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NIOSH Fire Fighter Fatality Investigation and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation *January 8, 2004*

Fire Fighter Recruit Suffers Sudden Cardiac Death During Physical Ability Training - Texas

SUMMARY

On February 12, 2003, a 46-year-old male career Fire Fighter Recruit was performing the tower climb portion of his fire fighter recruit training. After reaching the sixth (top) floor of the training tower for the third time that morning, he began to have leg and neck pain. The pain was severe enough that crew members carried him down the stairs and onto the sidewalk. Shortly thereafter, he lost consciousness. Crew members assessed him and found him to be unresponsive, not breathing, and pulseless. Approximately 37 minutes later, despite cardiopulmonary resuscitation (CPR) and advanced life support (ALS) administered on-scene and at the hospital, the Recruit died. The autopsy revealed "cardiac hypertrophy," "biventricular dilatation" and "cardiomegaly." The death certificate listed "cardiac hypertrophy" as the immediate 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 represent published research, or consensus votes of technical committees of the National Fire Protection Association (NFPA) or fire service labor/management groups.

- ***Consider incorporating exercise stress tests at part of the Fire Department's medical evaluation program***
- ***Equip training instructors with portable radios***
- ***Ensure defibrillation equipment is readily available for emergency use during training***
- ***Use a secondary (technological) test to confirm appropriate placement of the endotracheal (ET) tube during emergency intubations***
- ***Ensure ET tube is firmly secured in place to prevent dislodgement after intubation***

Although unrelated to this fatality, the Fire Department should consider these additional recommendations based on health and economic considerations:

- ***Conduct mandatory annual medical evaluations consistent with NFPA 1582 on ALL fire fighters to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others***
- ***Discontinue the routine use of annual chest x-rays for the Hazmat and Medical Strike Teams unless specifically indicated***

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**

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

- ***Phase-in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity***

INTRODUCTION & METHODS

On February 12, 2003, a 46-year-old male Fire Fighter Recruit lost consciousness while performing the tower climb component of his recruit training. 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 February 13, 2003, by the United States Fire Administration. On February 13, 2003, NIOSH contacted the affected Fire Department to initiate the investigation. On August 25, 2003, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Texas to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed:

- The Deputy Chief of Training
- The Fire Department Chaplain
- Training instructors
- The deceased's wife

During the site-visit NIOSH personnel reviewed:

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

INVESTIGATIVE RESULTS

Incident. On February 12, 2003, the Fire Fighter Recruit (the deceased) reported to work at the Training Center at approximately 0620 hours. At 0700 hours, the class began calisthenics (stretching, 50 situps, 50 push ups, and jumping jacks). After the calisthenics, the class took a water break for approximately 10 minutes and then walked to the apparatus room nearby to get their turnout gear and self-contained breathing apparatus (SCBA). The class was divided into two groups. The deceased was assigned to Group A which performed the tower climb. Group B ran one mile, performed once on the Kaiser sled, followed by 30 minutes of stretching. The tower was a six story structure, composed of concrete block, with 18 steps and a landing between floors (see photograph) for a total of 90 steps and five landings. It would take approximately five minutes for each trainee to complete one tower climb and return to the ground level. Each recruit was expected to make three tower climbs before taking a rest break.

Group A contained 17 recruits which were divided into four drill groups of four recruits each and one drill group of five recruits (the deceased's). Each recruit would wear full turnout gear and their SCBA (weighing a total of 51 pounds), carry the high rise pack (weighing approximately 65 pounds) and a tool. The recruits would leave their equipment (high rise pack and tool) at the top of the tower, descend the stairs empty handed, retrieve another tool, and immediately ascend the stairs again. The temperature at 0753 hours was 48 degrees Fahrenheit with a relative humidity of 48%.

The deceased donned his turnout gear and SCBA and carried the high rise pack and an ax (weighing approximately 6 pounds) on his first climb which he completed with no apparent problems. On his second trip, the deceased carried a saw and a pike pole and again completed the drill with no problems. On his third trip, he carried the high rise pack and a Halligan tool (weighing approximately 9 pounds). His training instructor and a recruit from another drill group followed him up the steps. Two other recruits in his drill group made it to the top and had started to come down the steps. At the fourth floor landing, the deceased dropped the high rise pack and used the Halligan tool as a cane as he continued his climb to reach the top floor. One crew member coming back down the steps asked the deceased where his high rise pack was but he never responded. The recruit appeared to be climbing in a slow, unsteady, tired, and disoriented manner. Once at the sixth (top) floor, the deceased dropped to his knees, then sat down and started to descend the stairs while sitting. His low air alarm on his SCBA began to sound. His air consumption this day was greater than the amount he usually consumed during this drill.

As the instructor got to the fourth floor landing, a recruit advised the instructor that the high rise pack belonged to the deceased. The instructor went back down with the first two recruits to record their times. The instructor and two recruits then went back up to the top floor to check on the deceased. At that point the deceased stood up, took two or three steps down the stairs, and sat down again, while complaining of leg pain. The instructor asked if the pain was caused by a pulled muscle, but the deceased then complained of neck pain. The instructor advised him to stop and the three recruits assisted with the removal of his helmet and SCBA mask. Two recruits assisted the deceased in walking down the stairs, but after descending one flight, he became limp (approximately 0826 hours). Four crew members then carried the deceased down the remaining five flights of stairs to the ground level. Crew members observed the deceased's lips were pale and his eyes were half open.

Crew members leaned the recruit against the wall of the tower and removed his SCBA and turnout gear and elevated his feet. Initial assessment revealed he was conscious but unresponsive to commands. He had a strong carotid pulse but a weak radial pulse. Working on the impression that the deceased had passed out, the instructor sent for another instructor. The second instructor called Dispatch on a cell phone and requested an ambulance. At 0832 hours, Rescue 19 and Engine 44 were dispatched.

Recruits retrieved oxygen equipment and an automated external defibrillator (AED) from a nearby Engine. The AED was connected to the deceased, but was not used due to a weak battery. [Note: The AED at the training facility was a training aid for demonstration purposes.] A non-rebreather mask with supplemental oxygen was placed over the deceased's face. Soon thereafter he stopped breathing and became pulseless. CPR (chest compressions and assisted ventilations via mouth-to-mouth) was begun while crew members retrieved a bag-valve-mask to be used for assisted ventilations. Rescue 19 arrived at 0836 hours and Engine 44 arrived at 0837 hours. Rescue 19 personnel connected a cardiac monitor to the deceased, revealing ventricular fibrillation (V.Fib.)(a heart rhythm unable to sustain life), which was immediately shocked (defibrillated) three times (0838 hours). His heart rhythm reverted to asystole (no heart beat). He was intubated (a breathing tube placed into his windpipe) and correct placement confirmed using bilateral breath sounds, but no secondary confirmation testing was used. An intravenous line was placed, resuscitation medications consistent with CPR protocols were administered, and he was loaded into the ambulance for transport to the hospital ED.

Rescue 19 departed the scene at 0842 hours and arrived at the hospital at 0851 hours.
Inside the hospital's ED, ALS measures continued. Intubation placement was checked and was found to have dislodged during transport. The deceased was re-intubated. CPR and ALS measures continued without a change in rhythm until 0907 hours, at which time he was pronounced dead and resuscitation efforts were discontinued.

Medical Findings. The death certificate, completed by the Medical Examiner, listed "Cardiac hypertrophy" as the immediate cause of death. The carboxyhemoglobin level was less than one percent, indicating inhaled carbon monoxide played no part in his death. Pertinent findings from the autopsy, performed by the Deputy Chief Medical Examiner, on February 13, 2003, included:

- Cardiac hypertrophy
- Biventricular and right atrial dilatation
- Cardiomegaly (an enlarged heart) weighing 440 grams (normal is less than 400 grams[1])
- The coronary arteries are free of atherosclerosis
- The cardiac valves are unremarkable
- No blood clots in the pulmonary vessels, therefore no evidence of a pulmonary embolus

The left ventricular free wall and septum each measured 1.0 centimeter (cm) in thickness [(normal is 0.76-0.88 cm)[2](normal echographic measurement is 0.6 to 1.1 cm)[3]] and the right ventricle measured 0.2 cm (normal is 0.3-0.5 cm).[4] Sections of the atrioventricular node were unremarkable. Microscopic examination revealed myocyte hypertrophy and moderate thickening of the intramyocardial arterioles.

Medical History.
The deceased was not currently taking any prescription medications. He exercised on-duty, performing strength and aerobic training. On autopsy the deceased weighed 174 pounds and was 66 inches tall, giving him a body mass index (BMI) of 28.1 kg/m^2. (A BMI between 25 and 29.9 kg/m^2 is overweight, while BMI above 30 kg/m^2 is considered obese).[5] However, according to family and crew members, he was very muscular with very little body fat.

In January 2003, he experienced abdominal pain, vomiting, and flu-like symptoms following vigorous training and saw a physician at a local hospital where he was evaluated, treated for a viral infection, and released. His pre-placement medical evaluation in October 2002 (the content of this medical evaluation is described in the next section of this report) revealed no health problems and he was cleared for full duty.

According to his wife and crew members, the deceased had no complaints of chest pains or any other heart-related illness. During the day of the incident, the deceased did not report any symptoms suggestive of angina or any other heart problems.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the Fire Department consisted of 1,600 uniformed personnel and served a population of 1,100,000 residents in a geographic area of 378 square miles. There are 55 fire stations.

In fiscal year 2001, the Department responded to 253,142 calls: 148,940 medical calls, 63,496 medical/rescue calls, 26,397 other calls, 11,858 fire alarm calls, 6,740 investigation calls, 5,549 service calls, 4,480 structure fires, 3,784 vehicle fires, 2,637 hazardous condition calls, 1,690 other fire calls, and 1,329 grass fires. These include 73 two-alarm calls, 26 three-alarm calls, 9 four-alarm calls, and 1 six-alarm call. There were an average of 408 daily emergency medical dispatches and 285 daily fire equipment dispatches.

Training. The Fire Department requires all new fire fighter applicants to have 45 college credit hours or a "C" average or better, pass a written civil service test, a math and reading test, a physical ability test, a polygraph test, a background check, a drug test, and a physical examination prior to being hired. Newly hired fire fighters are then sent to the 15-month fire fighter-paramedic training course at the City Fire Academy to become certified as a Fire Fighter-Paramedic.

Recurrent training occurs daily on each shift. The State minimum requirement for fire fighter certification is the 468-hour Fire Fighter I and II course and the 40-hour Emergency Care-Ambulance course. Career fire fighters must be State certified within one year of employment. The State also requires a minimum of 20 hours training for recertification. Annual re-certification is required for hazardous materials; while Emergency Medical Technician and Paramedic recertification is bi-annual. The deceased was a Fire Fighter Recruit and had two months of active service on the Fire Department.

Pre-placement Evaluations. The 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
- Blood tests: Blood Chemistry (SMA 20)
- Pulmonary function test (PFT)
- Audiogram
- Vision screen
- Chest x-ray
- Urinalysis
- Back x-ray

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

Periodic Evaluations.
Periodic medical evaluations are required by this Department for selected members. The hazardous materials (HazMat) fire fighters and Weapons of Mass Destruction Team (Medical Strike Team) members are evaluated yearly. The Driver-Engineers are evaluated every other year. Components of the evaluation for Hazmat and Medical Strike Team are:

- A complete medical history
- Physical examination
- Blood tests: CBC and heavy metals
- PFT
- Chest x-ray
- Maximal treadmill exercise stress test (EST) with 12 lead electrocardiogram (EKG)
- Urinalysis
- Audiogram
- Vision screen

Components of the periodic medical evaluation for Driver-Engineers include the following:

- Blood pressure
- Urinalysis
- Audiogram
- Vision screen

The City physician performs the periodic medical evaluations for Driver-Engineers. A contractor performs the evaluations for the Hazmat fire fighters and Medical Strike Team. Medical clearance for SCBA use and for fire suppression is not required for all fire fighters. A paramedic and an ambulance medical officer conduct three lead EKG's (looking at lead two) and blood pressure measurement semi-annually on all fire fighters. If an EKG is abnormal or a blood pressure is greater than 140/90, the

supervisor is notified, who then places the fire fighter on light duty until a release form from the fire fighter's primary care physician is provided to the Fire Department. If an employee is injured at work, or is ill and off work for more than three shifts, the employee is evaluated by their personal physician, who forwards their recommendation regarding "return to work" to the City physician, who makes the final determination. The deceased was cleared for duty by the City physician following his pre-placement physical examination on October 11, 2002.

Exercise (strength and aerobic) equipment is located in the fire stations. Mandatory wellness/ fitness programs are in place for the Department, however the type of exercise performed is left to the individual fire fighter. Health maintenance programs (smoking cessation, cholesterol reduction, employee assistance programs, etc.) are available from the City.

DISCUSSION

Hypertrophy of the heart's left ventricle (left ventricular hypertrophy) is a relatively common finding among individuals with long standing high blood pressure (hypertension), a heart valve problem, or cardiac ischemia (reduced blood supply to the heart muscle). However, the deceased was never known to have high blood pressure, and, on autopsy, did not have any valve abnormalities or CAD. Unexplained cardiac hypertrophy is one form of hypertrophic cardiomyopathy (HCM). This diagnosis of HCM was made by his: 1) large heart (440 grams)(normal is < 400 grams[1]), 2) thickened left heart ventricles (1.0 cm)(normal is 0.76-0.88 cm)[2](normal echocardiographic measurement is 0.6 to 1.1 cm),[3] and 3) microscopic findings of myocyte hypertrophy.

The pathologist conducting the autopsy also diagnosed biventricular dilatation. Our review of the subject, however, suggests the deceased had right ventricular dilatation (luminal diameter of 3 cm)(normal is 0.7-2.3 cm),[3] but not left ventricular dilatation (luminal diameter of 4 cm with normal being between 3.7-5.6 cm).[3] Thus, the deceased had a mixed hypertrophic and dilated cardiomyopathy.

Hypertrophic cardiomyopathy (HCM) is a relatively rare heart condition, affecting approximately 0.2% of the population.[6] The majority of patients are asymptomatic, however, and sudden cardiac death is often its first clinical manifestation, particularly among patients less than 30 years of age.[7] Risk factors for sudden death among HCM patients include young age (<30 years old) at diagnosis, a family history of HCM with sudden death, an abnormal blood pressure response to exercise, severe symptoms, non-sustained ventricular tachycardia, marked hypertrophy, marked left atrial dilatation, and genetic abnormalities associated with increased prevalence of a sudden death.[6-8]

Approximately half of the HCM cases are transmitted genetically, typically in an autosomal dominant trait with disease loci on at least eight different chromosomes.[9] Unfortunately, genetic testing is not routinely available and remains largely a research tool. The causes of HCM in the other half of patients is unknown.[7] Since the deceased had siblings and children, subsequent medical screening of relatives is warranted.

Dilated cardiomyopathy, is characterized by dilatation of the heart chambers and impaired ventricular contraction (pumping). Microscopic findings are non-specific, typically being myocyte hypertrophy [best appreciated as nuclear hypertrophy (e.g. "box-car nuclei")] with varying degrees of interstitial fibrosis.[10,11] Although most cases of dilated cardiomyopathy are of unknown etiology (idiopathic), a variety of acquired or hereditary disorders can cause the disorder. These secondary and potentially reversible forms are listed in Table 1.[11]

Idiopathic cardiomyopathy (IDC), diagnosed in the deceased from the autopsy, is not rare. Its age-adjusted prevalence in the United States averages 36 cases per 100,000 population,[12] and it accounts for 10,000 deaths each year.[13] Most patients are first seen between the ages of 20 and 50 years presenting with symptoms of moderate heart failure [shortness of breath on exertion, palpitations (fast heart beats), diminished exercise capacity] and advanced heart failure [shortness of breath upon lying down, and swelling of the ankles].[11] The deceased had sudden death as the initial presentation of IDC. Although sudden death is rarely the initial presentation,[14,15] it is a common cause of death among IDC patients accounting for 28 percent of all IDC deaths.[11]

The prognosis for ICD is poor. Early studies reported one- and five-year death rates of approximately 25 and 50 percent respectively,[16,17] but recent studies report an average five-year death rate of 20 percent.[14,15,18,19] This improved survival probably reflects the earlier detection of disease, a shift to population-based studies, and better treatment.[15,20] Although a variety of symptoms and medical tests can provide prognostic information, patients at greatest risk of sudden death or in need of anti-arrhythmic therapy cannot yet be prospectively identified.[11] Given the inability to identify patients at high risk for sudden death, the low degree of efficacy of anti-arrhythmic agents for IDC, the numerous side effects of these anti-arrhythmic agents, and the lack of symptoms in the deceased, it is unclear if an earlier diagnosis could have prevented his sudden death.

Investigations into the pathogenesis of IDC have focused on four basic mechanisms: (1) inherited factors, (2) viral myocarditis and other cytotoxic insults, (3) immune abnormalities, and (4) metabolic, energetic, and contractile abnormalities. These mechanisms are not mutually exclusive, and several may combine to produce clinical disease in susceptible patients. The inherited factors account for approximately one third of all IDC cases,[21-23] and 20 percent of patients with IDC have at least one first-degree relative with a decreased ejection fraction and cardiomegaly.[21] Although IDC can be transmitted as a recessive or X-linked trait, autosomal dominant inheritance occurs most frequently and exhibits both clinical variability and genetic heterogeneity.[24] It is unclear if this victim's IDC was due to inherited factors or due to post-viral myocarditis. In either case, first-degree relatives of this fire fighter should consult with their physicians regarding when, or if, an echocardiogram is warranted to screen for IDC.

IDC is often accompanied by conduction system disease and genetic studies have identified individual loci on chromosomes responsible for these cases.[24] The reported conduction systems diseases associated with IDC are sinus bradycardia, atrioventricular conduction block (first-, second-, and third-degree), and atrial arrhythmias.[24] Except for family history, no clinical or histopathological characteristics can distinguish familial from nonfamilial disease.[11] Future molecular genetic studies may lead to the identification and treatment of asymptomatic carriers who are at risk for symptomatic dilated cardiomyopathy.[24]

Could a more comprehensive FD pre-placement medical evaluation have identified this condition? As noted earlier, the City physician at the time of this fire fighter's pre-placement medical evaluation did not require a resting EKG. The 2000 Edition of NFPA 1582 (*Medical Requirements for Fire Fighters and Information for Fire Department Physicians*), does not recommend a routine pre-placement EKG unless specifically indicated.[25] If, for some reason a resting EKG was done, it might have detected his enlarged heart. However, in an active, healthy, asymptomatic 46 year-old man, this finding might have been attributed to an "athletic heart" and not investigated further.

Should this Recruit have had a screening EST? NFPA 1582 was developed to reduce the risk of sudden cardiac arrest and heart attacks among fire fighters. NFPA 1582 recommends, not as a part of the requirements but for informational purposes only, that all fire fighters above the age of 40 have an Exercise Stress Test (EST) to screen for obstructive coronary artery disease (CAD). Unfortunately, EST have problems with both false negatives (inadequate sensitivity) and false positives (inadequate specificity), particularly for asymptomatic individuals (individuals without symptoms suggestive of CAD), particularly in young men, and women.[26,27] This has led other expert groups to not recommend EST for asymptomatic individuals without risk factors for CAD.[28-30]

When asymptomatic individuals have risk factors for CAD, recommendations for EST vary by organization. NFPA 1582 recommends biannual EST for fire fighters with CAD risk factors beginning at age 35.[25] For medical certification for the commercial drivers license issued by the U. S. Department of Transportation (DOT), they recommend EST for drivers over the age of 45 with more than two CAD risk factors.[28] The American College of Cardiology/American Heart Association do not think that "there is evidence and/or general agreement that [EST] is useful and effective" in asymptomatic persons without known CAD, but they identify four groups of such persons for which "there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy" of EST. In these groups, EST's "usefulness/efficacy is less well established by evidence/opinion" (as opposed to the "weight of evidence/opinion [being] in favor of usefulness/efficacy)."[29]

- Group 1: Persons with multiple risk factors. Five risk factors for CAD are defined: hypercholesterolemia (total cholesterol greater than 240 mg/dL), hypertension (systolic blood pressure greater than 140 mm Hg or diastolic pressure greater than 90 mm Hg), smoking, diabetes, and family history of premature CAD (heart attack or sudden cardiac death in a first-degree relative less than 60 years old).
- Group 2: Men over the age of 40 and women over the age of 50 (especially if sedentary) who plan to start vigorous exercise.
- Group 3: Men over the age of 40 and women over the age of 50 who are at high risk for CAD due to other diseases (e.g., chronic renal failure).
- Group 4: Men over the age of 40 and women over the age of 50 who are involved in occupations in which impairment might impact public safety.

Finally, the U.S. Preventive Services Task Force (USPSTF) does not recommend EST for asymptomatic individuals, even those with risk factors for CAD; rather, they recommend the diagnosis and treatment of modifiable risk factors (hypertension, high cholesterol, smoking, and diabetes).[30] The USPSTF indicates that there is insufficient evidence to recommend screening middle age and older men or women in the general population but notes that "screening individuals in certain occupations (pilots, truck drivers, etc.) can be recommended on other grounds, including the possible benefits to public safety."[30]

Thus, the AHA and NFPA give a qualified suggestion that the Recruit should have had an EST, while the U.S. DOT and the USPSTF recommend that he should not have had an EST.

Had the deceased's HCM or IDC been identified during the FD's pre-placement evaluation, would he have been denied employment as a fire fighter? Neither HCM or IDC is specifically addressed in NFPA 1582. However, it would most likely be considered a Category B Medical Condition, defined as "a medical condition that, based on its severity or degree, **could** (our emphasis) preclude a person from

performing as a fire fighter in a training or emergency operational environment by presenting a significant risk to the safety and health of the person or others."

Had the deceased's HCM been identified, would this have prevented his death? Although a variety of symptoms and medical tests can provide prognostic information, patients at greatest risk of sudden death or in need of anti-arrhythmic therapy are hard to identify. Given the deceased's few above mentioned risk factors for sudden death, the low degree of efficacy of anti-arrhythmic agents and their numerous side effects, and the lack of symptoms in this fire fighter, it is unlikely that a diagnosis would have led to treatment. Therefore, it is unclear if his tragic sudden death would have been prevented even if his condition was identified.

RECOMMENDATIONS

The following recommendations address health and safety generally. 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 recommendations have not been evaluated by NIOSH, but represent published research, or consensus votes of technical committees of the NFPA or fire service labor/management groups.

Recommendation #1: Consider incorporating exercise stress tests as part of the Fire Department's medical evaluation program.

NFPA 1582 and the IAFF/IAFC wellness/fitness initiative both recommend at least biannual EST for fire fighters.[25,31]

Recommendation #2: Equip training instructors with portable radios.

While the training involved in this incident did not include live fire, it was very physically demanding and involved training in a six-story tower. If the instructors carried portable radios, they could summon help more readily if the need arose. This could have reduced the time for the ambulance to arrive on the scene, and, therefore, for the Recruit to receive ALS resuscitation.

Recommendation #3: Ensure defibrillation equipment is readily available for emergency use during training.

Preservation of human life is the primary responsibility of the fire department during fires and other emergencies. Fire departments should be prepared to perform rescue work and provide emergency medical care for those injured,[32] including cardiac arrest. The chain of survival from cardiac arrest includes: 1) early access to the emergency medical system (EMS and 9-1-1 system), 2) early CPR, 3) early defibrillation when indicated, and 4) early advanced emergency treatment.[33] Most of the sudden cardiac deaths in the United States result from ventricular fibrillation. AEDs have caused the cardiac arrest survivability rate to increase from 7 percent (CPR performed only) to 26 percent.[34] When defibrillation is provided within 5-7 minutes, the survival rate is as high as 49 percent.[35]

Having AEDs available at the training sites, in addition to those defibrillators carried on ambulances, would allow the Fire Department to provide a greater level of emergency medical care to its members. The timely use of an automated external defibrillator, even by minimally trained first responders, can increase the likelihood of survival following cardiac arrest.[35-37] Since this incident, the Fire Department has placed first aid equipment, including a functional AED at the training site. The equipment is checked daily.

Recommendation #4: Use a secondary (technological) test to confirm appropriate placement of the ET tube during emergency intubations.

To reduce the risk of improper intubation, the American Heart Association along with the International Liaison Committee on Resuscitation published recommendations in the Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care.[37] These guidelines recommend tube placement be confirmed by primary and secondary methods. Primary confirmation is the 5-point auscultation: left and right anterior chest, left and right midaxillary, and over the stomach. Secondary confirmation requires a technology test, either an end-tidal CO_2 detector or an esophageal detector device. In this incident, the fire fighter had bi-lateral breath sounds confirmed by auscultation, however secondary confirmation was not performed.

Recommendation #5: Ensure ET tube is firmly secured in place to prevent dislodgement after intubation.

Because the ET tube can become dislodged, it is important to secure it in place and to reassess its position periodically. This is especially true if there is a change in the patient's status.[38] However, it is unlikely that the tube becoming dislodged was a factor in the Recruit's failed resuscitation, but it did not improve his chances of survival.

Recommendation #6: Conduct <u>mandatory</u> annual medical evaluations on <u>ALL</u> fire fighters to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

This finding did not contribute to the death of this fire fighter but was identified by NIOSH during the investigation.

Guidance regarding the content and frequency of periodic medical evaluations and examinations for fire fighters can be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians,[25] and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.[31] The Department is not legally required to follow any of these standards. Nonetheless, we recommend the City and Union **work together** to establish the content and frequency in order to be consistent with the above guidelines.

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 should be applied in a **confidential**, **nondiscriminatory** manner. Appendix D of NFPA 1582 provides guidance for Fire Department Administrators regarding legal considerations in applying the standard.

Applying NFPA 1582 also involves economic issues. These 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.[39]

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.

Recommendation #7*: *Discontinue the routine use of annual chest x-rays for the Hazmat and Medical Strike Teams unless specifically indicated.

This finding did not contribute to the death of this Fire Fighter but was identified by NIOSH during the inspection.

Specifically, according to NFPA 1582, "the use of chest x-rays in surveillance activities in the absence of significant exposures, symptoms, or medical findings has not been shown to reduce respiratory or other health impairment. Therefore, only pre-placement chest x-rays are recommended."[25] The chest x-rays being conducted by the Fire Department for the Hazmat and the Medical Strike Team expose incumbents to unnecessary radiation and represent an unnecessary expense for the Fire Department, and are not recommended by the OSHA Hazmat standard unless specifically indicated by the medical/occupational history.[40]

Recommendation #8: Provide fire fighters with clearance to wear self-contained breathing apparatus (SCBA) as part of the Fire Department's medical evaluation program.

This finding did not contribute to the death of this fire fighter but was identified by NIOSH during the investigation.

OSHA's Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employees using respiratory protection.[41] These clearance evaluations are required for private industry employees and public employees in states operating OSHA-approved State plans. Texas is not a State-plan State, therefore, public sector employers are not required to comply with OSHA standards. Nonetheless, we recommend following this standard to ensure fire fighters are medically cleared to wear SCBA on an annual basis.

Recommendation #9: Phase-in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.

This finding did not contribute to the death of this fire fighter but was identified by NIOSH during the investigation.

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.[42] NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.[39] NFPA 1583, Standard on Health-Related Fitness Programs for Fire Fighters, provides the minimum requirements for a health-related fitness program.[43] 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.[31] The Fire Department and the Union should review these materials to identify applicable elements for their Department. Other large-city negotiated programs can also be reviewed as potential models.

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Table 1. Known Causes of Dilated Cardiomyopathy[10]

Toxins
- Ethanol
- Chemotherapeutic agents (doxorubicin, bleomycin)
- Cobalt
- Anti-retroviral agents (zidovudine, didanosine, zalcitabine)
- Phenothiazines
- Carbon monoxide
- Lead
- Cocaine
- Mercury

Metabolic Abnormalities
- Nutritional deficiencies (thiamine, selenium, carnitine)
- Endocrinologic disorders (hypothyroidism, acromegaly, thyrotoxicosis, Cushing's Disease, pheochromocytoma, diabetes mellitus)
- Electrolyte disturbances (hypocalcemia, hypophosphatemia)

Infectious
- Viral (coxsackie virus, cytomegalovirus, human immunodeficiency virus)
- Rickettsial
- Bacterial (diphtheria)
- Mycobacterial
- Fungal
- Parasitic (toxoplasmosis, trichinosis, Chagas' disease)

Noninfectious
- Collagen vascular disorders (scleroderma, lupus erythematosus, dermatomyositis)
- Hypersensitivity myocarditis
- Sarcoidosis
- Peripartum dysfuncion

Neuromuscular Causes
- Duchenne's muscular dystrophy
- Facioscapulohumeral muscular dystrophy
- Erb's limb-girdle dystrophy
- Myotonic dystrophy

Photograph. Fire Department Training Tower