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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* *July 1, 2003*

## Fire Fighter Dies After Leaving Fire Station - Pennsylvania

### SUMMARY

On April 27, 2002, a 56 year-old male career Fire Fighter/Driver began feeling ill at the start of his shift and left the fire station to go home. Within one hour of arriving at home, he had a witnessed collapse. Approximately 57 minutes later, despite cardiopulmonary resuscitation (CPR) and advanced life support (ALS) administered on-scene and at the hospital, the victim died. The Death Certificate, completed by the Deputy Coroner, listed "sudden cardiac death" as the immediate cause of death. An autopsy was not conducted.

The following recommendations address some general health and safety issues. This list includes some measures that have been recommended by other agencies to assist in the understanding of stressors among fire fighters. These selected recommendations have not been evaluated by National Institute for Occupational Safety and Health (NIOSH), but represent published research, or consensus votes of technical committees of the National Fire Protection Association (NFPA) or fire service labor/management groups.

- ***Use a secondary (technological) test to confirm placement of the endotracheal tube (ET) in the trachea.***
- ***Provide fire fighters with medical evaluations and clearance to wear SCBA.***
- ***Perform an autopsy on all on-duty fire fighter fatalities.***

### INTRODUCTION & METHODS

On April 27, 2002, a 56-year-old male Fire Fighter/Driver lost consciousness at home after becoming ill on duty. Despite CPR and ALS administered by the victim's wife, the ambulance crew and personnel in the hospital's emergency department (ED), the victim died. NIOSH was notified of this fatality on April 30, 2002, by the United States Fire Administration. On May 20, 2002, NIOSH contacted the affected Fire Department (FD) to initiate the investigation. On July 8, 2002, a Safety and Occupational Health Specialist and an Occupational Nurse Practitioner from the NIOSH Fire Fighter Fatality Investigation Team traveled to Pennsylvania to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed:

- The Chief of the affected Fire Department
- The FD Emergency Medical Service (EMS) Officer
- Crew members on duty with the victim
- The local President of the International Association of Fire Fighters
- The victim's wife

During the site-visit NIOSH personnel reviewed:

- FD policies and operating guidelines
- FD training records

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**

***Fire Fighter Dies After Leaving Fire Station - Pennsylvania***

- The FD annual report for 2001
- EMS (ambulance) incident reports
- Hospital ED report
- FD physical examination protocols
- Death certificate
- Past medical records of the deceased

## INVESTIGATIVE RESULTS

*Incident*. On April 27, 2002, the victim reported for work at South Central Station, which housed Engine 6, Tower 1, and Water Rescue 1, at approximately 0645 hours. Crew members often arrived for duty prior to actual shift change (0730 hours) to provide early relief in case of an emergency dispatch. The victim, the Driver of Engine 6, became nauseated upon arrival at the station. Other crew members arriving for duty at approximately 0700 hours noted his pale and sweaty appearance. They advised him to go to the hospital, but he refused. At approximately 0715 hours, he left the fire station to go home. A crew member called the victim's wife and advised her of the situation. The victim arrived at his residence at approximately 0735 hours and advised his wife that he had epigastric pain for which he took an antacid and went to bed. His wife stayed by his bedside. Approximately an hour later, his wife asked him if he was having pain but he did not want to answer her. After asking him several times if was having pain and receiving no answer, his wife called 911 to request an ambulance. 911 dispatched a volunteer Rescue unit and a paramedic unit (MP 35) for chest pains at 0833 hours. Shortly after calling 911, the victim collapsed face down onto the floor. His wife moved him onto his back and found him to have a pulse and shallow breathing, but was unresponsive.

A volunteer emergency medical technician (EMT), a member of the Rescue company and who lived nearby, arrived on scene at 0835 hours, finding the victim now to be unresponsive, pulseless, and with no respirations. CPR (chest compressions and assisted ventilations via mouth-to-mouth) was initiated. The Rescue unit and MP 35 arrived on-scene at 0838 hours and 0842 hours respectively. CPR followed by advanced life support (ALS) measures were initiated. At 0843 hours a cardiac monitor revealed ventricular fibrillation (a heart rhythm not compatible with life) and one shock (defibrillation) was administered. The victim's heart rhythm reverted to asystole (no heart beat). The victim was intubated and an intravenous (IV) line was placed allowing the administration of ALS medications. The victim was then placed onto a long backboard and his heart rhythm was re-assessed showing ventricular fibrillation (V. Fib.) and a second shock was administered. His heart rhythm again reverted to asystole and CPR continued. He was transferred onto a cot and loaded into the ambulance where the endotracheal tube (ET) placement was checked. The tube was found to be out of placement, an oral airway was inserted and ventilations continued for three minutes. The victim was re-intubated and positive breath sounds were verified by the EMT/Paramedic. The heart monitor again revealed V. Fib. and a third shock was administered, with the heart reverting again to asystole, which persisted for the duration of the transport. MP 35 departed the scene at 0907 hours enroute to the hospital, arriving at the ED at 0917 hours.

After the victim was transferred to the ED and the patient history report given, he was examined by the ED Physician. The following conditions were noted: no spontaneous respirations, no pulses without CPR, no obtainable BP, no heart sound audible, a cardiac monitor revealed asystole, central and peripheral cyanosis with pallor, emesis, distended abdomen, a nonfunctional IV line, and ET tube placement in the esophagus. An IV was placed in the right forearm. The ED physician was informed by EMS that pre-hospital ALS lasted 30-35 minutes. Because of this long period with no spontaneous pulse or respirations

no attempt was made to re-intubate. At 0930 hours the victim was pronounced dead by the attending physician, and CPR/ALS was discontinued.

*Medical Findings*. The Death Certificate listed "sudden cardiac death" as the cause of death. No autopsy was performed nor carboxyhemoglobin level checked (due to onset of symptoms soon after arriving at work).

Medical records indicated the Fire Fighter had the following major risk factors for coronary artery disease (CAD): male, age over 45, physical inactivity and mild obesity/overweight (BMI 29 kg/m$^2$)[1]. In his FD pre-placement/Fireman's Relief insurance physical examination (PE) in October 1968, the victim was diagnosed with a congenital anomaly of the aorta without heart disease (a configuration of a right sided aorta). The Fire Fighter and the FD were informed that while there was no contraindication to employment, he was not recommended as a "good insurance risk." The only further mention of the anomaly was in a January 1992 preoperative radiology consultation for a septoplasty which states that the right heart border was slightly prominent, which the Radiologist related to a mild rotation of the heart.

Recent electrocardiograms (ECG) in March and November of 1998 were abnormal (T- wave depressions and inferior Q-waves suggestive of myocardial ischemia). In October 1998 a complete PE conducted by his personal Physician revealed obesity class I (BMI 30.6 kg/m2) and hyperlipidemia, which was treated with dietary restrictions and a prescription medication. No other cardiovascular problems were identified in further primary care visits.

According to his family, co-workers, and crew members, the victim had no complaints of chest pains, shortness of breath or any other heart-related illness. During the two weeks prior to the incident, the victim did not report any symptoms suggestive of angina or heart problems to his family or co-workers.

## DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the career Fire Department consisted of 175 uniformed career personnel and served a population of approximately 104,000 residents in a geographic area of 20 square miles. There are six fire stations. Fire fighters work the following schedule: 24-hours on-duty, 72-hours off-duty, from 0730 hours to 0730 hours.

In 2001, the Department responded to 4,253 calls: 1,234 EMS calls, 614 motor vehicle accidents, 382 investigations, 378 false alarms, 293 rubbish/trash fires, 208 cooking calls, 187 alarm malfunctions, 172 accidental alarms, 164 other calls, 159 structure fires, 112 electrical calls, 92 vehicle fires, 90 aiding persons calls, 85 carbon monoxide calls, 73 grass/field fires, nine wash downs, and one hazardous materials call.

*Training*. The Fire Department requires all new career fire fighter applicants to pass a background check and a physical examination. The newly hired fire fighter is then sent to the Fire Academy for eight weeks to become certified as a Fire Fighter and an EMT. During the academy, the recruits must pass the candidate physical ability test (CPAT),[2] a component of the IAFF/IAFC wellness/fitness initiative.[3] Recurrent training occurs on each shift.

There is no State minimum requirement for fire fighter certification, however there is for hazardous materials response. There is also no State requirement for fire fighter recertification. All fire fighter certifications are voluntary. EMT/Paramedics recertify every 3 years (State requirement) and hazardous materials awareness level and operations level recertify annually. The victim was certified as a Fire Fighter

II, Driver/Operator, EMT, and Hazardous Materials Operations level, and had 36 years of fire fighting experience (33 years career and 3 years volunteer).

*Preplacement Evaluations.* The FD requires a preplacement medical evaluation for all new hires, regardless of age. The components of this evaluation are listed below:

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Blood tests: chemical profile to include liver profile, complete blood count with differential (CBC), lipid profile
- Urine tests: urinalysis, drug screen
- Spirometry
- Resting (ECG)
- Chest X-ray
- Audiogram
- Vision test

These evaluations are performed by a local medical clinic under contract with the City. Once this evaluation is complete, a decision regarding medical clearance for fire fighting duties is made by the examining physician and forwarded to the FD.

The FD currently requires all career fire fighter candidates to complete a timed performance evaluation of typical fire fighting duties (CPAT). Medical clearance is required prior to the CPAT evaluation.

*Periodic Evaluations.* Beginning in September of 2001, medical evaluations were phased in by this FD. The victim was scheduled for his first mandatory evaluation within the next month after his death. These mandatory yearly medical evaluations consist of:

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Blood tests: chemical profile to include liver profile, complete blood count with differential (CBC), lipid profile
- Urine tests: urinalysis, drug screen
- Spirometry
- Resting electrocardiogram (ECG)
- Stress electrocardiogram (ECG)
- Audiogram
- Vision test

These evaluations are performed by a local medical clinic under contract with the City. Once this evaluation is complete, a decision regarding medical clearance for fire fighting duties is made by the examining physician and forwarded to the FD.

If an employee is injured at work, he/she must be cleared for "return to work" by the contract physician. In addition, if a fire fighter has a non-occupational injury or medical condition, the employee must be cleared for "return-to-work" by the private physician.

A mandatory fitness program was recently initiated just prior to the victim's death. But, the patient did not exercise frequently either at home or work. All fire stations have either strength or aerobic fitness equipment and soon will have both types. Time was provided during the shift in which the fire personnel could exercise.

## DISCUSSION

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.[4] Risk factors for its development include age over 45, male gender, family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, obesity/overweight, physical inactivity, and diabetes.[5,6] The victim had four of these risk factors (male gender, age over 45, mild obesity/overweight,

and physical inactivity). By all accounts, the victim never reported symptoms of angina (e.g., chest pain on exertion), or congestive heart failure (e.g., shortness of breath on exertion, swollen ankles). Unfortunately, sudden cardiac death is often the first overt manifestation of ischemic heart disease.[7-9]

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.[10] However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.[11] Heart attacks typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply.[12] This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. Since an autopsy was not performed, it cannot be determined if a thrombus was present. Due to the nature of the 911 call (chest pains), it is probable the victim had a heart attack. The term "probable" is used because autopsy findings (thrombus formation), blood tests (cardiac isoenzymes), or ECG findings are required to "confirm" a heart attack (myocardial infarction). No autopsy was performed, blood tests would not have been positive yet, and the victim had no heart beat to show the characteristic findings of a heart attack on his ECG.

To reduce the risk of sudden cardiac arrest, heart attacks and other medical causes of incapacitation among fire fighters, the NFPA has developed the NFPA 1582 guideline entitled "Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians."[13] NFPA 1582 recommends a yearly physical evaluation to include a medical and occupational history, height, weight, and blood pressure.[13] NFPA 1582 recommends a comprehensive physical examination to include vision testing, audiometry, pulmonary function testing, a complete blood count, urinalysis, and biochemical (blood) test battery be conducted on a periodic basis according to the age of the fire fighter (less than 30: every 3 years; 30-39: every 2 years; over 40 years: every year).

NFPA 1582 also recommends fire fighters over the age of 35 with risk factors for CAD be screened for obstructive CAD by an Exercise Stress Test (EST).[13] Unfortunately, the EST has problems with both false negatives (inadequate sensitivity) and false positives (inadequate specificity), particularly for asymptomatic individuals (individuals without symptoms suggestive of angina), young men, and women.[14,15] This has led other expert groups to **not** recommend EST for asymptomatic individuals without risk factors for CAD.[16,17]

When these asymptomatic individuals **have** risk factors for CAD, however, recommendations vary by organization. The American College of Cardiology/American Heart Association (ACC/AHA) identifies two groups for EST: 1) men over the age of 40 with a history of cardiac disease (as a screening test prior to beginning a strenuous exercise program), and 2) men over age 40 with one or more risk factors.[16] They define five risk factors for CAD: hypercholesterolemia (total cholesterol > 240 mg/dL), hypertension (systolic >140 mm Hg or diastolic > 90 mm Hg), smoking, diabetes, and family history of premature CAD (cardiac event in 1st degree relative < 60 years old).[16] 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).[17]

These recommendations change for individuals who might endanger public safety if an acute episode were experienced, or those who require high cardiovascular performance such as police and fire

fighters. The NFPA recommends fire fighters without CAD risk factors get their first EST at age 40; for those with one or more CAD risk factors, at age 35.[13] NFPA considers CAD risk factors to be family history of premature (less than age 55) cardiac event, hypertension, diabetes mellitus, cigarette smoking, and hypercholesterolemia (total cholesterol greater than 240 or HDL cholesterol less than 35).[13] The EST should then be performed on a periodic basis, at least once every two years.[13] The ACC/AHA indicates that there is insufficient data to justify periodic EST in people involved in public safety, however, as mentioned previously, they recommend that men over age 40 with a history of cardiac disease be screened before beginning a strenuous exercise program.[16] Fire suppression activities involve strenuous physical activity; therefore, the ACC/AHA seem to be making a distinction between those already engaged in strenuous physical activity (conditioning), and those **beginning** a strenuous exercise program. The USPSTF indicates that there is insufficient evidence to recommend screening middle age and older men or women in the general population, however, "screening individuals in certain occupations (pilots, truck drivers, etc) can be recommended on other grounds, including the possible benefits to public safety."[17]

Since the victim was over 40 years old, according to NFPA 1582, he should have received an EST which was scheduled within the month. If an EST would have been performed, it is possible his cardiac condition would have been identified and he could have been referred for further evaluation and treatment.

During the resuscitation effort, the ED physician reported the ET was placed in the victim's esophagus, not the trachea. Exactly when the ET became dislodged is unknown. It is possible that the ET shifted during movement from the ambulance to the ED. Previously, the EMS Service reported the ET had slipped while transporting the patient from the bedroom to the ambulance. Primary confirmation (5-point auscultation: left and right anterior chest, left and right midaxillary, and over the stomach) of placement was validated after every move and re-intubation.

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.[18] The current recommended guidelines were followed, namely Cricoid pressure by a second rescuer followed by the actual intubation. Once this is accomplished, primary confirmation of the endotracheal tube is needed. These recommendations now include secondary confirmation which can be either an end-tidal $CO_2$ detector or an esophageal detector device. After both primary and secondary confirmations have been verified, then Cricoid pressure can be released .[18]

## 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: Use a secondary (technological) test to confirm placement of the endotracheal tube (ET) in the trachea.***

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 which suggest that EMS personnel confirm ET placement by primary confirmation (physical examination) and secondary confirmation (technological test). Secondary confirmation consists of using one of several commercial devices including end-tidal $CO_2$ detectors or esophageal detector devices for the secondary confirmation.[18]

***Recommendation #2: Provide fire fighters with medical evaluations and clearance to wear SCBA.***

The Fire Department is commended for implementing NFPA 1582 standards for both preplacement and periodic medical evaluations. Pennsylvania is not an OSHA State-plan State, therefore, public sector employers are not required to comply with OSHA standards. However, OSHA's Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employees using respiratory protection.[19] These clearance evaluations are required for private industry employees and public employees in states operating OSHA-approved State plans. Therefore, we recommend following this standard, and a copy of the OSHA medical checklist has been provided to the Fire Department. The OSHA standard can easily be met by using the NFPA 1582 standard screening program to fulfill the medical evaluations. Given the extensive PE recently instituted in this FD, this should not involve any additional financial burden.

***Recommendation #3: Perform an autopsy on all on-duty fire fighter fatalities.***

In 1995, the United States Fire Administration (USFA) published the *Firefighter Autopsy Protocol*.[20] This publication hopes to provide "a more thorough documentation of the causes of firefighter deaths for three purposes:

(a.) to advance the analysis of the causes of firefighter deaths to aid in the development of improved firefighter health and safety equipment, procedures, and standards;

(b.) to help determine eligibility for death benefits under the Federal government's Public Safety Officer Benefits Program, as well as state and local programs; and

(c.) to address an increasing interest in the study of deaths that could be related to occupational illnesses among firefighters, both active and retired."

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