire fighters, the fire service and others to prevent similar fire fighter deaths in the future. The agency does not enforce compliance with state or federal occupational safety and health standards and does not determine fault or assign blame. Participation of fire departments and individuals in NIOSH investigations is voluntary. Under its program, NIOSH investigators interview persons with knowledge of the incident who agree to be interviewed and review available records to develop a description of the conditions and circumstances leading to the death(s). Interviewees are not asked to sign sworn statements and interviews are not recorded. The agency's reports do not name the victim, the fire department, or those interviewed. The NIOSH report's summary of the conditions and circumstances surrounding the fatality is intended to provide context to the agency's recommendations and is not intended to be definitive for purposes of determining any claim or benefit.

For further information, visit the program website at [www.cdc.gov/niosh/fire](http://www.cdc.gov/niosh/fire) or call toll free 1-800-CDC-INFO (1-800-232-4636).

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## **Fire Boat Captain Suffers Sudden Cardiac Death After Winterizing Fire Boat—Michigan**

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### **Introduction**

On November 20, 2015, a 65-year old Captain suffered sudden cardiac death after piloting, winterizing, and giving a tour of the department's fire boat. NIOSH was notified of this fatality on November 24, 2015, by the U.S. Fire Administration. NIOSH contacted the affected fire department on November 24, 2015, to gather additional information and on January 20, 2016, to initiate the investigation. On February 8, 2016, 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:

- Executive Fire Commissioner
- Deputy Fire Commissioner
- Deputy Fire Chief
- Division Chief of Training
- International Association of Fire Fighters local President
- International Association of Fire Fighters local Secretary
- Crew members
- Captain's family

NIOSH personnel reviewed the following documents:

- Fire Department standard operating guidelines
- Training records
- Fire Department annual report for 2015
- Emergency medical service (ambulance) report
- Hospital ED records
- Death certificate
- Fire department self-contained breathing apparatus (SCBA) records

### **Investigation**

On November 20, 2015, the Captain arrived at Station 16 at about 0730 hours for his 24-hour shift. One crewmember was on-duty with the Captain. The Captain was the pilot of the fire department's fire boat. The fire boat provides fire and emergency response service to the city's port area which includes 32 miles of river. The fire boat was built in 1979, is 75 feet long and 22 feet wide. It has dual water pumps that can flow 11,000 gallons per minute through its clean water cannons.

At about 0830 hours, the Captain piloted the fire boat to the USCG station. After docking, the Captain

## **Fire Boat Captain Suffers Sudden Cardiac Death After Winterizing Fire Boat—Michigan**

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and the crewmember winterized the fire boat by stowing equipment, adding antifreeze to the fuel supply, connecting the electrical supply cable to the dock's electrical box, and completing administrative paperwork. The Executive Fire Commissioner and the Deputy Fire Commissioner arrived and the Captain gave them a tour of the fire boat. At about 1115 hours, the crew returned to Engine 16 for the remainder of their shift.

From 1135 hours to 1200 hours, the Captain and his crewmember performed station duties. Upon completion, the Captain returned to his quarters to nap. At about 1605 hours, another crewmember arrived at the fire station. When told later that the Captain had been napping since around noon (which was unusual), both crewmembers entered the Captain's bunkroom. They found the Captain unresponsive with no pulse.

The crewmembers began CPR, notified Dispatch, and requested an ambulance (1615 hours). An automated external defibrillator was placed but no shock was advised. The ambulance arrived at 1622 hours. Paramedics placed their automated external defibrillator on the Captain and again, no shock was advised. They inserted an oropharyngeal airway and administered oxygen via bag-valve-mask. The ambulance departed the scene at 1632 hours en route to the hospital's ED, arriving at 1635 hours.

ED staff administered advanced life support. Measures included cardiac monitoring, intubation, intravenous line placement, and cardiac resuscitation medication administration. CPR continued for 9 minutes with no positive change in the Captain's clinical status. The cardiac monitor revealed asystole (no heart beat). The attending physician pronounced the Captain dead at 1645 hours.

### **Medical Findings**

The Assistant Medical Examiner completed the death certificate. It listed "arteriosclerotic cardiovascular disease" as the cause of death. No autopsy was performed.

The Captain was 70 inches tall and weighed 165 pounds, giving a normal body mass index of 23.7 kilograms per meter squared [CDC 2015]. The Captain's only known modifiable risk factor for CHD was cigarette smoking; he had smoked about ½ pack per day for decades. It is unclear if the Captain had other modifiable CHD risk factors (hypertension, high blood cholesterol, diabetes). His last known medical evaluation was in 2002 (fire department's pre-employment/preplacement medical evaluation) and this evaluation did not include blood pressure, blood cholesterol, or blood glucose measurements.

### **Fire Department**

At the time of the NIOSH investigation, the fire department consisted of 38 fire stations with 1,350 career uniformed personnel. It served 700,000 residents in a geographic area of 139 square miles. In 2015, the fire boat responded to six incidents.

### **Employment and Training**

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## **Fire Boat Captain Suffers Sudden Cardiac Death After Winterizing Fire Boat—Michigan**

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The fire department requires all new fire boat pilot applicants to have a General Education Diploma/high school diploma, be a registered/licensed river pilot with water rescue certification, and pass a background check. Applicants are not required to pass a physical ability test. Newly hired fire boat pilots must pass a preplacement medical evaluation prior to being placed on a shift. All new members work 24 hours on duty, 24 hours off-duty, 24 hours on duty. Then, they are off 3 days (averaging 49-hours per week). The Captain was certified as a fire fighter II, a boat pilot, and in hazardous materials operations. He had 13 years of fire fighting experience.

### **Medical Evaluation**

The fire department requires a comprehensive preplacement medical evaluation for all fire fighter applicants. Fire boat applicants and emergency mechanics, however, receive an abbreviated preplacement medical evaluation consisting of:

- Complete medical history
- Physical examination
- Urinalysis
- Urine drug screen
- Pregnancy test (females only)

These evaluations are performed by the Fire Department-contracted physician. The physician makes a determination regarding medical clearance and forwards this decision to the fire department's personnel director. The Captain passed his preplacement medical evaluation in 2002.

Annual medical clearance for fire fighting is required only for HazMat fire fighters. Other fire fighters receive a medical evaluation at promotion, including fire boat crewmembers when they are promoted to Captain. The Captain was hired as a Captain and received only the preplacement medical evaluation.

The fire department requires all fire fighters, including fire boat members, to complete a medical questionnaire for medical clearance to wear SCBA. The questionnaire is reviewed by an occupational health nurse. In addition, an SCBA mask fit test is required annually.

### **Return to Work Medical Evaluations and Wellness/Fitness Programs**

Members injured on duty may be evaluated by the Fire Department-contracted physician or the member's primary care physician. The Fire Department-contracted physician makes the final determination regarding return to work. Members who are ill and miss 28 calendar days must also be medically cleared to return to duty. Fire boat members off duty for 1 year or more must also be medically cleared, then have an SCBA mask fit test.

The fire department does not have a comprehensive wellness/fitness program as recommended by the IAFF/IAFC Wellness Fitness Initiative [IAFF, IAFC 2008]. Fitness equipment (strength and aerobic) is available in most fire stations except for Engine 16 station. An annual physical ability test is not required.

### **Discussion**

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## **Fire Boat Captain Suffers Sudden Cardiac Death After Winterizing Fire Boat—Michigan**

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### **Sudden Cardiac Events: Heart Attacks and Arrhythmias**

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 2015; AHA 2016]. The Captain had two non-modifiable risk factors (age older than 45 and male gender) and one known modifiable CHD risk factor (smoking). Due to the Captain's limited contact with the health care system, it is unclear if he had other modifiable CHD risk factors (hypertension, high blood cholesterol, diabetes).

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 electrocardiogram (EKG) changes, elevated cardiac enzymes, or coronary artery thrombus. In this case, the Captain did not have a heart rhythm to perform an EKG, his blood was not tested for cardiac enzymes, and an autopsy was not performed. Although a cardiac event is most likely the cause of the Captain's death, it is unclear if it was a heart attack.

Besides heart attack, primary cardiac arrhythmia (e.g., ventricular tachycardia/fibrillation) is another cardiac cause of sudden death. Risk factors for primary arrhythmias include heart disease, heart attack, dietary supplements, smoking, alcohol, drug abuse, medications, diabetes, and hyperthyroidism [AHA 2014; Mayo Clinic 2016]. The Captain's only known risk factor for a primary arrhythmia was his smoking history. NIOSH investigators conclude it is unlikely that the Captain had a cardiac arrhythmia although it cannot be ruled out.

### **Physiological Stress of Firefighting**

Heart attacks and sudden cardiac death can be triggered by heavy physical exertion [Mittleman et al. 1993; Willich et al. 1993; Albert et al. 2000]. Among fire fighters, sudden cardiac events have been associated with or 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 Captain's activities winterizing the fire boat expended about 4 metabolic equivalents, which is considered light physical activity [Gledhill and Jamnik 1992; Ainsworth et al. 2011]. Because the Captain had no symptoms or signs of cardiac problems while winterizing the fire boat or immediately after, it is unclear what role, if any, physical exertion played in his sudden cardiac death.

### **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

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## **Fire Boat Captain Suffers Sudden Cardiac Death After Winterizing Fire Boat—Michigan**

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industry standard provides the components of a preplacement and annual medical evaluation and medical fitness for duty criteria. Due to the Captain's limited contact with the health care system, it is unclear if NFPA fitness for duty criteria were applicable, or if additional tests [e.g., ESTs] to screen for CHD were indicated. Recommendations on whether to screen asymptomatic individuals for CHD with EST are varied. All the guidelines require knowledge about CHD risk factors, which was largely missing in this case. The following paragraphs summarize the positions of widely recognized organizations on this topic.

### **NFPA**

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 2013a]. 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) ESTs as a screening tool to evaluate a fire fighter's aerobic capacity. Maximal (i.e., symptom-limiting) ESTs with imaging should be used for fire fighters with the following conditions:

- abnormal screening submaximal tests
- cardiac symptoms
- known CHD
- one or more risk factors for CHD (in men older than 45 and women older than 55)
  - Hypercholesterolemia (total cholesterol greater than 240 milligrams per deciliter)
  - Hypertension (diastolic blood pressure greater than 90 mm of mercury)
  - Diabetes mellitus
  - Smoking
  - Family history of premature CHD (heart attack or sudden cardiac death in a first-degree relative less than 60 years old)
- Framingham Risk Score > 10%

The Captain's age, gender, and smoking history suggest NFPA 1582 would have recommended a symptom-limiting EST.

### **American College of Cardiology/American Heart Association (ACC/AHA)**

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 coronary artery disease due to other diseases (e.g., peripheral vascular disease and chronic renal failure)

## **Fire Boat Captain Suffers Sudden Cardiac Death After Winterizing Fire Boat—Michigan**

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The ACC/AHA guideline suggests an EST was indicated, despite the evidence being “less well established,” because the Captain was in a safety sensitive position and had at least one known modifiable CHD risk factor.

### **U.S. Department of Transportation**

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 incomplete information about the Captain’s CHD risk factors, it cannot be determined if the U.S. Department of Transportation would have been recommended for an EST if the Captain was trying to obtain a commercial drivers’ license [Blumenthal et al. 2007].

### **U.S. Preventive Services Task Force (USPSTF)**

The U.S. Preventive Services Task Force (USPSTF) does not recommend stress tests for asymptomatic individuals at low risk for CHD 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, given the absence of information regarding the Captain’s risk for CHD, applying the guidelines discussed above produces conflicting results regarding the indication for an EST.

## **Recommendations**

***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, to identify fire fighters at increased risk 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]. Although the Fire Department is not legally required to follow the NFPA



## **Fire Boat Captain Suffers Sudden Cardiac Death After Winterizing Fire Boat—Michigan**

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standard or the IAFF/IAFC guideline, steps could be taken to ensure the medical ability of fire fighters to perform duties without presenting a significant risk to the safety and health of themselves or others.

### ***Recommendation #2: Perform symptom-limiting ESTs on fire fighters at increased risk for CHD.***

Discussion: Firefighters with multiple or severe CHD risk factors, or a Framingham risk score > 10%, are at increased risk of a sudden cardiac event [ACC 2014; AHA 2014]. The fire department does not screen members for CHD risk factors, does not conduct aerobic capacity tests, and does not require ESTs when fire fighters are at increased risk for a sudden cardiac event.

### ***Recommendation #3: 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.***

Discussion: According to NFPA 1582, 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 [NFPA 2013a]. The physician should review job descriptions and essential job tasks required for all fire department positions 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 allows the member's personal physician to clear fire fighters who miss work due to injury/illness. However, personal physicians may be unaware of the hazardous and physical demands of structural fire fighting and the guidance provided by NFPA 1582.

NIOSH investigators commend the Fire Department for requiring that all personal physician clearances be reviewed by the Fire Department-contracted physician.

The following recommendations address general safety and health issues and would not have prevented the Captain's death:

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

Discussion: 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 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]. This evaluation could be performed as part of the annual training program.

### ***Recommendation #5: Phase in a mandatory comprehensive wellness and fitness program for fire fighters.***

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

## **Fire Boat Captain Suffers Sudden Cardiac Death After Winterizing Fire Boat—Michigan**

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[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 [Pelletier 2009; Baicker et al. 2010]. 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 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 et al. 2013].

The fire department does not offer a wellness/fitness program. However, exercise equipment is available in the fire stations; much of the equipment was purchased by the members. NIOSH recommends a formal, mandatory wellness/fitness program and that fitness equipment provided by the Fire Department be placed in each fire station.

### ***Recommendation #6: Perform an autopsy on all on-duty fire fighter fatalities.***

In 2008, the USFA published the *Firefighter Autopsy Protocol* [USFA 2008]. The provisions of the protocol were to provide “a more thorough documentation of the causes of firefighter deaths for three purposes:

1. to advance the analysis of the causes of firefighter deaths to aid in the development of improved firefighter health and safety equipment, procedures, and standards;
2. to help determine eligibility for death benefits under the Federal government’s Public Safety Officer Benefits Program, as well as state and local programs; and
3. to address an increasing interest in the study of deaths that could be related to occupational illnesses among firefighters, both active and retired.”

## **References**

- AHA [2014]. Understand your risk for arrhythmia. Dallas, TX: American Heart Association. [[http://www.heart.org/HEARTORG/Conditions/Arrhythmia/UnderstandYourRiskforArrhythmia/Understand-Your-Risk-for-Arrhythmia\\_UCM\\_002024\\_Article.jsp](http://www.heart.org/HEARTORG/Conditions/Arrhythmia/UnderstandYourRiskforArrhythmia/Understand-Your-Risk-for-Arrhythmia_UCM_002024_Article.jsp)]. Date accessed: April 2016.
- AHA (American Heart Association) [2016]. Understand your risk of heart attack. Dallas, TX: American Heart Association. [[http://www.heart.org/HEARTORG/Conditions/HeartAttack/UnderstandYourRiskofHeartAttack/Understand-Your-Risk-of-Heart-Attack\\_UCM\\_002040\\_Article.jsp](http://www.heart.org/HEARTORG/Conditions/HeartAttack/UnderstandYourRiskofHeartAttack/Understand-Your-Risk-of-Heart-Attack_UCM_002040_Article.jsp)]. Date accessed: April 2016.
- Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR Jr, Tudor-Locke C, Greer JL,

## **Fire Boat Captain Suffers Sudden Cardiac Death After Winterizing Fire Boat—Michigan**

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- Vezina J, Whitt-Glover MC, Leon AS [2011]. Compendium of physical activities: a second update of codes and MET values. *Med Sci Sports Exerc* 43(8):1575–1581.
- Albert CM, Mittleman MA, Chae CU, Lee IM, Hennekens CH, Manson JE [2000]. Triggering of sudden death from cardiac causes by vigorous exertion. *N Engl J Med* 343(19):1355–1361.
- Baicker K, Cutler D, Song Z [2010]. Workplace wellness programs can generate savings. *Health Affairs* 29(2):1–8.
- 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.
- Blumenthal RS, Epstein AE, Kerber RE [2007]. Expert panel recommendations. Cardiovascular disease and commercial motor vehicle driver safety. [[http://www.mrb.fmcsa.dot.gov/documents/CVD\\_Commentary.pdf](http://www.mrb.fmcsa.dot.gov/documents/CVD_Commentary.pdf)]. Date accessed: April 2016.
- CDC (Centers for Disease Control and Prevention) [2015]. Assessing your weight. [<http://www.cdc.gov/healthyweight/assessing/index.html>]. Date accessed: April 2016.
- CFR. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.
- 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.
- Gibbons RJ, Balady GJ, Bricker JT, Chaitman BR, Fletcher GF, Froelicher VF, Mark DB, McCallister BD, Mooss AN, O'Reilly MG, Winters WL Jr., Antman EM, Alpert JS, Faxon DP, Fuster V, Gregoratos G, Hiratzka LF, Jacobs AK, Russell RO, Smith SC Jr [2002]. ACC/AHA 2002 guideline update for exercise testing: a report of the American College of Cardiology/ American Heart Association Task Force on Practice Guidelines. *Circulation* 106(14):1883–1892.
- Gledhill N, Jamnik VK [1992]. Characterization of the physical demands of firefighting. *Can J Spt Sci* 17(3):207–213.
- 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.
- Kales SN, Soteriades ES, Christoudias SG, Christiani DC [2003]. Firefighters and on-duty deaths from coronary heart disease: a case control study. *Environ health: a global access science source*. 2:14. [<http://www.ehjournal.net/content/2/1/14>]. Date accessed: April 2016.
- Kales SN, Soteriades ES, Christophi CA, Christiani DC [2007]. Emergency duties and deaths from heart disease among fire fighters in the United States. *N Engl J Med* 356(12):1207–1215.
- Kuehl KS, Elliot DL, Goldberg L, Moe EL, Perrier E, Smith J [2013]. Economic benefit of the PHLAME wellness programme on firefighter injury. *Occup Med* 63(3):203–209.
- Libby P [2013]. Mechanisms of acute coronary syndromes and their implications for therapy. *N Engl J Med* 368(21):2004–2013.

## **Fire Boat Captain Suffers Sudden Cardiac Death After Winterizing Fire Boat—Michigan**

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Mayo Clinic [2016]. Heart arrhythmia. [<http://www.mayoclinic.org/diseases-conditions/heart-arrhythmia/symptoms-causes/dxc-20188128>]. Date accessed: April 2016.

Meyerburg RJ, Castellanos A [2008]. Cardiovascular collapse, cardiac arrest, and sudden cardiac death. In: Fauci AS, Braunwald E, Kasper DL, Hauser SL, Longo DL, Jameson JL, Loscalzo J, eds. *Harrison's principles of internal medicine*. 17th ed. New York: McGraw-Hill, pp. 1707–1713.

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(23):1677–1683.

NFPA [2008]. Standard on health-related fitness programs for fire fighters. Quincy, MA: National Fire Protection Association. NFPA 1583.

NFPA [2013a]. Standard on comprehensive occupational medical program for fire departments. Quincy, MA: National Fire Protection Association. NFPA 1582.

NFPA [2013b]. Standard on fire department occupational safety and health program. Quincy, MA: National Fire Protection Association. NFPA 1500.

NHLBI [2015]. Who is at risk for coronary artery disease? National Heart, Lung, and Blood Institute. [<http://www.nhlbi.nih.gov/health/health-topics/topics/cad/atrisk.html>]. Date accessed: April 2016.

NIOSH [2007]. NIOSH alert: preventing fire fighter fatalities due to heart attacks and other sudden cardiovascular events. [<http://www.cdc.gov/niosh/docs/2007-133/>]. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2007-133.

Pelletier KR [2009]. A review and analysis of the clinical and cost-effectiveness studies of comprehensive health promotion and disease management programs at the worksite: update VII 2004–2008. *J Occup Environ Med* 51(7):822–837.

Poston WSC, Haddock CK, Jahnke SA, Jitnarin N, Day RS [2013]. An examination of the benefits of health promotion programs for the national fire service. *BMC Pub Health* 13(1):805–819.

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

USFA [2008]. *Firefighter autopsy protocol*. Emmitsburg, MD: Federal Emergency Management Agency; United States Fire Administration.

USPSTF [2004]. U.S. Prevention Services Task Force. Screening for coronary heart disease: Recommendation Statement. *Ann Intern Med* 140(7):569–572.

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(23):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.

## **Fire Boat Captain Suffers Sudden Cardiac Death After Winterizing Fire Boat—Michigan**

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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).

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