



Career Lieutenant Suffers Sudden Cardiac Death At His Station After Making Multiple Runs During the Day – Tennessee

SUMMARY

On October 24, 2005, the Lieutenant (LT) arrived for duty at his fire station at 0700 hours. Throughout the morning the crew checked the fire apparatus and equipment, then performed station housework (cleaning, sweeping, mopping, etc.). During the day, the crew responded to four incidents: two fire alarms and two EMS calls. During all four responses, the LT performed only light physical activity. Later that evening, while sitting in a chair, the LT collapsed. Despite exhaustive cardiopulmonary resuscitation (CPR) performed at the scene, in the ambulance, and in the emergency department (ED) of the local hospital, the LT died. The autopsy, completed by the medical examiner, revealed marked enlargement of the heart with left ventricular hypertrophy. The death certificate, also completed by the medical examiner, listed cardiac arrhythmia as the immediate cause of death due to hypertensive cardiovascular disease.

The NIOSH investigator concluded the LT's underlying heart disease, possibly triggered by the stress of responding to two emergency calls earlier in the day caused his sudden cardiac death (SCD). His death may have been avoided at this time if the fire department (FD) followed National Fire Protection Association (NFPA) 1582, *Standard on Comprehensive Occupational Medicine Program for Fire Departments*. NIOSH investigators also concluded that to minimize the risk of similar occurrences, the FD should:

- *Provide annual medical evaluations to 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.*

- *Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting, the personal protective equipment used by fire fighters, and the various components of NFPA 1582, Standard on Comprehensive Occupational Medicine Program for Fire Departments.*
- *Phase in a mandatory wellness/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 physically capable of performing the essential job tasks of structural fire fighting.*

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

- *Discontinue lumbar spine x-rays as a screening test administered during the pre-placement medical evaluation.*

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 Web site at

www.cdc.gov/niosh/fire
or call toll free 1-800-35-NIOSH



Career Lieutenant Suffers Sudden Cardiac Death at His Station After Making Multiple Runs During the Day – Tennessee

INTRODUCTION & METHODS

In the evening of October 24, 2005, a 47-year-old male LT suffered a sudden cardiac death at his fire station after making multiple runs earlier that day. On January 19, 2006, NIOSH contacted the affected FD to gather information pertaining to the fatality and coordinate a site visit for an investigation. On January 30, 2006, an Occupational Health Nurse Practitioner from the NIOSH Fire Fighter Fatality Investigation and Prevention Team traveled to Tennessee to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed the following people:

- FD personnel
- LT's wife
- City administrators
- Third party insurance administrators

During the site visit NIOSH personnel reviewed the following documents:

- FD policies and operating guidelines
- FD training records
- FD annual report for 2004
- FD incident report
- Ambulance response report
- Hospital records
- Medical records
- Autopsy results
- Death certificate

INVESTIGATIVE RESULTS

On October 24, 2005, the LT arrived for duty at his fire station (Station #19) at 0700 hours. He was assigned to Engine 19 (E-19), which was staffed with two fire fighters (FFs), a driver, and the LT. Throughout the morning the crew checked the fire apparatus and equipment, then performed station housework (cleaning,

sweeping, mopping, etc.). At 0810 hours they received a fire call of smoke in a residential kitchen. Upon their arrival they were met by personnel from another station who had already extinguished the fire. The LT did not exit the vehicle, and E-19 returned to quarters.

At 0928 hours, E-19 responded to a first responder call for chest pains. E-19 arrived on scene as the patient was being loaded into the ambulance for transport to the hospital. Once again the LT did not exit the vehicle, and E-19 returned to quarters. Some time during the day, the LT called his wife to complain of shortness of breath, which he relieved by deep breaths. He did not notify any crew members about these symptoms.

At 1723 hours, E-19 was dispatched to an automatic fire alarm. Upon arrival it was determined to be a false alarm, and the E-19 crew stayed on the scene less than a minute before returning to quarters. At 1801 hours, E-19 was dispatched again to assist the paramedics with a medical call involving a 75-year-old male with syncopal episodes. E-19 stayed on scene for 17 minutes, but was not asked by the ambulance crew to provide assistance. The crew returned to the station. Shortly thereafter, the LT spoke with his wife and stated he felt much better.

The LT and his crew prepared dinner and cleaned up before sitting down to watch television. At approximately 2022 hours, while sitting in a chair, the LT exhibited seizure-like activity and collapsed. His crew members evaluated him and called dispatch for an ambulance. The LT was breathing and had a pulse, but was not conscious. Crew members placed a non-rebreather mask with oxygen (15 liters per minute) on him and continued to evaluate his respiration (24 breaths per minute) and pulse (60 beats per minute). Although an Automatic External Defibrillator was available on E-19, it was not retrieved because the crew members felt the LT was having a seizure. About 1½ minutes later, the LT lost his pulse.

An ambulance arrived at 2024 hours with two paramedics. Their initial evaluation found the LT



Career Lieutenant Suffers Sudden Cardiac Death at His Station After Making Multiple Runs During the Day – Tennessee

unconscious with no respirations or pulse. He was placed on a cardiac monitor, which showed ventricular fibrillation (VFib), a heart beat incompatible with life. Three stacked shocks were administered. The LT's heart rhythm degenerated into asystole (no heart beat). The paramedics started an IV and began CPR. Multiple attempts at intubation were unsuccessful. The LT was loaded onto a stretcher and placed in the ambulance, where he was successfully intubated on the third attempt. Placement of the endotracheal tube was verified by auscultation and confirmed by end tidal Carbon Dioxide measurement. The ambulance left for the emergency department (ED) at 2043 hours, 19 minutes after its arrival. Three rounds of advanced life support (ALS) intravenous medications were administered en route to the ED, with no change in heart rhythm or clinical condition.

The ambulance arrived at the hospital ED at 2059 hours, 38 minutes after collapse. Initial evaluation in the ED found the LT to be in VFib, unresponsive, with no spontaneous respirations. He was given 16 rounds of ALS medications and defibrillated 15 times over 31 minutes. After 31 minutes of resuscitation efforts in the ED, in addition to the 37 minutes of resuscitation efforts in the field, the LT was pronounced dead at 2132 hours.

Medical Findings. The death certificate, completed by the medical examiner, listed cardiac arrhythmia as the immediate cause of death due to hypertensive cardiovascular disease. An autopsy was performed by the Medical Examiner. Significant findings were as follows:

- Cardiomegaly (enlarged heart) based on a weight of 700 grams (normal < 400 grams)
- Left ventricular hypertrophy
 - left ventricle thickness 1.8 cm (normal .6-1.1 cm)
 - interventricular septum thickness 1.6 cm (normal .6-1.1 cm)

- Microscopic examination of the left ventricular myocardium (three sections) showed myocyte hypertrophy and small foci of subendocardial interstitial fibrosis (findings consistent with hypertensive heart disease)
- Patent coronary arteries with mild atherosclerosis and no intracoronary thrombosis.
- Normal heart valves
- No pulmonary embolus

The LT had an extensive history of cardiac dysfunction. In 1986 he had a normal pre-employment physical examination including a normal electrocardiogram. In the summer of 2003 he was diagnosed and treated for hypertension, dilated cardiomyopathy with congestive heart failure (by echocardiogram showing a left ventricular ejection fraction of 30% [normal typically above 50%]), and heart valve problems (mitral and tricuspid insufficiency probably secondary to dilated cardiomyopathy). Evaluation at that time also included a cardiac catheterization that showed no coronary artery disease. He was last seen by his cardiologist seven months prior to his death. He was cautioned to watch his weight and exercise and continue current medications. A repeat echocardiogram and cardiology visit was scheduled for November of 2005.

Because the FD did not require annual or periodic medical evaluations for members, it is unclear if the FD was fully aware of the LT's heart condition. The LT attended medical appointments on his days off and none of the medical records reviewed by NIOSH mentioned medical clearance for fire fighting duties by his primary care physician or his cardiologist.

DESCRIPTION OF THE FIRE DEPARTMENT

This career FD consisted of approximately 1,436 uniformed personnel serving a population of 800,000 in a 340-square-mile area. It had 54 fire stations.



Career Lieutenant Suffers Sudden Cardiac Death at His Station After Making Multiple Runs During the Day – Tennessee

In 2004, the FD responded to 74,757 calls: 21,748 structure fires, 666 grass fires, 1,776 vehicle fires, 419 trash fires, 208 aircraft alert/fires, 54 rescue calls, 46 fuel spill calls, 2 bomb threats, and 49,838 emergency medical calls.

Training. The FD requires all fire fighter candidates to complete an application; be at least 18 years of age; possess a high school diploma or equivalent; possess a valid state driver's license; and pass a timed physical agility test (PAT), an oral interview, and a written test. The candidate is then placed on a hiring list based on test score. When vacancies occur, the top candidates undergo and must pass a background check and a physical examination prior to being hired. The newly hired fire fighter receives training for six months at the Fire Training Academy, which certifies the fire fighter to the Fire Fighter I/Emergency Medical Technician (FFI/EMT) or the FF/Paramedic level. The FF is placed on shift and works 24 hours on-duty, 24 hours off-duty for three shifts, 0700 hours to 0700 hours, and is then off duty for 96 hours. Subsequent training to the Fire Fighter II level is conducted on shift.

All fire fighters are tested by personnel from the State of Tennessee to become certified as a Fire Fighter I or II. There is no State requirement for annual fire fighter recertification. However EMT, confined space, and respiratory protection require annual recertification. The LT was certified as a Fire Fighter II, a Driver/Operator, a first responder, and had 20 years of fire fighting experience.

Pre-placement Physical Examination. A pre-placement physical examination is required by this FD for all applicants. Components of this evaluation include the following:

- Complete medical and occupational history
- Height, weight, and vital signs
- Physical examination
- Blood tests: complete blood count, sickle cell screen, comprehensive chemical screening profile, syphilis screening, hemoglobin electrophoresis

- Urine tests: urinalysis with microscopy, urine drug screen, urine alcohol screen
- Chest X-ray (PA and lateral views) with interpretation and report
- Lumbosacral spine X-ray (AP and lateral views) with interpretation and report
- 12-lead resting electrocardiogram (ECG) with interpretation and report
- Audiometry
- Spirometry
- Vision test: Snellen vision screen, visual acuity, visual field, color vision
- Pregnancy test (if applicable)
- Pap smear (if applicable)

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

Periodic Evaluations. Required annual medical evaluations are offered to hazardous materials operations and rescue/special operations members only. A City-contracted physician performs the medical evaluations and forwards the clearance for duty decision to the City's personnel director, who makes the final determination.

No annual physical agility test is required, and the fitness program is voluntary. Exercise equipment (strength and aerobic) is available in all the fire stations. Employees who are injured at work or ill must be evaluated and cleared for return to work by their private or treating physician. The results are reviewed by the City-contracted physician. A medical evaluation for clearance to wear self-contained breathing apparatus (SCBA) is required if a member has a change in health. However, as evident from this case, the lack of a periodic medical evaluation limits the FD's contract physician's awareness of important medical conditions among FFs.



Career Lieutenant Suffers Sudden Cardiac Death at His Station After Making Multiple Runs During the Day – Tennessee

DISCUSSION

Cardiomyopathies (CM) constitute a group of diseases involving the heart muscle. Damage to the heart muscle is not the result of hypertensive, ischemic (coronary artery), valvular, pericardial, or congenital disease.¹ There are three types of CM based on functional impairment:

- 1) dilated (DCM), the most common form, accounts for 60% of all cardiomyopathies
- 2) hypertrophic (HCM), recognized by inappropriate left ventricular hypertrophy often with involvement of the interventricular septum
- 3) restrictive (RCM), the least common form in western countries, marked by impaired diastolic filling and in some cases with endocardial scarring of the ventricle¹

In June 2003 the LT was diagnosed by his personal physician with dilated cardiomyopathy (DCM) and significant valvular regurgitation. DCM is characterized by cardiac enlargement and impaired systolic function of one or both ventricles.² As the ventricular function deteriorates, the following signs and symptoms of congestive heart failure (CHF) appear: shortness of breath with exertion or when lying flat, ankle swelling, fatigue, weakness, etc. The LT had many of these symptoms confirmed on various physician visits. As in the case with the LT, laboratory studies (radionuclide and cardiac catheterization) reveal left ventricular enlargement and dysfunction, mitral and/or tricuspid regurgitation, elevated left- and often right-sided filling pressures, elevated pulmonary artery wedge pressures, and diminished cardiac output.^{1,2}

The incidence rate of DCM in the United States is 5 to 8 cases per 100,000 per year with an age-adjusted prevalence of 36 cases per 100,000.³ Most cases of DCM are of unknown cause, although a variety of acquired or hereditary disorders can cause the disorder (Figure 1).² Once diagnosed with DCM, patients typically have a downhill course. Patients over the age of 55 usually die within 3 years of the onset of symptoms.¹ DCM is also associated with an

increased incidence of sudden cardiac death (SCD), mostly from arrhythmias.^{1,2,4} Although a variety of symptoms and medical tests can provide prognostic information, patients at greatest risk of SCD are hard to identify.²

On autopsy the LT was found to have left ventricular hypertrophy (LVH). 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). Because the LT was diagnosed with high blood pressure and valvular problems but showed no signs of ischemia on autopsy, his LVH was likely due to these conditions.

Fire fighting activities are strenuous and often require fire fighters to work at near maximal heart rates for long periods. The increase in heart rate has been shown to begin with responding to the initial alarm and to persist through the course of fire suppression activities.⁵⁻⁷ Although the LT did not perform strenuous activity, his heart rate may have been elevated throughout the four alarms and likely continued until each call was cancelled. Given the LT's cardiac history, increased risk of sudden cardiac death (SCD) due to DCM/LVH, and his clean coronary arteries, NIOSH investigators conclude that his death was most likely due to a cardiac arrhythmia associated with the DCM/LVH. The emotional stress and light physical exertion while responding, coupled with his underlying DCM/LVH could have triggered his SCD. When the LT complained to his wife of shortness of breath, following the first two runs, this may have been an early symptom of his cardiac arrhythmia.

NFPA 1582, *Standard on Comprehensive Occupational Medicine Program for Fire Departments* has identified, "Medical conditions that potentially interfere with a member's ability to safely perform essential job tasks."⁸ The LT was diagnosed with conditions that should have restricted his fire fighting duties, including reduced LVEF and cardiac hypertrophy. If the department had routine medical



Career Lieutenant Suffers Sudden Cardiac Death at His Station After Making Multiple Runs During the Day – Tennessee

evaluations or had the LT's personal medical providers restricted his fire fighting duties, the LT may not have died at this time.

RECOMMENDATIONS

It is likely the LT's death could have been prevented. The NIOSH investigators offer these recommendations to reduce the risk of on-the-job sudden cardiac deaths among fire fighters.

Recommendation #1: Provide annual medical evaluations to 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.

Guidance regarding the content and frequency of pre-placement and periodic medical evaluations and examinations for structural fire fighters can be found in NFPA 1582⁸ and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.⁹ Although the FD is not legally required to follow any of these standards, they provide effective guidelines for implementing a medical evaluation requirement.

Applying NFPA 1582 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*, Chapter 8-7.1 and 8-7.2¹⁰ addresses these issues.

The physical evaluation could be conducted by the fire fighter's primary care physician or a City/County-contracted physician. If the evaluation is performed by the fire fighter's primary care physician, the results must be communicated to the City or County physician, who makes the final determination for clearance for duty.

Recommendation #2: Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting, the personal protective equipment used by fire fighters, and the various components of NFPA 1582, Standard on Comprehensive Occupational Medicine Program for Fire Departments.

Physicians who provide input regarding medical clearance for fire fighting duties should be knowledgeable about the physical demands of fire fighting and understand that fire fighters frequently respond to environments that are dangerous to life and health. They should also be familiar with a FF's personal protective equipment and the consensus guidelines published by NFPA 1582, *Standard on Comprehensive Occupational Medicine Program for Fire Departments*.⁸ To ensure physicians are aware of these guidelines, we recommend that the FD or the FF provide the personal physicians with a copy of NFPA 1582.

We also recommend the FD retain a "fire department physician" to review all medical clearances. The FD physician should not "rubber stamp" the opinions of specialists or other treating physicians regarding return to work. This decision requires knowledge not only of the medical condition, but also of the fire fighter's job duties. Personal physicians may not be familiar with a FF's job duties, or with guidance documents such as NFPA 1582. In addition, they may consider themselves patient advocates and dismiss the potential public health impact of public safety officials who may be suddenly incapacitated. Therefore, we recommend that a "FD physician" who has the final decision regarding medical clearance review all return-to-work clearances.

Recommendation #3: 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 coronary artery disease (CAD) in the



Career Lieutenant Suffers Sudden Cardiac Death at His Station After Making Multiple Runs During the Day – Tennessee

United States. Physical inactivity, or lack of exercise, is associated with other CAD risk factors: obesity and diabetes.¹¹ NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.¹⁰ NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters*, provides the minimum requirements for a health-related fitness program.¹² 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 create a practical fire service program. They produced a manual and a video detailing elements of such a program.⁹

Large-city negotiated programs can also be reviewed as potential models. Wellness programs have been shown to be cost effective, typically by reducing the number of work-related injuries and lost work days.¹³⁻¹⁵ A similar cost savings has been reported by the wellness program at the Phoenix Fire Department, where a 12-year commitment has resulted in a significant reduction in their disability pension costs.¹⁶

Recommendation #4: Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are physically capable of performing the essential job tasks of structural fire fighting.

NFPA 1500 requires fire department members who engage in emergency operations to be annually evaluated and certified by the fire department as meeting the physical performance requirements identified in paragraph 8-2.1.¹⁰

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

Recommendation #5: Discontinue lumbar spine x-rays as a screening test administered during the pre-placement medical evaluation.

The FD currently performs pre-placement physical evaluations, which include routine lumbar spine X-rays. While these X-rays may be useful in evaluating individuals with existing problems, the American College of Radiology, American College of Occupational and Environmental Medicine, and NIOSH have concluded that lumbar spine X-rays have no value as a routine screening measure to determine risk for back injuries.¹⁷⁻¹⁹ This procedure involves both an unnecessary radiation exposure for the applicant and an unnecessary expense for the FD.



Career Lieutenant Suffers Sudden Cardiac Death at His Station After Making Multiple Runs During the Day – Tennessee

REFERENCES

1. Wynne J and Braunwald E [2001]. The cardiomyopathies and myocarditides. In: Braunwald E, Zipes DP, and Libby P, eds. Heart Disease. 6th Edition. Philadelphia: W.B. Saunders. pp. 1751-1755.
2. Dec GW, Fuster V [1994]. Medical progress: idiopathic dilated cardiomyopathy. N Eng J Med 331:1564-75.
3. Codd MB, Sugrue DD, Gersh BJ, et al. [1989]. Epidemiology of idiopathic dilated cardiomyopathy: a population-based study in Olmsted County, Minnesota, 1975-1984. Circulation 80:564-72.
4. Bansch D, Antz M, Boczor S, et al. [2002]. Primary prevention of sudden cardiac death in idiopathic dilated cardiomyopathy. The cardiomyopathy trial (CAT). Circulation 105:1453-58.
5. Barnard RJ, Duncan HW [1975]. Heart rate and ECG responses of fire fighters. J Occup Med 17:247-250.
6. Manning JE, Griggs TR [1983]. Heart rate in fire fighters using light and heavy breathing equipment: Simulated near maximal exertion in response to multiple work load conditions. J Occup Med 25:215-218.
7. Lemon PW, Hermiston RT [1977]. The human energy cost of fire fighting. J Occup Med 19:558-562.
8. NFPA [2003]. Standard on comprehensive occupational medical program for fire departments. Quincy MA: National Fire Protection Association. NFPA 1582.
9. IAFF, IAFC [2000]. The fire service joint labor management wellness/fitness initiative. Washington, D.C.: International Association of Fire Fighters, International Association of Fire Chiefs.
10. NFPA [1997]. Standard on fire department occupational safety and health program. Quincy MA: National Fire Protection Association. NFPA 1500.
11. Plowman SA and Smith DL [1997]. Exercise physiology: for health, fitness and performance. Boston, MA: Allyn and Bacon.
12. NFPA [2000]. Standard on health-related fitness programs for fire fighters. Quincy MA: National Fire Protection Association. NFPA 1583.
13. Maniscalco P, Lane R, Welke M, Mitchell J, Husting L [1999]. Decreased rate of back injuries through a wellness program for offshore petroleum employees. J Occup Environ Med 41:813-820.
14. Stein AD, Shakour SK, Zuidema RA [2000]. Financial incentives, participation in employer sponsored health promotion, and changes in employee health and productivity: HealthPlus health quotient program. JOEM 42:1148-1155.
15. Aldana SG [2001]. Financial impact of health promotion programs: A comprehensive review of the literature. Am J Health Promot 15:296-320.
16. Unpublished data [1997]. City Auditor, City of Phoenix, AZ. Disability retirement program evaluation. Jan 28, 1997.
17. Gibson ES [1998]. The value of pre-placement screening radiography of the low back. In: Deyo RA, ed. Occupational medicine, state of the art reviews. Philadelphia: Hanley & Belfus, pp. 91-108.
18. Present AJ [1974]. Radiography of the Lower Back in Pre-employment Physical Examinations. Conclusions of the ACR/NIOSH Conference, January 11-14, 1973. Radiology 112:229-230.
19. ACOEM [1979]. Use of routine X-ray Examinations in Occupational Medicine.



*Career Lieutenant Suffers Sudden Cardiac Death at His Station After Making Multiple Runs
During the Day – Tennessee*

INVESTIGATOR INFORMATION

This investigation was conducted, and the report written by:

*J. Scott Jackson, RN, MSN
Occupational Nurse Practitioner*

Mr. Jackson is with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component located in Cincinnati, Ohio.



Career Lieutenant Suffers Sudden Cardiac Death at His Station After Making Multiple Runs During the Day – Tennessee

Figure 1. Known Causes of Dilated Cardiomyopathy²

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 dysfunction

Neuromuscular Causes

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

U. S. Department of Health and Human Services
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
4676 Columbia Parkway, MS_C-13
Cincinnati, OH 45226-1998

OFFICIAL BUSINESS

Penalty for private use \$300



**Delivering on the Nation's promise:
Safety and health at work for all people
through research and prevention**