



Fire Fighter Suffers Sudden Cardiac Death After Responding to Two Calls - Kansas

SUMMARY

On the morning of November 21, 2007, a 48-year-old male career Senior Fire Fighter (FF) and his crew responded to two calls: a carbon monoxide alarm and a reported residential kitchen fire. The carbon monoxide call ended without any evidence of carbon monoxide exposure. The reported kitchen fire was eventful for icy road conditions which resulted in a near crash of the apparatus. The response was cancelled and after the crew returned to their fire station, the FF suddenly collapsed with seizure-like activity. Crew members found him unresponsive, with agonal (gaspings) breathing, and without a pulse. Crew members began cardiopulmonary resuscitation (CPR) and advanced life support treatment as the station's ambulance transported him to the local hospital's emergency department. Approximately 40 minutes later, despite CPR and advanced life support administered on-scene and at the hospital, the FF died. The death certificate, completed by the local county coroner's office listed "mitral valve redundancy" as the cause of death. The autopsy was performed by the forensic pathologist at a neighboring coroner's office who concluded the FF "expired as a consequence of an arrhythmic event related to a defective mitral valve." The NIOSH investigator agrees with this conclusion, and that the emergency response may have triggered the FF's cardiac arrhythmia.

The following recommendations address general safety and health issues. Had these recommendations been in place prior to the FF's

collapse, perhaps his sudden cardiac death could have been prevented.

- *Provide mandatory annual medical evaluations to fire fighters consistent with National Fire Protection Association (NFPA) 1582 to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.*
- *Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of firefighting.*
- *Incorporate exercise stress tests following standard medical guidelines into the Fire Department's medical evaluation program.*
- *Provide fire fighters with medical clearance to wear self-contained breathing apparatus (SCBA) as part of the Fire Department's medical evaluation program.*

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. The program does not seek to determine fault or place blame on fire departments or individual fire fighters. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at

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- *Phase-in a comprehensive wellness and fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.*
- *Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are capable of performing the essential job tasks of structural firefighting.*
- *Review procedures for maintaining batteries in cardiac monitors.*

INTRODUCTION & METHODS

On November 21, 2007, a 48-year-old male FF lost consciousness after responding to two calls. Despite CPR and advanced life support administered by crew members and in the emergency department, the FF died. NIOSH was notified of this fatality on November 26, 2007, by the United States Fire Administration. On November 30, 2007, NIOSH contacted the affected Fire Department to gather additional information, and on December 5, 2007 to initiate the investigation. On December 10, 2007, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Kansas to conduct an on-site investigation of the incident.

During the investigation, NIOSH personnel interviewed the following people:

- Deputy Fire Chiefs
- Local Secretary of the International Association of Fire Fighters (IAFF)
- FF's daughter

NIOSH personnel reviewed the following documents:

- Fire Department incident report and witness statements
- Emergency medical service (ambulance) incident report
- Emergency department record
- Death certificate
- Autopsy record
- Primary care provider medical records
- Fire Department policies and operating guidelines
- Fire Department training records
- Fire Department annual report for 2006
- Fire Department physical examination protocols

RESULTS OF INVESTIGATION

Incident. On November 21, 2007, the FF arrived for duty at 0745 hours. He was assigned to a different duty station and designated as the Driver/Operator of Pumper 9. After shift change, he performed apparatus and equipment check on the engine. At 0800 hours, Pumper 9 was dispatched to investigate a complaint of carbon monoxide inside a residence. On scene, the investigation did not reveal any hazardous condition and Pumper 9 returned to service at 0819 hours. In the station, the FF talked with crew members and did not report or show any symptoms of cardiac problems.

At 0952 hours, Pumper 9 was dispatched as part of a first alarm complement to a reported kitchen fire in a single-family residence. The weather conditions included a temperature of 35 degrees Fahrenheit with 82% relative humidity, a 12.7 mile per hour wind speed gusting up to 23 miles per hour, freezing rain, and falling snow. While en route, Pumper 9 lost traction and skidded



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toward a utility pole. The FF regained control of the apparatus, but was shaken by the incident, according to crew members. Dispatch cancelled Pumper 9's response to the reported kitchen fire, and the crew proceeded to Headquarters to refuel. While refueling, the FF commented to several crew members that he was still shaken from the incident. After refueling, Pumper 9 returned to Station 9.

Crew members ate breakfast, and the FF sat on the day room couch and discussed various events planned for the day. The FF then raised his arms in a stretching manner and began snoring. A crew member spoke to the FF, but he was unresponsive. The FF then exhibited seizure-like motions. Crew members, including station paramedics, lowered the FF to the floor and alerted the Station Captain. Assessment revealed the FF was unresponsive, with agonal breathing, and no pulse. CPR was begun as crew members retrieved medical equipment (oxygen, cardiac monitor, and intravenous [IV]). Dispatch was notified of the incident at 1121 hours.

The FF was placed on a cardiac monitor, which revealed ventricular fibrillation (VF). The FF was defibrillated with no positive change and CPR continued. An IV was started, and cardiac resuscitation medications were administered while intubation (breathing tube inserted into the windpipe) was attempted. A pulse then returned for a short time (a few seconds). After delivering the first shock, the cardiac monitor batteries stopped working and a second monitor was used. The batteries of the first monitor had been changed at shift change and were in working order at that time. The FF's heart rhythm reverted to VF and another shock was delivered; a pulse returned, and he was successfully intubated. Proper tube placement was confirmed by auscultation and

end-tidal carbon dioxide testing. After this defibrillation, the second monitor's batteries ceased working and were replaced. His heart rhythm reverted to VF and a third and fourth shock were delivered as CPR continued. The FF was placed on a long spine board and cot and a fifth shock was delivered. He was then loaded into the ambulance, departing the scene at 1135 hours en route to the hospital's emergency department. While en route, additional advanced life support treatment, including a sixth defibrillation was given, and CPR continued.

The ambulance arrived at the hospital at 1141 hours. Inside the Emergency Department, CPR and advanced life support measures, including eight additional defibrillation attempts, continued until 1201 hours, when the FF was pronounced dead by the attending physician.

Medical Findings. The death certificate, completed by the local county coroner, listed "mitral valve redundancy" as the immediate cause of death. The forensic pathologist from the neighboring county conducted the autopsy. Pertinent findings from the autopsy included:

- Abnormal mitral valve
 - Redundant, ballooned, thickened, with "vegetations" present
 - Valve leaflets rise above the valve ring
 - Histologic (microscopic) exam of the mitral valve showed 1) large areas of low cellularity with myxoid change and 2) subendocardial fibrosis and hemorrhage
- Cardiomegaly (heart weighed 485 grams [g])(normal weight is <400g)[Siegel 1997a]



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- Left ventricular hypertrophy (LVH)
 - Histologic exam revealed hypertrophic myocytes and focal interstitial fibrosis
- No evidence of coronary artery disease (e.g., no plaque; no thrombus [blood clot])
- No evidence of a pulmonary embolus (blood clot in the lung arteries)
- Negative alcohol and drug tests

mitral insufficiency, and leaflet thickening. Since the FF never missed work due to this condition, the Fire Department did not require medical clearance for fire fighting duties. The Fire Department contract physician conducting the Fire Department cycle ergometry tests learned of his history of heart murmur in 2006, and mitral valve prolapse in 2007. However, this Fire Department contract physician was not responsible for medically clearing fire fighters for fire fighting duties.

In summary, the forensic pathologist concluded the FF “expired as a consequence of an arrhythmic event related to a defective mitral valve.”

In 1994, the FF was noted to have a high blood pressure measurement (160/72 mmHg), but was not diagnosed and treated for hypertension until 2002. The FF’s compliance with the medication was intermittent.

The FF was 71” tall and weighed 167 pounds, giving him a normal body mass index of 23.2 [National Heart Lung and Blood Institute 2005]. The FF reported having a heart murmur since childhood. In 2003, the FF’s primary care physician noted a very loud heart murmur and advised him to see a cardiologist for further evaluation. A work-up by a cardiologist in 2004 included an electrocardiogram (EKG) which showed LVH, and an echocardiogram which revealed an enlarged left ventricle, mitral valve prolapse, moderate mitral regurgitation without

Since 1992 the Fire Department has contracted with the City physician to conduct intermittent bicycle ergometry stress tests to estimate a fire fighter’s aerobic capacity (fitness). The table below summarizes the FF’s results. The NIOSH investigator had access to the entire bicycle ergometry stress test results in only 2006 and 2007; prior years were provided only in summary form. In 2006, the FF checked his pre-test questionnaire for a heart murmur, and in 2007 checked mitral valve prolapse and

Fire Department Bicycle Ergometry

<u>Date</u>	<u>Age</u>	<u>Max HR</u>	<u>Actual HR</u>	<u>Time</u>	<u>METs</u>
9-1-92	33	187	189	12:02	13.4
6-28-93	34	186	188	10:14	13.2
8-22-94	35	185	187	9:08	12.7
8-14-95	36	184	187	9:59	13.0
11-6-00	41	179	179	7:59	11.6
11-26-02	43	177	177	7:09	13.3
2-25-04	44	176	176	7:08	9.3
2-14-06	46	174	174	7:24	8.8
9-7-07	48	172	172	7:03	7.8



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hypertension. During both tests the FF's resting EKG revealed ventricular premature contractions which did not increase in frequency during exercise, and showed no ischemic changes.

According to his family and crew members, the FF had no complaints of chest pains, unusual shortness of breath on exertion, or any other heart-related symptoms.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the Fire Department consisted of 420 uniformed personnel and served a population of 149,000 residents in a geographic area of 125 square miles. There are 18 fire stations. Fire fighters work the following schedule: 24-hours on-duty, 48-hours off-duty, from 0800 hours to 0800 hours. In 2006, the Fire Department responded to 23,603 calls, including over 18,000 emergency medical calls.

Employment and Training. The Fire Department requires all new fire fighter applicants to be 21 years of age, complete an application, possess a high school diploma or a GED, and be an Emergency Medical Technician (EMT) or Mobile Intensive Care Technician (MICT) (paramedic). In addition, applicants must pass a physical ability test, a background check, a truth verification test, and a psychological evaluation, prior to being offered conditional employment. The successful applicant must then pass a medical evaluation (described below). Newly-hired fire fighters are placed into a 10-12 week fire fighter training program. The fire fighter must be an EMT at the time of hiring and become a MICT within one year. The fire fighter remains on probation for one year. There is no mandatory State requirement for fire

fighter certification. Re-certification is required for EMT/MICT/Paramedics every 2 years. The FF was certified as a Fire Fighter II, EMT, Driver/Operator, in Hazardous Materials Operations, Confined Space Rescue, Rope Rescue, and had 15 years of firefighting experience.

Post-Offer/Pre-placement Medical Evaluations. The Fire Department requires a pre-placement medical evaluation for all new hires, regardless of age. Components of this evaluation include the following:

- A complete medical history
- Physical examination (including vital signs)
- Complete blood count with lipid panel
- Pulmonary function test
- Audiogram
- Vision screen
- Urinalysis
- Urine drug screen
- Resting EKG
- Chest x-ray (baseline only)

These evaluations are performed by a physician contracted by the City. Once this evaluation is complete, the contract physician makes a determination regarding medical clearance for firefighting duties and forwards this decision to the City's personnel director and the Fire Department.

Periodic Medical Evaluations. Annual medical evaluations are required only for members of the Hazardous Materials (HazMat) Response Team. Components of this evaluation are the same as the post-offer/pre-placement medical evaluation except the drug screen is not repeated, and a bicycle ergometry stress test is included. The evaluation is conducted by the same contracted physician who conducts the post-offer/pre-



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placement medical evaluation. For non-HazMat members, a voluntary medical evaluation (including a cholesterol screen) is offered by the Fire Department. This evaluation is conducted by the City-contracted physician, who shares the results only with the fire fighter; the findings are not used as a “fit-for-duty” evaluation. Random drug and alcohol tests are conducted quarterly.

Health and Wellness Programs. The Fire Department has a voluntary fitness program. Exercise (strength and aerobic) equipment is located in the fire stations. Health maintenance/wellness programs are available from the City. No physical agility test for members is required.

If an employee is injured at work, or is ill and off work for two 24-hour shifts or more, the fire fighter must be evaluated by his/her personal physician. The fire fighter then provides a medical release form to his/her shift commander. The shift commander then forwards the release to the City’s Human Resources Office, who makes the final determination regarding “return to work.”

DISCUSSION

Sudden Cardiac Death.

The autopsy revealed no coronary artery disease (CAD) and no thrombus in the coronary arteries; therefore, the FF did not suffer a heart attack (myocardial infarction). The autopsy did reveal a heart valve problem (mitral valve prolapse), LVH, and an enlarged heart (cardiomegaly). The LVH and cardiomegaly were probably a result of his heart valve problem or his history

of hypertension. All three conditions increase the risk for sudden cardiac death. Therefore, the FF’s sudden cardiac death was probably due to an arrhythmia resulting from any combination of his mitral valve prolapse, his LVH, or his cardiomegaly. The arrhythmia could have been triggered by the stress of emergency response, and of losing control and almost crashing Pumper 9.

Mitral Valve Prolapse.

Mitral valve prolapse occurs when one or both of the mitral valve leaflets prolapse into the left atrium during systole (contraction of the heart muscle). It is the most common heart valve disorder, affecting about 2-4% of the population. Both sexes and all ages can be affected [Braunwald 2005]. The prolapse can be due to problems with the valve leaflets or other parts of the mitral valve apparatus (e.g., annulus, chordae tendineae, papillary muscles, and the supporting walls of the left ventricle, left atrium, and the aorta) [Bonow et al. 1998]. Problems with the valve leaflets are classified as primary mitral valve prolapse (Table 1).

Clinical presentations range from asymptomatic heart murmurs to severe mitral valve regurgitation with symptoms of fatigue, shortness of breath on exertion, and reduced exercise tolerance [Braunwald 2001]. The diagnosis is made by echocardiography which measures the abrupt posterior movement of one or both of the mitral valve leaflets [Malkowski and Pearson 2000]. The EKG is usually normal in asymptomatic patients, but more severe cases can show signs of LVH. The basic microscopic feature of primary MVP is marked thickening and redundancy of the middle layer of the valve leaflet (myxomatous proliferation of the



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spongiosa connective tissue) [Bonow et al. 1998].

Like the clinical presentation, the clinical course and prognosis are variable. Patients can remain asymptomatic, but some cases progress over decades to severe regurgitation, putting the patient at risk for endocarditis (infection of the heart valve), strokes, and arrhythmias. Arrhythmias associated with mitral valve prolapse include ventricular premature contractions (which the FF had on EKGs in 2006 and 2007), paroxysmal supraventricular tachycardia, and ventricular tachycardia. These arrhythmias can cause palpitations, light-headedness, and syncope.

As mentioned previously, patients with mitral valve prolapse are at increased risk of sudden cardiac death. Studies estimate the risk of ventricular tachycardia and VF to be about 2% per year with a 1% mortality rate [Vohra et al. 1993; Martini et al. 1995]. Risk factors for sudden cardiac death among mitral valve prolapse patients include a family history of sudden cardiac death at a young age, a history of syncope or previous cardiac arrest, prolonged QT interval on EKG, complex ventricular arrhythmias, severe mitral regurgitation, increased left ventricle or left atrial size, and thickened and redundant mitral valve leaflets [Priori 2002; Boudoulas and Wooley 2000; Kligfield et al. 1987; Bonow 1998]. This FF's only risk factor for sudden cardiac death among patients with mitral valve prolapse was mitral valve thickening and redundancy.

Left Ventricular Hypertrophy (LVH). On autopsy, the FF was found to have LVH and an enlarged heart. These conditions increase the risk for sudden cardiac death [Levy et al. 1990]. Hypertrophy of the heart's left ventricle is a relatively common finding among individuals with long-standing high blood pressure (hypertension), a heart valve problem, or chronic cardiac ischemia (reduced blood supply to the heart muscle) [Siegel 1997b]. Because the FF was diagnosed with both high blood pressure and mitral valve prolapse, his LVH could have been due to either condition.

Firefighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations [Gledhill and Jamnik 1992]. Firefighting activities are strenuous and often require fire fighters to work at near maximal heart rates for long periods. Even when energy costs are moderate (as measured by oxygen consumption) and work is performed in a thermoneutral environment, heart rates may be high (over 170 beats per minute), owing to the insulative properties of the personal protective clothing [Smith et al. 1995]. The FF responded to two calls while wearing full bunker gear. During the last response, the FF nearly lost control of Pumper 9 due to slick roads. This is considered a light level of physical exertion [Gledhill and Jamnik 1992; American Industrial Hygiene Association Journal 1971]. The FF's sudden cardiac death was probably due to an arrhythmia associated with mitral valve prolapse and/or LVH. It is possible the stresses of emergency response and of nearly losing control of Pumper 9 could have triggered his sudden cardiac death.



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Occupational Medical Standards for Structural Fire Fighters. To reduce the risk of sudden cardiac arrest or other incapacitating medical conditions among fire fighters, the NFPA developed NFPA 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments* [NFPA 2007a]. This voluntary industry standard specifies minimum medical requirements for candidates and current fire fighters.

NFPA 1582 considers valvular heart disease to be a Category B condition, that is, “a medical condition that, based on its severity or degree, **could** [our emphasis] 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 member or others” [NFPA 2007a]. Mitral insufficiency is “acceptable if in sinus rhythm with normal left ventricular size and function” [NFPA 2007a]. An echocardiogram in 2004 determined the FF’s left ventricular size was enlarged, but the function was normal.

According to NFPA 1582, for members, mitral valve prolapse interferes with safe performance of critical job tasks if it is associated with arrhythmias or if moderate to severe mitral regurgitation is present [NFPA 2007a]. Although asymptomatic, an echocardiogram in 2004 revealed moderate mitral regurgitation.

Screening Tests for Cardiac Disease – EKG. NFPA 1582 recommends annual medical evaluations and an EKG as part of the annual medical evaluation. Prior to the FF’s death, annual medical evaluations were not required. Had an EKG been conducted as part of a Fire Department annual medical evaluation, perhaps the FF’s LVH would have been detected. This may have led to further medical evaluation (e.g., a more recent

echocardiogram) and a possible restriction in job duties. However, EKGs were conducted as part of the annual bicycle ergometry test and the physician reading these EKG’s did not comment on LVH. NIOSH investigators could not determine whether these tracings met the voltage criteria for LVH due to the poor quality of the photocopy.

Screening Tests for Cardiac Disease – Stress Tests. In addition to screening for risk factors for CAD, NFPA 1582 recommends conducting diagnostic exercise stress tests on members over the age of 45 with two or more CAD risk factors (hypercholesterolemia, hypertension, smoking, diabetes mellitus, or family history of premature CAD) [NFPA 2007a]. These recommendations are similar to those of the American College of Cardiology (ACC)/American Heart Association (AHA) [Gibbons et al. 2002]. The FF had only one risk factor for CAD (hypertension), therefore, according to NFPA 1582, a symptom-limiting exercise stress test would not have been indicated. Currently, the Fire Department requires bicycle ergometer tests for all members, and the FF had participated since 1992. The FF’s exercise tolerance had been dropping since 2002 (see METs column in earlier table). If this information had been put together with his echocardiogram findings of moderate mitral regurgitation in 2004, perhaps he would have been put on restricted duty until he received further medical evaluation and treatment.

RECOMMENDATIONS

NIOSH investigators offer the following recommendations to address general safety and health issues. Had these recommendations been in place prior to 2007, perhaps the FF’s sudden cardiac death could have been prevented at this time.



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Recommendation #1: Provide mandatory annual medical evaluations to fire fighters consistent with National Fire Protection Association (NFPA) 1582 to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

Guidance regarding the content and frequency of these evaluations can be found in NFPA 1582 and in the International Association of Fire Fighters (IAFF)/International Association of Fire Chiefs (IAFC) *Fire Service Joint Labor Management Wellness/Fitness Initiative* [NFPA 2007a; IAFF, IAFC 2000]. However, the Fire Department is not legally required to follow this standard or this initiative. Nonetheless, we recommend the City and Union work together to establish an annual medical evaluation consistent with the above guidelines.

Recommendation #2: Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of firefighting.

Physicians providing input regarding medical clearance for firefighting duties should be knowledgeable about the physical demands of firefighting and familiar with the consensus guidelines published in NFPA 1582 [NFPA 2007a]. This return-to-work decision requires knowledge not only of the member's medical condition, but also of the member's job duties. Frequently, private physicians are not familiar with a member's job duties or with guidance documents such as NFPA 1582. Thus, we recommend the final decision regarding medical clearance for return to work lie with the Fire Department physician, with input from many sources, including the employee's private physician.

Recommendation #3: Incorporate exercise stress tests following standard medical guidelines into the Fire Department's medical evaluation program.

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 over the age of 45 with two or more CAD risk factors [NFPA 2007a; IAFF, IAFC 2000; Gibbons et al. 2002]. The exercise stress test could be conducted by the fire fighter's personal physician or the City contract physician. If the fire fighter's personal physician conducts the test, the results must be communicated to the City physician, who should be responsible for decisions regarding medical clearance for firefighting duties.

Recommendation #4: Provide fire fighters with medical clearance to wear self-contained breathing apparatus (SCBA) as part of the Fire Department's medical evaluation program.

The Occupational Safety and Health Administration (OSHA)'s *Revised Respiratory Protection Standard* requires employers to provide medical evaluations and clearance for employees using respiratory protection [29 CFR¹ 1910.134]. These clearance evaluations are required for private industry employees and public employees in States operating OSHA-approved State plans. Kansas does not operate an OSHA-approved State plan; therefore, public sector employers are not required to comply with OSHA standards. Nonetheless, we recommend voluntary compliance to enhance safety and health.



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Recommendation #5: Phase-in a comprehensive wellness and fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.

Guidance for fire department wellness/fitness programs is found in NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters*, and the IAFF/IAFC *Fire Service Joint Labor Management Wellness/Fitness Initiative* [NFPA 2008; IAFF, IAFC 2000]. Worksite health promotion programs have been shown to be cost effective by increasing productivity, reducing absenteeism, reducing the number of work-related injuries, and reducing the number of work-related lost work days. Fire service health promotion programs have been shown to reduce CAD risk factors and improve fitness levels, with mandatory programs showing the most benefit [Aldana 2001; Stevens et al. 2002; Blevins et al. 2006; Dempsey et al. 2002; Womack et al. 2005, Garfi et al. 1996; Harger et al. 1999].

Recommendation #6: Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are capable of performing the essential job tasks of structural firefighting.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Programs* [NFPA 2007b], requires Fire Department members who engage in emergency operations to be evaluated and certified annually by the Fire Department as meeting the physical performance requirements identified in paragraphs 5.2.1 and 5.5.3 of the standard. The Fire Department will begin implementing annual physical performance evaluations as part of their training program in 2008.

Recommendation #7: Review procedures for maintaining batteries in cardiac monitors.

This recommendation would not have changed the outcome in this case.

Two sets of cardiac monitor batteries were used during efforts to resuscitate the FF. Changing these batteries did not delay efforts to defibrillate the FF, however the impact could be different in future incidents. Currently, the Fire Department changes cardiac monitor batteries at the beginning of each shift. Since the cardiac monitor had not been used the morning of this incident, it is unclear why the batteries failed. Therefore, we suggest the Fire Department review their procedures and the manufacturer's recommendations regarding maintaining the batteries in their cardiac monitors [Medtronic 2004, 2007].

¹Code of Federal Regulations. See CFR in references.

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Fire Fighter Suffers Sudden Cardiac Death After Responding to Two Calls - Kansas

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Table 1. Classification of Mitral Valve Prolapse [Bonow et al. 1998]

- Primary MVP
 - Familial
 - Nonfamilial
 - Marfan’s syndrome
 - Other connective tissue diseases
- Secondary MVP
 - CAD
 - Rheumatic heart disease
 - Reduced LV dimensions
 - Hypertrophic cardiomyopathy
 - Atrial septal defect
 - Pulmonary hypertension
 - Anorexia nervosa
 - Dehydration
 - Straight-back syndrome/pectus excavatum
 - “Flail” mitral valve leaflet(s)
- Normal variant
 - Inaccurate auscultation
 - “Echocardiographic heart disease”