



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

December 31, 2003

Sudden Cardiac Death Due to Myocardial Sarcoidosis Claims the Life of an On-Duty Fire Fighter - Connecticut

SUMMARY

On November 12, 2002 at 1347 hours, a 38-year-old male Fire Fighter collapsed at his fire station. Despite cardiopulmonary resuscitation (CPR) and Advanced Life Support (ALS) administered at the fire station, in the ambulance, and in the hospital's emergency department (ED), the victim died. An autopsy revealed an enlarged heart and granulomatous lesions consistent with sarcoidosis in the victim's heart, lungs, lymph nodes, and liver. There was no evidence of coronary artery disease or evidence of a heart attack (myocardial infarction). This is the second NIOSH fire fighter fatality investigation of an on-duty sudden cardiac death due to sarcoidosis involving the heart. It is unclear whether fire fighters have an increased prevalence of sarcoidosis compared to the general population, however, the possible association warrants further epidemiologic study. Other agencies have proposed a three-pronged strategy for reducing the risk of on-duty sudden cardiac death among fire fighters. This strategy consists of: 1) minimizing physical stress on fire fighters; 2) screening to identify and subsequently rehabilitate high risk individuals; and 3) encouraging increased individual physical capacity. Issues relevant to this Fire Department (FD) include:

- *Provide annual medical evaluations to fire fighters to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others. The Department and Union should negotiate the content and frequency to be consistent with NFPA 1582.*
- *Evaluate abnormal findings uncovered during annual medical evaluations. If this follow-up medical evaluation is conducted*

by the fire fighter's personal physician, results should be reviewed by a fire department physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582.

- *Ensure that fire fighters are cleared for duty, following an injury/illness, by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582.*
- *Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by phasing in a mandatory wellness/fitness program negotiated between the Fire Department and the Union.*

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

- *Discontinue automatic pre-placement screening x-rays of the lumbar spine.*

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

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- ***Discontinue pre-employment/pre-placement exercise stress test for applicants under the age of 35.***

INTRODUCTION & METHODS

On November 12, 2002, a 38-year-old male Fire Fighter experienced a witnessed collapse while on duty at his fire station. NIOSH was notified of this fatality on November 14, 2002, by the United States Fire Administration. On December 11, 2002, NIOSH contacted the affected Fire Department to initiate the investigation. On March 24, 2002, an Occupational Nurse Practitioner from the NIOSH Fire Fighter Fatality Investigation Team traveled to Connecticut to conduct an onsite investigation of the incident.

During the investigation NIOSH personnel met with and interviewed the

- Fire Chief
- Assistant Fire Chiefs
- Local President of the International Association of Fire Fighters (IAFF)
- Crew members on-duty at the time of the incident
- Victim's spouse.

During the site-visit NIOSH personnel also reviewed

- Fire Department policies and operating guidelines
- The victim's FD training records
- The victim's pre-placement physical examination
- Emergency medical services - ambulance report
- Hospital emergency department records of the resuscitation effort
- Death certificate
- Autopsy
- Past medical records of the deceased.

INVESTIGATIVE RESULTS

Incident. On November 12, 2002, three fire fighters and their officer began their 10-hour shift at 0700

hours. The morning was spent performing light duties (paperwork, station maintenance, and inspections). The crew did not respond to any calls during the morning. At approximately 1230 hours, the crew members ate lunch, after which time the Fire Fighter (victim) and a fellow fire fighter went to the bunk room to rest. At approximately 1347 hours an exercising fire fighter heard sounds of distress coming from the victim and upon assessing him, found the Fire Fighter to be unresponsive, pulseless, and not breathing. He began CPR and administered two breaths before leaving the fallen Fire Fighter to notify the other crewmembers, grab the automated external defibrillator (AED) and notify the Emergency Medical Service (EMS). The crew moved the Fire Fighter to the floor, continued CPR and attached the AED. Over an approximately five minutes period, the AED advised and administered a total of six defibrillations. At 1355 hours, EMS arrived and found the victim unresponsive with no pulse in ventricular fibrillation (a heart rhythm incompatible with life). EMS initiated ALS procedures (intubation [a breathing tube placed into the victim's windpipe] and placing an intravenous [IV] line) and departed the station at 1412 hours. Enroute EMS administered two defibrillations plus lidocaine and epinephrine (two IV drugs) before the Fire Fighter's heart rhythm reverted to asystole (no heartbeat). They arrived at a local hospital's ED at 1420 hours. The Fire Fighter was given additional cardiac medications through his IV but never regained consciousness or regained a heart beat. He was pronounced dead at 1434 hours by the Emergency Department (ED) Physician and resuscitation efforts were discontinued. The victim did not have a history of any previous chest pain or shortness of breath, nor did he complain of any pain earlier in his shift.

Medical Findings. The death certificate and autopsy, completed by the Deputy Chief Medical Examiner, listed myocardial sarcoidosis as the immediate cause of death. No carboxyhemoglobin



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level (a marker of carbon monoxide poisoning) was tested. His alcohol and drug screen were negative. Pertinent findings from the autopsy, performed by the Deputy Chief Medical Examiner on November 13, 2002 were significant for:

1. Myocardial sarcoidosis (non-caseating granulomas) of the heart, lung, lymph nodes, and liver;
2. The right heart ventricle revealed lymphocytic infiltrates and noncaseating granulomas that are confluent, with dense fibrosis between the granulomas. There is also some nodule involvement of the papillary muscles and interventricular septum (all findings consistent with sarcoidosis involving the heart);
3. Cardiomegaly (an enlarged heart) weighing 640 grams (normal < 400 grams);
4. No atherosclerotic disease of the coronary arteries.

The final autopsy report listed “Myocardial Sarcoidosis” as the cause of death.

Ten years prior, the deceased had a FD pre-placement medical evaluation which included a physical examination, a chest X-ray (CXR), a lung function test (spirometry), and a graded exercise stress test, all of which were normal. He was subsequently approved for duty. In November 1995, the victim had an unremarkable physical examination conducted by his primary care physician. In March 2000 the Fire Fighter returned to his primary care physician for another scheduled general physical examination which, again, was unremarkable. No other examinations were conducted on the Fire Fighter. The Fire Department does utilize a contract physician to conduct medical screenings (medical questionnaire but no spirometry or physical examination) as part of the self contained breathing apparatus (SCBA) usage program and the victim always passed successfully.

**DESCRIPTION OF THE FIRE
DEPARTMENT**

At the time of the NIOSH investigation, the Fire Department was comprised of 108 uniformed personnel and served a population of 62,000 residents, in a geographic area of 21.7 square miles. There are 5 fire stations where fire fighters work the following tour of duty: 0700-1700 or 1700-0700 for three days on-duty and are then off-duty for three days. Each engine company is staffed with an officer and three fire fighters. Each Quint company is staffed with an officer and three fire fighters. Throughout the day, the victim did not report or show any signs of discomfort, pain, or distress. The victim did not make any responses that shift, which was the first day of his three day rotation.

In 2001, the Department responded to 4,408 total calls: 1517 emergency medical calls, and 138 structure fires, with 11 working fires requiring attack lines, and 2,753 other calls (false calls, good intent calls overpressure/rupture calls, etc.). The emergency medical service is provided by private companies.

Training. The Fire Department provides all new fire fighters with the basic 8-week training to become certified to the National Fire Protection Association (NFPA) Fire Fighter I level. All are State-certified First Responders and are certified in CPR, defibrillator, and hazardous materials operations. The Department also conducts monthly training. The victim had ten years of fire fighting experience and was a NFPA-certified Fire Fighter I and a HAZMAT operations level technician.

Pre-placement Evaluations. The Department requires a pre-placement medical evaluation for all new hires, regardless of age. Components of this evaluation include

- A complete medical history
- Height, weight, and vital signs
- Physical examination



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- Blood Tests: Complete blood count (CBC), SMA 6, Liver Function tests, Lipid test, and Hepatitis B Titer Testing
- Urinalysis and Urine Drug screen
- CXR
- Electrocardiogram (EKG) by a cardiologist
- Exercise Stress Test by a cardiologist
- Pulmonary function test to include spirometry
- Audiogram
- Vision Test
- Lumbar-Sacral Spine X-ray

These evaluations are performed by a City contract physician, who makes a decision regarding medical clearance for fire fighting duties. Notification of any condition requiring modification or restriction at the work site is relayed to the City. Otherwise, the results of the medical examination are kept confidential by the contract physician and only the clearance status is reported to the Fire Department. New hires are also required to complete a physical agility test. This is a timed performance evaluation of typical fire fighting duties.

Periodic Evaluations.

HAZMAT technician level team personnel and individuals newly promoted to driver/operator are required to undergo a physical examination which includes

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Urinalysis
- Electrocardiogram (EKG) by a cardiologist
- Pulmonary function test to include spirometry
- Vision Test

However, a heavy metal blood screen is included for the HAZMAT team personnel.

These evaluations are also performed by the City contract physician who makes a decision regarding

medical clearance for fire fighting duties. If an employee is injured at work, he/she must be cleared for “return to work” by their primary care physician only. Most stations have exercise (strength and aerobic) equipment, purchased by the Department and the fire fighters. There is a mandatory fitness program but enforcement is nonexistent. The victim exercised frequently at home and at work and would regularly achieve an estimated Metabolic Equivalents (METs) level of 8 (extreme or peak exertion).

DISCUSSION

Sarcoidosis is a chronic, multi system disorder of unknown etiology (cause). It is characterized by the accumulation of inflammatory cells (T-helper lymphocytes and mononuclear phagocytes), followed by the formation of “noncaseating epithelioid granulomas,” (a term used by pathologists to describe the microscopic lesions), which can disrupt the normal tissue structure and function. The lung and lymph nodes are most commonly involved, but other organs can be affected including the skin, eyes, and heart. The clinical course of the disease is variable, ranging from acute onset, typically involving respiratory symptoms, to a chronic disease with symptoms that wax and wane over many years. As in the case of this Fire Fighter, some cases are completely asymptomatic and are only identified by chest X-ray.¹

The characteristic histologic (microscopic) lesions are typically found on lung biopsy. Although the histologic findings are required for a definitive diagnosis, noncaseating granulomas are not specific to Sarcoidosis and are found in a number of other diseases, including infections and malignancies. Thus, the diagnosis of Sarcoidosis is made by a combination of clinical, radiographic (X-rays), and histologic (microscopic) findings.¹

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The incidence and prevalence of sarcoidosis in the United States vary by race, gender, and age.²⁻⁸ The study which best adjusted for these demographic variables, was published by Rybicki et al. in 1997.² They conducted a longitudinal cohort study of newly diagnosed cases between 1990 and 1994 among members of a health maintenance organization in Detroit, Michigan. They found the following demographic variables as being independent risk factors for sarcoidosis:

- African-American race [relative risk (RR)=3.8];
- Female gender (RR=1.3);
- Ages 30-39 years (RR=1.7);
- Ages 40-49 years (RR=1.4)

As mentioned earlier, the cause of sarcoidosis is unknown, but environmental, infectious, and genetic risk factors have been hypothesized as etiologic agents. Fire fighters have been reported to have relatively high rates (discussed below), presumably due to their exposure to a variety of toxins in smoke or exposure to communicable diseases while performing their duties as first responders.^{3,9} The first report, published by Kern et. al. in 1993, investigated a cluster of three cases of sarcoidosis among ten Caucasian fire fighters who trained together as apprentices in 1979.⁹ A subsequent case finding questionnaire survey of 1,282 active and retired male fire fighters and police officers, followed by a medical evaluation, found one additional case for an overall point prevalence of 312 per 100,000. This point prevalence is higher than the general population point prevalence of 17 per 100,000 for Caucasians and 64 per 100,000 in African-Americans collected 30 years earlier.⁸

Prezant and colleagues conducted a longitudinal cohort study of newly diagnosed cases between 1985 and 1998 among New York City (NYC) fire fighters.³ Using chest X-rays taken during periodic wellness medical evaluations and requiring cases to be biopsy-proven, Prezant et al. found an annual

incident rate of 12.9 cases per 100,000 among Caucasian fire fighters. This rate is higher than the incident rate of age-adjusted biopsy proven cases of sarcoidosis in Caucasian males (5.9 per 100,000 per year) or of age-adjusted biopsy and clinical cases of sarcoidosis in Caucasian males (9.6 per 100,000 per year).² Unfortunately, this finding could be due to the following differences between the two studies: case ascertainment (active versus passive), case definitions (biopsy versus clinical), and age distributions (not age-adjusted versus age-adjusted). Looking specifically at the age distribution, Rybicki et al. found the incidence rates among Caucasian males to be highest among the 40-49 years old group (24 per 100,000 per year), followed by the 30-39 year old group (22 per 100,000 per years) and the 20-29 year old group (12 per 100,000 per year).² Using these age specific rates as the comparison group (typical ages of active duty fire fighters), the incident rates of NYC fire fighters do not appear elevated.

Among patients diagnosed with sarcoidosis, granulomatous lesions in the heart have been found in approximately 15% of patients.¹⁰⁻¹² Cardiac involvement is clinically recognized in about 5% of known sarcoid patients, and subclinical (identified at autopsy) in the other 10%. Both groups are at increased risk of sudden death, conduction abnormalities (bundle branch blocks, partial and complete heart block), arrhythmias (ventricular and supra ventricular), and congestive cardiomyopathy.¹⁰⁻¹⁹ In fact, as in the case of this Fire Fighter, sudden cardiac death is the most common first manifestation of cardiac sarcoidosis.¹²⁻¹⁵

To ensure that candidates and current fire fighters are medically capable of performing their required tasks and to reduce the risk of occupational injuries and illnesses, the National Fire Protection Association (NFPA) has developed guidelines entitled "Medical



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Requirements for Fire Fighters and Information for Fire Department Physicians,” otherwise known as NFPA 1582.²⁰ This guideline, updated in 2000, specifies minimum medical requirements for candidates and current fire fighters. Although sarcoidosis is not specifically mentioned, the guideline does address the effect sarcoidosis can have on the various organs (e.g. lungs, heart). Given the victim’s fitness level, lack of symptoms, and normal PFTs, the decision to clear the victim for fire fighting duties in 1992 was consistent with NFPA guidelines.

Annual medical evaluations are also recommended by NFPA 1582 and the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.²¹ Perhaps, if this FD required and the local union supported annual medical evaluations, and the FD physician detected an abnormality through the examination, further testing may have led to the diagnosis of sarcoidosis, and probable treatment with corticosteroids. It is possible that this could have prevented the victim’s sudden cardiac death.

RECOMMENDATIONS AND DISCUSSION

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 sudden cardiac arrest and or death among fire fighters. However, it is unclear if any of these recommendations would have prevented this Fire Fighter’s death. In addition, these recommendations have not been evaluated by NIOSH, but represent research presented in the literature or of consensus votes of Technical Committees of the National Fire Protection Association or labor/management groups within the fire service. This strategy consists of: 1) minimizing physical stress on fire fighters; 2) screening to identify and subsequently rehabilitate high risk individuals; and 3) encouraging increased individual physical

capacity. Issues relevant to this Fire Department (FD) include:

Recommendation #1: Provide annual medical evaluations to fire fighters to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others. The Department and Union should negotiate the content and frequency to be consistent with NFPA 1582.

Guidance regarding the content and frequency of periodic medical evaluations for fire fighters can be found in NFPA 1582, Medical Requirements for Fire Fighters²⁰ and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.²¹

Applying the above NFPA standard involves legal and economic repercussions and must be carried out in a nondiscriminatory manner. Appendix D of NFPA 1582 provides guidance for Fire Department Administrators regarding legal considerations in applying the standard.

Economic repercussions go beyond the costs of administering the medical program. Department administrators, unions, and fire fighters must also deal with the personal and economic costs of the medical testing results. NFPA 1500 addresses these issues in Chapter 8-7.1 and 8-7.2.²² The success of medical programs may hinge on protecting the affected fire fighter. The department should provide alternate duty positions for fire fighters in rehabilitation programs, if possible. If the fire fighter is not medically qualified to return to duty after repeat testing, supportive and/or compensated alternatives for the fire fighter should be pursued by the Department. Other than for the statement regarding duty status, these medical records should be kept confidential.

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Recommendation #2: Evaluate abnormal findings uncovered during annual medical evaluations. If this follow-up medical evaluation is conducted by the fire fighter's personal physician, results should be reviewed by a fire department physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582.

NFPA 1582 requires all evaluations completed by outside physicians be reviewed and approved by the Fire Department physician (Chapter 2-2.5.1 and Chapter 2-4.1.1).²⁰

Recommendation #3: Ensure that fire fighters are cleared for duty, following an injury/illness, by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582.

Physicians providing input regarding medical clearance for fire-fighting duties should be knowledgeable about the physical demands of fire fighting and familiar with the consensus guidelines published by *NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians*. To ensure physicians are aware of these guidelines, we recommend that the Fire Department provide the contract and private physicians with a copy of NFPA 1582. In addition, we recommend the fire department not automatically accept the opinion of the employee's private physician regarding return to work. This decision requires knowledge not only of the employee's medical condition, but also of the employee's job duties. Frequently, private physicians are not familiar with an employee's job duties, or guidance documents, such as NFPA 1582. Also, we recommend that all return-to-work clearances be reviewed by the department contracted physician. Thus, the final decision regarding medical clearance for return to work lies with the department with input

from many sources including the employee's private physician.

Recommendation #4: Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by phasing in a mandatory wellness/fitness program negotiated between the Fire Department and the Union.

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.²² In 1997, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) joined in 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.²¹ The Fire Department should review these materials to identify applicable elements. Other large-city negotiated programs can also be reviewed as potential models. Some enforcement mechanism must be negotiated in order for effectiveness to be achieved.

Recommendation #5: Discontinue automatic pre-placement screening x-rays of the Lumbar Spine.

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 scheduling of periodic medical examinations for fire fighters can be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters, and in the report of the International Association of Fire



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Fighters/International Association of Fire Chiefs wellness/fitness initiative. The department is not legally required to follow any of these standards. Nonetheless, we recommend the City and Union negotiate the content and frequency to be consistent with the above guidelines.

Pre-placement screening radiography (X-rays) of the low back, lack clinical and predictive value, while exposing the candidate to unnecessary radiation.²⁴ This screening test represent an unnecessary expense for the department.²⁴

Recommendation #6: Discontinue pre-employment/pre-placement exercise stress test for applicants under the age of 35.

According to NFPA 1582, the pre-employment/pre-placement exercise stress tests are not necessary for applicants under the age of 35. A report from the American College of Cardiology/American Heart Association Task Force on Guidelines state, "Persons whose occupations may affect public safety (airline pilots, truck or bus drivers, railroad engineers, fire fighters, and law enforcement officers) often undergo periodic exercise testing for assessment of exercise capacity and prognostic evaluation of possible coronary disease. There are insufficient data to justify this approach,...."²⁵ This screening test also represents an unnecessary expense for the department.

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