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43

NIOSH
Fire Fighter Fatality Investigation and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation *July 17, 2003*

Fire Fighter Dies After Collapse at Apartment Building Fire - Kentucky

SUMMARY

On October 9, 2002, a 49-year-old male career Captain (the deceased) responded to a fire in a two-story apartment building. On scene, acting as Incident Commander (IC), he was directing post-extinguishment ventilation when he collapsed. Crew members found him unresponsive, with no pulse, and no respirations. Cardiopulmonary resuscitation (CPR) was initiated immediately and continued until an ambulance arrived on-scene five minutes later. Despite CPR by crew members and advanced life support (ALS) administered by the ambulance crew and the hospital's emergency department, the victim suffered anoxic brain damage and died two days later. The death certificate, completed by the Cardiologist, listed "ventricular tachyarrhythmia" as the cause of death. No autopsy was performed.

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

- ***Conduct mandatory preplacement and periodic medical evaluations consistent with NFPA 1582 to determine a candidate's medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others. These should incorporate exercise stress testing (EST), depending on the fire fighter's age and coronary artery disease risk factors.***
- ***Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582 and the results of the exam are discussed with the fire fighter.***
- ***Designate a City employee to administer the pre-placement and annual medical evaluations and their outcomes.***
- ***Provide automated external defibrillators (AEDs) as part of the basic life support equipment for fire apparatus.***
- ***Perform an autopsy on all on-duty fire fighter fatalities.***
- ***Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.***

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 Collapse at Apartment Building Fire - Kentucky

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

- ***Provide adequate fire fighter staffing to ensure safe operating conditions.***

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

INTRODUCTION & METHODS

On October 9, 2002, a 49-year-old male fire fighter lost consciousness while directing fire scene operations at a fire in an apartment building. Despite CPR administered by crew members and ALS administered by the ambulance crew and the hospital's emergency department (ED), the victim suffered anoxic brain damage and died two days later. On October 21, 2002, NIOSH contacted the affected Fire Department (FD) to initiate the investigation. On November 12, 2002, a Safety and Occupational Health Specialist and an Occupational Nurse Practitioner from the NIOSH Fire Fighter Fatality Investigation Team traveled to Kentucky to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed the following:

- Fire Chief
- FD Assistant Chief
- FD Training Officer
- FD Crew members
- City Occupational Health Nurse
- Victim's spouse

During the site visit NIOSH personnel reviewed the Following:

- FD policies and operating guidelines
- FD training records
- Emergency medical service (EMS) ambulance incident report
- Hospital ED report
- Hospital in-patient treatment records
- Death certificate
- Past medical records of the deceased

INVESTIGATIVE RESULTS

Incident. On October 9, 2002, the Captain (the deceased) arrived at his fire station for duty at 0700 hours. Due to the absence of the Major, the Captain assumed shift commander responsibilities. At 0832 hours, the Fire Department was dispatched to a garage apartment fire. At 0834 hours, Engine F12, Engine F15, Engine F16, and Shift Commander F8 (the victim) responded. A total of 18 personnel responded, including the Fire Chief and Training Officer. Units arrived on-scene at 0837 hours. Engine F12 was assigned to fire attack, Engine F15 was assigned water supply, and Engine F16 was assigned "back-up engine" and to be available for search and rescue.

The structure involved was a two-story, concrete block structure, measuring 30-feet by 40-feet, with a garage at ground level and two apartments (end-to-end) on the second story. A stairway led from ground level to each of the two apartments. The occupants were not present at the time of the fire.

Fire fighters made entry into the burning (front) apartment to find fire in one bedroom. Utilizing a 1¾-inch hoseline, the fire was knocked down within two minutes (0842 hours). During the initial attack, before knock down occurred, the electric meters were pulled. The deceased climbed approximately five stairs toward the landing outside the burned apartment and directed crew members to perform ventilation. Crew members checked the rear apartment and found only a light smoke condition. After they exited the apartment and went to the Captain's location on the front stairs (0843 hours), he dropped his portable radio and collapsed.

Crew members carried the Captain down to ground level and found him to be unresponsive, not breathing, and pulseless. Crew members notified dispatch at 0844 hours and requested an ambulance. CPR, consisting of chest compressions and assisted ventilations via bag-valve-mask, was begun immediately. EMS Unit 2 arrived on-scene at 0849 hours and, after identifying ventricular fibrillation (VF) on the cardiac monitor, initiated ALS. After shocks (defibrillation) were delivered, the Captain was intubated and intravenous (IV) access gained. Correct intubation was verified by bilateral breath sounds. Attempts at defibrillation were continued, alternated with ALS medications(total of nine shocks were delivered). The Captain's heart rhythm eventually converted to ventricular tachycardia (VT), and he was transported via ambulance to the hospital's (ED), arriving at 0910 hours.

Upon arrival in the ED, his initial heart rhythm was VT, which was defibrillated to normal sinus rhythm after the administration of additional medications. Due to the anterior wall ST segment elevation on his electrocardiogram (EKG), the Captain underwent an emergent coronary angiogram which failed to identify an obstructive coronary artery lesion. This was an unexpected finding given his EKG and subsequently elevated cardiac enzymes [Creatine Kinase (CK) 19242 Units per Liter (U/L), normal 55-170 U/L; CK-MB 118.9 anograms per milliliter (ng/ml), normal 0.0-5.0 ng/ml; Troponin-I 98.8 ng/ml, normal 0.0-1.5 ng/ml].

A blood specimen obtained at 1023 hours in the ED revealed a 0.3% carboxyhemoglobin (COHb) level. With 98 minutes of pre-mortem oxygen administration and a COHb half-life of 80 minutes at 100% oxygen,[1] the Captain's COHb level when he collapsed would still have been less than 1%, which is not indicative of significant carbon monoxide (CO) exposure. Multiple drug screens and an alcohol screen were also negative.

The Captain was transferred to the Intensive Care Unit where multiple episodes of ventricular fibrillation responded to anti-arrhythmic medication and defibrillation. The Captain never regained consciousness, and neurological evaluation indicated brain stem damage from anoxic encephalopathy (inadequate oxygen to the brain), with a negligible prospect of recovery. Two days later, his family decided to discontinue artificial life support, and he died at 1650 hours on October 11. The death certificate, completed by the Cardiologist on staff who oversaw the care of the deceased, listed "ventricular tachyarrhythmia" as the immediate cause of death. No autopsy was performed.

Medical History.

Prior to 2000 the Captain had no known coronary artery disease (CAD), but had the following CAD risk factors: male gender, mild obesity, and smoking. He weighed 215 pounds and was 70 inches tall, giving him a body mass index (BMI) of 30.8 kg/m^2 (A BMI above 30 kg/m^2 indicates obesity.)[2]

In September 2000 the Captain experienced chest pains and after evaluation in a local ED, underwent a cardiac catheterization. After discovering a 100% occlusion of the right coronary artery, a stent was placed (without incident) that fully opened the occlusion. Due to the stent, the Captain had quarterly checkups with his cardiologist.

His most recent cardiac catheterization performed in November 2001 revealed:

- Moderate calcification of the coronary arteries on fluoroscopy
- Proximal LAD 20% narrowing
- Right coronary artery large dominant with ectasia, mild areas of narrowing (none greater than 30%), PTCA stent site patent
- Inferior wall markedly hypokinetic with a mildly dilated left ventricle chamber

Fire Fighter Dies After Collapse at Apartment Building Fire - Kentucky

His most recent EST performed in April 2002, revealed an old myocardial infarction (MI otherwise known as a heart attack) [Reached stage three of the Bruce Protocol in nine minutes achieving a heart rate of 160 beats per minute (bpm) which was 93% of his maximum heart rate and with a performance of ten Metabolic Equivalents (METS)]. His most recent cardiologist examination was in August 2002. At that time, he was admitted to a telemetry unit at a regional hospital for atrial fibrillation (AF) following a recent episode of syncope (loss of consciousness). His work-up included a chest x-ray (borderline enlargement of the cardiac silhouette), an EKG (AF with premature ventricular complexes), an echocardiogram (slight left ventricular dilation, hypokinetic inter-ventricular septum, and mildly decreased ejection fraction) and cardiac enzymes (negative for acute MI). After discussion with the Cardiologist, the Captain opted for 5 milligrams (mg) of Coumadin instead of drug therapy (Digitalis, Diltiazem/Verapamil, or Esmolol) or cardioversion as a treatment for the AF. He was released later that day when no disarrhythmias were noted on subsequent EKG's or telemetry.

FD policy requires release from the primary care physician or treating physician for "return to work" following injury or illness. The Captains medical record did have releases for his 2000 MI/stent and his hospitalization in August 2002 for the AF/syncope. The FD was aware of the Captain's prior medical condition but, was probably unaware of the anticoagulation therapy.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the combination Fire Department consisted of 56 career fire fighters and 5 staff serving a resident population of 19,300 in a geographic area of 18.54 square miles. There are four fire stations. Fire Department engines in Station 1 are typically staffed with four fire fighters; Stations 2, 3, and 4 typically have three fire fighters per engine. The ladder truck, if needed, responds instead of one engine, utilizing the same crew. Fire fighters, including the deceased, worked the following schedule: 24 hours on duty, 24 hours off duty, from 0700 hours to 0700 hours for three tours, then are off duty for four days. The Captain was on the last day of his tour cycle.

In 2001, the Fire Department responded to 424 calls: 180 false alarms, 79 rescue/EMS calls, 70 structure fires, 30 wildland fires, 26 vehicle fires, 16 hazardous materials calls, 15 other hazardous condition calls, 6 mutual aid calls, and 2 other service calls.

Training. New career fire fighter applicants must complete an application and a Fire Fighter Civil Service Exam. Applicants are ranked by score. When a vacancy occurs, the potential candidate at the top of the hiring list must then pass a physical agility test, background checks, oral interviews, and a physical examination prior to being hired. Once hired, the fire fighter receives 400-hours training (in approximately eight weeks) to become certified as a Fire Fighter I and II. Additional in-service training includes orientation, drivers training, specialty training (i.e. confined space, HazMat, Extrication, etc.), blood borne pathogens, and OSHA training. The newly hired fire fighter does not respond as part of a crew until all the training is complete. The fire fighter is on probation for one year. Fire fighters receive recurrent training in their station or on training sites during each shift.

The State minimum standard for career fire fighter certification is the 400-hour Fire Fighter I and II program. The State also requires 100 hours of training annually for State incentive pay. Annual recertification is also required for hazardous-materials certification. The Captain was trained as a Fire Fighter I & II, Driver Operator, and Fire Service Instructor and he had 26 years of fire-fighting experience.

Preplacement Evaluations. The Fire Department requires a preplacement medical evaluation for all new hires. The components of this evaluation are listed below:

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Blood tests: Comprehensive metabolic panel
- complete blood count with differential (CBC)
- liver profile
- Urinalysis (microscopic)
- Spirometry
- Resting electrocardiogram (EKG)
- Chest x-ray
- Audiogram
- Vision test

These evaluations are performed by a 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 City Human Resources Department.

Annual medical evaluations and physical agility tests are not required by this FD. The Captain was required annually to be medically cleared for respirator use. If an employee has either an occupational/non-occupational injury or illness involving time away from work, he/she must be cleared for "return to work" by their private physician. Aerobic fitness and strength training equipment are available while on duty, but no mandatory programs are in place for usage. The Captain sanded and refinished hardwood floors as a second job, which his wife stated was quite strenuous. She estimated that he worked to a METS level of 6, more than 3 times a week for a minimum of 20 minutes each time. Other than the sanding of hardwood floors the victim did not exercise frequently, either at home or work. According to his wife, family members, and co-workers, the Captain did not express symptoms of chest pain, shortness of breath, or any other symptom indicative of a heart condition at any time preceding the incident.

DISCUSSION

Upon examination of the EKG changes, it is possible that the Captain's ventricular fibrillation could have been secondary to ischemia in the anterior wall distribution. Also, the elevated levels of enzymes in his blood stream (CK, CK-MB, and Troponin) indicated an acute myocardial infarction. Because no autopsy was performed, full identification of the cause of death are speculative. There are three ways to confirm an acute myocardial infarction, including: EKG changes, cardiac enzyme elevations, and or a thrombus in the coronary artery. The Captain did present with the first two.

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.[3] Risk factors for its development including increasing age, male gender, heredity, tobacco smoke, high blood cholesterol, high blood pressure, physical inactivity, obesity and overweight, and diabetes.[4] The victim had four of these risk factors: gender, tobacco smoking, obesity, and physical inactivity. However, he stopped smoking after being diagnosed with CAD in September 2000.

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.[5] However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.[6] 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.[6] This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. Blood clots, or thrombus formation, in coronary arteries is

initiated by disruption of atherosclerotic plaques. Certain characteristics of the plaques (size, composition of the cap and core, presence of a local inflammatory process) predispose the plaque to disruption.[7] Disruption then occurs from biomechanical and hemodynamic forces, such as increased blood pressure, increased heart rate, increased catecholamines, and shear forces, which occur during heavy exercise.[8]

Firefighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.[9] Firefighting 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 persist through the course of fire suppression activities.[10-12] Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.[13-17] While on-scene, the Captain did not engage in strenuous fire suppression nor did he enter the burning structure, as he was not wearing PPE. However, responding to the alarm and driving to the scene probably increased his heart rate and blood pressure, thereby increasing his cardiac oxygen demand, and possibly triggering his probable heart attack.

To reduce the risk of sudden cardiac arrest and heart attacks (as well as other medical conditions) 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."[18] NFPA 1582 recommends a yearly physical evaluation to include a medical history, height, weight, blood pressure, and visual acuity test.[18] NFPA 1582 recommends a thorough 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, not as a part of the requirements but for informational purposes only, fire fighters over the age of 35 with risk factors for CAD be screened for obstructive CAD by an EST.[18] In this case, within the past year, the victim had not only had an EST to screen for ischemic heart disease but also an echocardiogram and a cardiac catheterization. It is unclear if any further tests could have been done to prevent his death.

If the Captain had been examined by a physician familiar with NFPA 1582 he may have been precluded from duty as a firefighter. The Captain had five "Category B" medical conditions: AF, anticoagulant agent use, cardiac hypertrophy, CAD, and syncope. Considered separately, they are not prohibitive; however, when evaluated together, there is justification to not release him to full duty. NFPA 1582 states use of anticoagulant agents can be permitted if the anticoagulation is controlled within the therapeutic range of the prothrombin time for a minimum period of 1 month on a stable medical regimen without incidence.[18] The Captain was having his blood level checked weekly and was within therapeutic range over the last six weeks, but dosages were being adjusted in small increments without radical shifts in the blood/drug saturation levels; cardiac hypertrophy is conditionally accepted by NFPA 1582.[18] The Captain's cardiac enlargement (inter ventricular septum, posterior left ventricular wall, and right ventricular wall) could be preclusive if taken in context with his CAD, decreased ejection fraction, AF, and syncope.

EMS reported during the resuscitation efforts the patient was intubated by ACLS guidelines. Later, the ET tube placement was verified using bilateral breath sounds. The EMS personnel properly used

primary confirmation of ET tube placement by physical examination (auscultation of bilateral breath sounds). However, they did not proceed with secondary confirmation recommended by the American Heart Association Guidelines (end-tidal CO_2 detector).[31] Primary confirmation was later validated by the ED physician.

RECOMMENDATIONS

The following recommendations address health and safety generally. However, it is unclear if any of these recommendations could have prevented the sudden cardiac arrest and the subsequent death of this fire fighter. 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: Conduct mandatory preplacement and periodic medical evaluations consistent with NFPA 1582 to determine a candidate's medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others. These should incorporate exercise stress testing, depending on the fire fighter's age and coronary artery disease risk factors.

Guidance regarding the content of 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*[18] and in the report of the International Association of Fire Fighters/ International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.[19] The Department is not legally required to follow any of these standards. Nonetheless, we recommend that the Fire Department be consistent with the above guidelines.

In addition to providing guidance on the 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.[20]

Recommendation #2: Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582 and the results of the exam are discussed with the fire fighter.

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*.[18] 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. Lastly, we recommend that the results of the examination be discussed with the fire fighter.

Recommendation #3: Designate a City employee to administer the preplacement and annual medical evaluations and their outcomes.

This employee should maintain the confidentiality of the medical records. If this employee is a member of the FD and participating in the City's annual medical evaluation, a policy should prevent them from administering the program to themselves.

Recommendation #4: Provide automatic external defibrillators (AEDs) as part of the basic life support equipment for fire apparatus.

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 care for those injured.[21] Such injuries include cardiac arrest. Most of the sudden cardiac deaths in the United States result from ventricular fibrillation. 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.[22] AEDs have caused the cardiac arrest survivability rate to increase from 7 percent (CPR performed only) to 26 percent.[23] When defibrillation is provided within 5-7 minutes, the survival rate is as high as 49 percent.[23] To provide emergency medical care, adequate supplies and equipment should be available to treat bleeding, fractures, cardiac arrest, etc. Placing AEDs on fire apparatus, in addition to those defibrillators carried on ambulances, would allow the Fire Department to provide a greater level of emergency medical care to the public. Although the Fire Department does not have medical first responder responsibilities, fire fighters may find themselves in the position of having to provide CPR. The timely use of an automatic external defibrillator, even by minimally trained first responders, can increase the likelihood of survival following cardiac arrest.[24,25]

Recommendation #5: Perform an autopsy on all on-duty fire fighter fatalities.

In 1995, the United States Fire Administration (USFA) published the *Firefighter Autopsy Protocol*.[26] This publication hopes to provide "a more thorough documentation of the causes of firefighter deaths for three purposes:

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

Recommendation #6: Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.

NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, and *NFPA 1583, Standard on Health-Related Fitness Programs for Fire Fighters*, require a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.[20,27] 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.[19] The Fire Department should review these materials to identify applicable elements. Wellness programs have been shown to be cost effective, typically by reducing the number of work-related injuries and lost work days.[28,29]

Recommendation #7: Provide adequate fire fighter staffing to ensure safe operating conditions.

This finding did not contribute to this fatality, but was identified during the NIOSH investigation. Currently, the FD staffs its engines with three personnel and its ladders with one person. NFPA 1710 requires that "on-duty personnel be assigned to fire suppression shall be organized into company units and shall have appropriate apparatus and equipment assigned to such companies."[30] Those companies may respond with two apparatus, depending on the seating configuration of the apparatus to ensure four personnel arrive on-scene.[30] Personnel assigned to the initial arriving company shall have the capability to implement an initial rapid invention crew (IRIC),[30] which requires four personnel (two to enter the structure and two standing by outside). NFPA 1500 recommends that "members operating in hazardous areas at emergency incidents shall operate in teams of two or more."[20] Understaffing causes those members on-scene to work harder and for longer periods of time. Additionally, it requires the use of extra fire companies in order to meet the demand for manpower. According to NFPA 1710, Engine and Ladder Companies should be staffed with four personnel at a minimum.[30]

Recommendation #8: Use a secondary (technological) test to confirm placement of the ET tube in the trachea.

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.[31] These guidelines recommend Cricoid pressure by a second rescuer followed by the actual intubation. Placement is 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. After both primary and secondary confirmations have been performed, Cricoid pressure can then be released. In this incident, the Captain had bi-lateral breath sounds confirmed by auscultation, however secondary confirmation was not performed.

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INVESTIGATOR INFORMATION

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