



Fire Fighter Dies at Kitchen Fire - North Carolina

SUMMARY

On August 9, 2000, a 30-year-old female volunteer Fire Fighter (the victim) responded to a reported kitchen fire in a one-story, two-unit, multi-family dwelling. The resident of the apartment involved had extinguished the fire before the Fire Department's arrival, but smoke remained in the structure. Wearing full bunker gear, the victim removed a smoke ejector from the pumper, carried it to the dwelling, and walked back to the pumper. Soon after, while conversing with crew members, she collapsed. An Emergency Medical Technician-Intermediate (EMT-I) assessed her and found her to be unresponsive, with shallow breathing, and a pulse. After placing her into the ambulance, she soon stopped breathing, became pulseless, and cardiopulmonary resuscitation (CPR) was begun. Approximately 80 minutes later, despite CPR and advanced life support (ALS) administered on the scene, en route, and at the hospital, the victim died. The death certificate, completed by the Acting Medical Examiner, and the autopsy record, completed by the Forensic Pathologist, listed "hypoxia due to pulmonary edema due to cardiomyopathy" as the cause of death.

The following recommendations address some general health and safety issues. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These selected recommendations have not been evaluated by NIOSH, but they represent published research or consensus votes of technical committees of the National Fire Protection Association (NFPA) or fire service labor/management groups. While these recommendations could be used at this Fire Department, it is unlikely

any of these measures could have prevented this victim's untimely death.

- *Institute preplacement and periodic medical evaluations. These should incorporate exercise stress testing, depending on the fire fighter's age and coronary artery disease risk factors.*
- *Fire fighters should be cleared for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582, the National Fire Protection Association Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians.*
- *Provide fire fighters with medical evaluations and clearance to wear self-contained breathing apparatus (SCBA).*
- *Phase in a mandatory wellness/fitness program for fire fighters to reduce risk*

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 www.cdc.gov/niosh/firehome.html or call toll free **1-800-35-NIOSH**



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factors for cardiovascular disease and improve cardiovascular capacity.

INTRODUCTION & METHODS

On August 9, 2000, a 30-year-old female Fire Fighter lost consciousness while at the scene of a kitchen fire. Despite CPR and ALS administered by crew members, the ambulance crew, and in the emergency department, the victim died. NIOSH was notified of this fatality on August 11, 2000, by the United States Fire Administration. On January 31, 2002, NIOSH contacted the affected Fire Department to initiate the investigation. On February 25, 2002, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to North Carolina to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed the following:

- Fire Chief
- Crew members on duty with the victim
- Ambulance crew
- Victim's personal physician
- Victim's mother

During the site-visit NIOSH personnel reviewed the following:

- Fire Department policies and operating guidelines
- Fire Department training records
- Fire Department annual report for 2001
- Fire Department incident report
- Emergency medical service (ambulance) incident report
- Hospital emergency department report
- Fire Department medical records
- Death certificate
- Autopsy record
- Past medical records of the deceased

INVESTIGATIVE RESULTS

Incident. On August 9, 2000, at 1809 hours, the involved Fire Department and County Rescue Unit 6 (ambulance) were dispatched to a fire in the kitchen of a one-story, two-unit, multi-family dwelling. Engine 51 (Fire Chief), Brush Truck 59 (one Fire Fighter), Tanker 58 (Assistant Chief and one Junior Fire Fighter), Equipment Truck 56 (one Fire Fighter), and Unit 6 (EMT-I, EMT-Defibrillator, and two EMT-Basics) responded. Five additional personnel (four Fire Fighters [including the victim] and a Junior Fire Fighter) drove their privately owned vehicles to the scene. The temperature was approximately 90E Fahrenheit (F) and the relative humidity was approximately 90%.

All units arrived on the scene between 1814 hours and 1816 hours. As the Fire Chief arrived, he observed the victim quickly donning her bunker gear. The Fire Chief entered the structure to assess the situation and found the gas oven had caught fire and the resident had extinguished the fire with a garden hose. The victim, wearing full bunker gear but no SCBA, retrieved a smoke ejector (fan) weighing approximately 45 pounds from Equipment Truck 56 and carried the fan to the front porch of the dwelling for ventilation. After this, the victim walked to Brush Truck 59 where she began conversing with crew members. A flashlight was needed to check for fire spread in the kitchen cabinets and the victim retrieved the light, carried it to the rear of Brush Truck 56, and passed the light to another Fire Fighter. Approximately 5 minutes later, the victim removed her bunker coat and walked to her privately owned vehicle to obtain a paper towel to wipe perspiration from her face. When she walked back to Brush Truck 56, she leaned against the truck seat and called to a nearby Fire Fighter. The victim's head then slumped to her chest and she began to collapse.

The Fire Fighter ran to the victim and assisted her to the ground. The Fire Fighter tried to awaken the



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victim, but she was unresponsive. The Fire Fighter called to the EMT-I who assessed the victim, finding her unresponsive, with shallow respirations, and a pulse. Another EMT retrieved portable oxygen equipment from the ambulance, and 100% oxygen was administered to the victim via non-rebreather mask.

Once the smoke inside the residence had been cleared and the gas service turned off, the Fire Chief (from inside the residence) declared the scene under control and advised Dispatch that Unit 6 could clear the scene. As Dispatch notified Unit 6, Unit 6 advised Dispatch “there was a fire fighter with them” (1830 hours). (Upon hearing the transmission from Unit 6, the Fire Chief then became aware of the victim’s situation). The victim was placed onto a stretcher and loaded into the ambulance for transport.

Once inside the ambulance, assisted ventilations via bag-valve-mask were begun. The victim soon became pulseless and chest compressions were also begun. A semi-automatic external defibrillator revealed a non-shockable rhythm and CPR continued. The victim was intubated (with a combi-tube) and Unit 6 departed the scene for the hospital at 1832 hours. En route, ALS measures, including intravenous therapy, were begun. Suction was performed numerous times due to vomitus in the victim’s mouth and the combi-tube. While en route, Unit 6 picked up an additional EMT-I (Unit 6 would pass by the EMT-I’s home en route to the hospital and the EMT-I heard the radio transmissions on her portable radio). The defibrillator’s monitor was checked several times with no change in patient status. Unit 6 arrived at the hospital emergency department at 1908 hours. Inside the emergency department, CPR and ALS measures continued. The heart monitor revealed intermittent rhythms of asystole (no heartbeat) and ventricular fibrillation, for which a total of three shocks were administered. The victim’s heart rhythm reverted to electromechanical

dissociation (EMD) and asystole. CPR and ALS measures continued until 1950 hours when the victim was pronounced dead by the attending physician.

Medical Findings. The death certificate, completed by the Acting Medical Examiner, listed “hypoxia due to pulmonary edema due to cardiomyopathy” as the cause of death and mitral valve replacement as a significant contributing condition. A carboxyhemoglobin level (to assess the victim’s carbon monoxide exposure) was not performed. Pertinent findings from the autopsy, performed by the Forensic Pathologist, on August 10, 2000, included

- Dilated cardiomyopathy
- Status post-mitral valve replacement
- Severe pulmonary edema
- History of rheumatic heart disease
- Cardiomegaly (an enlarged heart weighing 475 grams)
- Evidence of chronic ischemia
- Morbid obesity (Body Mass Index of 43 kg/m² [normal #26 kg/m²])
- Mild occlusive coronary artery disease (CAD)
 - 0-25% narrowing of the left main coronary artery
 - 0-25% narrowing of the left anterior descending coronary artery
 - 0-25% narrowing of the left circumflex
 - 0-25% narrowing of the right coronary arteries

The victim was diagnosed with mitral value insufficiency, probably due to rheumatic fever, for which she underwent mitral value replacement with a prosthetic valve in 1996. Her surgery was complicated 2 weeks postoperatively by an abnormal heart rhythm (supraventricular tachycardia and recurrent atrial fibrillation) resulting in acute congestive heart failure (CHF). Fortunately, these abnormal heart rhythms were successfully treated with medications, thereby



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resolving her CHF. Unfortunately, once her condition stabilized, the victim's heart function was not quantified (e.g. a measurement of her left ventricular ejection fraction). However, if any residual CHF was present, it was mild due to the low doses of medications prescribed (furosemide 40 milligrams per day) and her lack of CHF symptoms (shortness of breath on exertion or upon lying down, or swollen ankles). For her prosthetic mitral valve, she was maintained on a blood thinner (coumadin).

One month after her valve surgery, her heart surgeon cleared her to "return to work with no physical limitations except for contact sports due to her coumadin therapy." Despite this letter, her employer, the North Carolina Department of Corrections had her primary care physician review the essential job tasks of a correctional officer and whether she could perform those tasks without putting herself or others at increased risk. Her primary care physician questioned her ability to perform two essential job functions (#6, "...climbing stairs, working for extended periods of time on elevated surfaces..." and #11, "...running, jumping, climbing, crawling, balancing on narrow or uneven surfaces, jumping down from elevated surfaces and using bodily force to gain entrance through barriers.") but cleared her for duty.

On her 1999 application to join the Fire Department, the victim identified her medical history and current condition. She also indicated her current position of employment and a statement that her private physician had cleared her to return to full work activities. Given her job duties and lack of symptoms of CAD or other heart-related problems, she was accepted as a new member.

According to her family, coworkers, and crew members, the victim had no complaints of chest pains or any other heart-related illness. She worked a full-time, regular schedule as a Correctional Officer. There was no family history of heart disease. During

the 2 weeks before and the day of the incident, the victim did not report any symptoms suggestive of angina (e.g., chest pain with exertion) or congestive heart failure (e.g., shortness of breath on exertion, swollen ankles) to her family or coworkers. The day of the incident, the victim was on vacation from her job and had visited with family and friends before responding to the call.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the volunteer Fire Department consisted of 12 uniformed personnel and served a population of 2,000 residents in a geographic area of 175 square miles. There is one fire station.

In 2001, the Fire Department responded to 37 calls: 11 motor vehicle accidents, 9 grass fires, 7 structure fires, 4 EMS assist calls, 3 vehicle fires, 2 trash fires, and 1 boat fire. Two trash fire calls and 1 grass fire were mutual-aid calls. This incident was the victim's first response within 24 hours.

Training. The Fire Department requires all new fire fighter applicants to submit an application including a medical statement (reviewed by the Assistant Chief), attend two training sessions or meetings, and are voted on at a membership meeting before becoming a probationary member. Once accepted, the new member is on probation and is not allowed to wear SCBA and perform structural fire fighting for 6 months or until fully trained. The fire fighter must attend 36 hours of training and business meetings annually. Recurrent training occurs biweekly. There is a voluntary State minimum requirement for initial fire fighter certification and recertification. NFPA 1001, *Fire Fighter Professional Qualifications*, is the performance standard used for fire fighter certification (Fire Fighter I and Fire Fighter II). Requirements for recertification include 150 hours



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of fire fighter training within 5 years or by passing a written exam.

The victim, still a probationary Fire Fighter, was certified in Hazardous Material Operations and had 10 months of fire-fighting experience. She was not cleared for SCBA use or interior structural fire-fighting duties, and, therefore, performed external support duties.

Preplacement Evaluations. The Fire Department does not require a preplacement medical evaluation. However, a medical statement is required. Components of this medical statement include a complete medical history. The medical statement is reviewed by the Assistant Chief, an EMT-I, who, along with the Fire Chief, makes a determination regarding medical clearance for fire-fighting duties.

Periodic Evaluations. No periodic medical evaluations are required by this Department. Medical clearance for self-contained breathing apparatus (SCBA) use and for fire-suppression duties is also not required. If an employee is injured or is ill and cannot participate in emergency responses or Department activities, the employee is evaluated by his/her personal physician, who forwards his/her recommendation regarding return to work to the Fire Department, which makes the final determination. Exercise (strength or aerobic) equipment is available for the fire fighters. No wellness/fitness or health maintenance programs are in place for the Department. The victim saw her private physician regularly since her mitral valve replacement in 1996, and she had begun exercising regularly and dieting.

DISCUSSION

The deceased fire fighter had mitral valve insufficiency, probably due to rheumatic fever. Her enlarged and dilated heart (valvular cardiomyopathy) was due to the effect this valvular condition had on

the heart muscle before her valve replacement. An unexpected finding on the autopsy was the microscopic evidence of fibrosis and scar tissue in the certain areas of the heart (anterior and posterior papillary muscles). This finding suggests chronic ischemia (not enough blood flow to the heart muscle), an unusual situation for a young woman with relatively clear coronary arteries (<25% narrowing).

CHF is the inability of the heart to pump blood normally at a sufficient rate to meet the body's needs.^{1,2} As mentioned above, her mild CHF (based on her minimal CHF symptoms and relatively low doses of diuretic [furosemide]), was most likely due to her mitral valve insufficiency. Since there are multiple mechanisms by which the body can adapt, or compensate, for impaired cardiac function, CHF can be present without any symptoms or interference with ordinary activity. A variety of conditions can precipitate acute/overt CHF.³ In addition, those with CHF are at increased risk for cardiac arrhythmias.³ In 1996, the victim had an acute exacerbation of her CHF triggered by a cardiac arrhythmia. The recent fatal incident was most likely due to an arrhythmia, possibly triggered by heat stress.³

NFPA considers CHF to be a Category A condition, that is, "a medical condition that **would** (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."⁴ Given the victim's minimal CHF symptoms and no recent tests of left ventricular function, it is unclear if this deceased fire fighter met the NFPA criteria for current heart failure.

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



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safety and health of the member or others.”⁴ Mitral insufficiency is “acceptable if in sinus rhythm with normal left ventricular size and function.”⁴ Once again, without tests of the left ventricular size or function, we cannot determine if this criteria was met.

NFPA 1582 also considers prosthetic valves to be a Category B condition. “Prosthetic valves are acceptable unless full anticoagulation is in effect.”⁴ The deceased fire fighter required full anticoagulation and therefore, according to NFPA 1582, should not have been cleared for unrestricted fire-fighting duties. In fact, the victim was restricted to external, support activities. However, these activities can and did include heavy physical exertion. In this incident, the combination of heat stress and mild physical exertion could have triggered her sudden cardiac death.

RECOMMENDATIONS

The following recommendations address health and safety issues identified during this investigation. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job cardiac arrest among fire fighters. These selected recommendations have not been evaluated by NIOSH, but they represent published research or consensus votes of Technical Committees of the National Fire Protection Association or fire service labor/management groups.

Recommendation #1: Institute preplacement and periodic medical evaluations. These should incorporate exercise stress testing, depending on the fire fighter’s age and coronary artery disease risk factors.

The purpose of periodic medical evaluations is to ensure that fire fighters have the ability to perform duties without presenting a significant risk to the safety and health of themselves or others. Guidance regarding the content and scheduling of periodic

medical examinations for fire fighters can be found in NFPA 1582.⁴ In addition to providing guidance on the frequency and content of the medical evaluation, NFPA 1582 provides guidance on medical requirements for persons performing fire fighting tasks. NFPA 1582 recommends a limited annual evaluation, including a medical and occupational history, and a limited physical examination (height, weight, blood pressure, heart rate and rhythm). In addition, NFPA 1582 recommends a more extensive medical evaluation at an interval of 1 to 3 years, depending on the fire fighter’s age. NFPA 1582 recommends that periodic exercise stress tests begin at age 35 for those with CAD risk factors and at age 40 for those without CAD risk factors.

Applying NFPA 1582 involves legal and economic issues, so it should be carried out in a **confidential, nondiscriminatory** manner. Appendix D of NFPA 1582 provides guidance for Fire Department administrators regarding legal considerations in applying the standard. The economic concerns go beyond the costs of administering the medical program; they involve the personal and economic costs of dealing with the medical evaluation results. NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, addresses these issues in Chapter 8-7.1 and 8-7.2.⁵ The success of medical programs hinges on protecting the affected fire fighter. The department must (1) keep the medical records confidential, (2) provide alternate duty positions for fire fighters in rehabilitation programs, and (3) if the fire fighter is not medically qualified to return to active fire-fighting duties, provide permanent alternate duty positions or other supportive and/or compensated alternatives. Unfortunately, the second and third requirements may not be workable in a volunteer department and could thus impair both acceptance by fire fighters and the Fire Department’s ability to recruit and retain fire fighters.



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Applying this recommendation involves economic repercussions and may be particularly difficult for small, rural, volunteer fire departments to implement. To overcome the financial obstacle, the Fire Department could urge current members to get annual medical clearances from their private physicians (but see Recommendation #2). Another option is having the brief annual medical evaluations recommended by NFPA 1582 completed by the volunteer fire fighters themselves (medical and occupational history) and by EMTs from the county's emergency medical service (vital signs, height, weight, and visual acuity). This information could then be provided to a community physician, perhaps volunteering his or her time, to review the data and provide medical clearance (or further evaluation, if needed). The more extensive periodic medical examinations could be performed by a private physician at the fire fighter's expense, provided by a physician volunteer, or paid for by the Fire Department. Sharing the financial responsibility for these evaluations between volunteers, the Fire Department, and willing physician volunteers should reduce the negative financial impact on recruiting and retaining needed volunteers.

Recommendation #2: Fire fighters should be cleared for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582, the National Fire Protection Association's Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians.

The decision regarding medical clearance for fire fighters requires knowledge not only of the fire fighter's medical condition, but also of the fire fighter's job duties and NFPA 1582 medical fitness criteria. NFPA 1582 recommends that return-to-duty evaluations (after an injury or illness) be done by the "fire department physician."⁴ As part of the return-to-duty evaluation, the fire department

physician should review relevant records from the fire fighter's personal physicians and/or discuss with them the fire fighter's illness or injury.

Recommendation #3: Provide fire fighters with medical evaluations and clearance to wear self-contained breathing apparatus (SCBA).

OSHA's Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employees using respiratory protection.⁶ These clearance evaluations are required for private industry employees and public employees in States operating OSHA-approved State plans. North Carolina is a State-plan State and public sector employers are required to comply with OSHA standards. However, volunteer fire departments not a part of a municipality and volunteer fire departments within a municipality of less than 10,000 population in which a resolution has been passed are exempt from these standards (except those volunteer fire fighters who are municipal employees).⁷ However, we recommend following this standard, and a copy of the OSHA medical checklist has been provided to the Fire Department.

To ensure private physicians are aware of these guidelines, we recommend that the Fire Department provide the private physicians with a copy of NFPA 1582. In addition, we recommend the Fire Department not automatically accept the opinion of the fire fighter's private physician regarding return to work. Frequently, private physicians are not familiar with an employee's job duties, or guidance documents, such as NFPA 1582. Thus, the final decision regarding medical clearance for return to work lies with the Fire Department with input from many sources including the fire fighter's private physician. Physicians providing input regarding medical clearance for fire-fighting duties should be knowledgeable about the physical demands of fire



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fighting and familiar with the consensus guidelines published in NFPA 1582.

Recommendation #4: Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.

Physical inactivity is the most prevalent modifiable risk factor for CAD in the United States. Additionally, physical inactivity, or lack of exercise, is associated with other risk factors, namely obesity and diabetes.⁸ NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.⁵ In 1997, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) published a comprehensive Fire Service Joint Labor Management Wellness/Fitness Initiative to improve fire fighter quality of life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service program. They produced a manual and a video detailing elements of such a program.⁹ Small, volunteer fire departments should review the programs mentioned above and determine which components are applicable to them.

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