



## **District Chief Dies of a Stroke After Serving as the Incident Commander at a Structure Fire - Tennessee**

### **SUMMARY**

On September 28, 1998, a 60-year-old male District Chief served as Incident Commander at a structure fire. After commanding fire scene operations for almost 3 hours, he complained of a headache and was noted to have an elevated blood pressure. The next day, the victim's wife found him unresponsive in their home. Subsequent medical evaluation and treatment revealed the victim had suffered a massive stroke, from which he died on September 30, 1998. The death certificate, completed by the attending physician, listed "intracerebral hemorrhage due to hypertension, essential" (otherwise known as a "stroke") as the immediate cause of death. No autopsy was performed.

The following recommendations address some general health and safety issues. While this list includes some preventive measures that have been recommended by other agencies, these measures would not have been able to prevent this District Chief's death due to a stroke. These selected recommendations have not been evaluated by NIOSH, but represent published research, consensus votes of technical committees of the National Fire Protection Association (NFPA), or fire service labor/management groups.

- ***Fire Fighters should have mandatory annual medical evaluations and periodic physical examinations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.***
- ***Exercise stress tests should be incorporated into the Fire Department's medical evaluation program.***

- ***Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.***
- ***Perform an autopsy on all on-duty fire fighter fatalities.***
- ***Provide adequate fire fighter staffing to ensure safe operating conditions.***

### **INTRODUCTION AND METHODS**

On September 28, 1998, a 60-year-old male District Chief complained of a headache and was noted to have an elevated blood pressure after commanding operations at a structure fire. The next day he suffered a stroke and died on September 30, 1998. On May 31, 2000, NIOSH contacted the affected Fire Department to initiate the investigation. On July 19, 2000, a Safety and Occupational Health Specialist and a physician from the NIOSH Fire Fighter Fatality Investigation Team traveled to Tennessee to conduct an onsite investigation of the incident.

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. 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:

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During the investigation NIOSH personnel interviewed:

- ▶ The Deputy Chief for Suppression;
- ▶ The Deputy Chief for Training;
- ▶ Administrative Services Chief;
- ▶ Union representative;
- ▶ Crew members on duty with the victim;
- ▶ The victim's wife.

During the site-visit, NIOSH personnel reviewed:

- ▶ Fire Department policies and operating guidelines;
- ▶ Fire Department training records;
- ▶ The Fire Department annual report for 1999;
- ▶ Fire Department physical examination protocols;
- ▶ Ambulance report;
- ▶ Hospital records;
- ▶ Past medical records of the deceased from his private physician.

### **INVESTIGATIVE RESULTS**

*Incident.* On September 28, 1998, the victim reported for work at 0600 hours. Throughout the day, he performed his daily tasks of completing administrative paperwork and overseeing station operations. At 1711 hours, his station was dispatched to a fire in a three-story, wood-frame, single-family dwelling. The temperature at this time was 89-degrees Fahrenheit and relative humidity was 49%. Four Engines, one Truck, one Rescue, one Medic unit, and one District Chief (victim) responded and arrived on scene at 1713 hours. As District Chief, the victim assumed the role of Incident Commander (IC). As IC, he sent one fire fighter back to the fire station due to heat exhaustion. After approximately 2½ hours of fighting the fire, the fire was declared under control. At that time, the victim reported a slight headache and thought his blood pressure was elevated. The on-scene Medic unit checked his blood pressure, which was 160/110 mm Hg. Units departed the scene at 2009 hours and returned to their respective stations.

Later that evening, the victim telephoned his wife and related to her that he was tired but mentioned no other complaints. He awoke the next morning, September 29, at approximately 0700 hours, drank coffee, talked to crew members, and then departed for an 80-minute drive home. When the victim entered his residence a neighbor reported that the victim was not in any apparent distress, but they had no verbal contact.

The victim's wife entered their home at approximately 1400 hours and heard her husband snoring loudly in the bedroom. Thinking he was sleeping, she went into the kitchen. After approximately 10 minutes she entered the bedroom and found her husband apparently asleep. She noticed he had vomited a small amount, and she tried to wake him, without success. At 1409 hours, she called 911 and requested an ambulance. She ensured his airway was open and rolled him onto his side.

Ambulance 56F responded at 1414 hours and arrived on-scene at 1419 hours. Paramedics found the victim unresponsive, with a blood pressure of 180/84, a pulse of 112, and a respiratory rate of 40. His pupils were midpoint and fixed. He responded to painful stimuli in a "combative" manner. Oxygen was administered via non-rebreather mask. A cardiac monitor was attached to the victim; it revealed sinus tachycardia (normal heart beats faster than 100 beats per minute). An intravenous line was placed and he was transported to the nearest hospital at 1444 hours.

On arrival at the local hospital's emergency department (ED) at 1451 hours, the victim had a blood pressure of 203/84, a pulse of 70, and a respiratory rate of 32. He remained responsive only to painful stimuli. An electrocardiogram (EKG) revealed a normal sinus rhythm with occasional premature supraventricular complexes and nonspecific ST segment abnormalities. The victim



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was intubated and treated with nitroglycerin while arrangements were made to transport him via helicopter to the closest regional medical facility.

En route to the regional facility, the victim's clinical condition did not change, and he arrived at 1642 hours. A head CT scan revealed a very large acute hemorrhage (bleed) in the left side of the brain with much mass effect on the right side brain stem. A neurosurgeon who evaluated the victim described the hemorrhage as a hypertensive basal ganglionic hemorrhage (intracerebral). Another EKG showed no acute ischemic (heart attack or angina) changes. An electroencephalogram (EEG) showed left cerebral silence compatible with brain death. On September 30, at 0430 hours, the victim's condition deteriorated despite treatment and he became unresponsive to pain and had no spontaneous respirations. Another EEG was performed at 0615 hours, which again revealed electrocerebral silence (brain death). At 1700 hours, the victim was pronounced dead by the attending physician, and treatment was discontinued.

*Medical Findings.* The death certificate, completed by the attending physician, listed "intracerebral hemorrhage due to hypertension, essential" as the immediate cause of death. Since the District Chief had not been engaged in fire suppression activities for 2 days, his blood was not tested for carboxyhemoglobin (an indication of carbon monoxide poisoning). No autopsy was performed. His medical records document a history of hypertension (high blood pressure) treated with medication prescribed by his personal physician.

#### **DESCRIPTION OF THE FIRE DEPARTMENT**

At the time of the NIOSH investigation, the Fire Department consisted of 1172 uniformed career personnel and served a population of 534,000

residents in a geographic area of 533 square miles. There are 36 fire stations. Fire fighters, including the victim, worked the following schedule: 24 hours on duty, 0600-0600 hours, and 48 hours off duty.

In 1999, the Department responded to 66,790 calls: 49,021 EMS runs, 72 hang up calls to 911, 3867 structure fires, 3825 fire alarms, 2927 residential alarms, 1531 vehicle fires, 1519 refuse fires, 1109 citizen assist calls, 765 wildland fires, 616 other fires, 349 wires down, 313 water flow alarms, 253 animal rescues, 181 hazardous location calls, 166 mutual aid calls, 82 smoke calls, 59 washdowns, 38 water cutoff calls, 28 odor calls, 25 electrical fires, 16 gas leaks, 9 rescues, 5 water leaks, 4 small aircraft crashes, 3 alerts, 2 explosions, 2 biohazard calls, 2 airport standbys, and 1 other water call. The structure fire discussed above was the victim's only emergency response during his shift.

*Training.* The Fire Department requires all new fire fighters to pass a timed physical agility test, a written test, a pre-employment physical examination, a background check, and an oral interview prior to being hired. Once hired, the fire fighter must complete the 20-week fire fighter training course at the City Fire Academy to become certified as a NFPA-compliant Fire Fighter I/emergency medical technician (EMT). Once recruit training is completed, the Fire Fighter is assigned to a shift. Subsequent training is conducted on shift. There is no State requirement for annual fire fighter recertification, although there is for hazardous materials (HAZMAT), EMT, confined space, and respiratory protection. The victim was certified as a Fire Officer/EMT and had 28 years of fire fighting experience.

*Preemployment/Preplacement Evaluations.* The Department requires a pre-employment/ pre-placement medical evaluation for all new hires,



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regardless of age. Components of this evaluation for all applicants include the following:

- A complete medical history
- Height, weight, and pulse
- Physical examination
- Urine Tests: Urinalysis, Urine drug screen
- Chest X-ray
- Resting EKG (if new hire is over 40 years old, or if indicated by medical history)
- Audiometry
- Vision test: Color vision, distant and near vision, intraocular tension, field of vision, visual acuity

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

*Periodic Evaluations*

At the time of this investigation, there were no periodic medical evaluations offered by this Department. A voluntary cardiovascular risk assessment is offered by the City; which is conducted by a private company and paid for by each fire fighter's medical insurance. If an employee is ill or injured at work, the employee is evaluated by and must be cleared for "return to work" by the City physician. Although all fire stations have exercise (strength and aerobic) equipment, primarily purchased by the Fire Department, the Department does not have a mandatory fitness program. The Fire Department is considering a mandatory annual fitness test, which would include an annual medical evaluation. Voluntary wellness programs (smoking cessation, weight control, and screening for high blood pressure, diabetes, and cholesterol) are offered by the City.

The victim's last Fire Department medical examination was in 1983. According to records

available to NIOSH, this evaluation included a medical history and a resting EKG. No abnormalities were noted, and he was cleared for fire fighting duties.

**DISCUSSION**

The victim's cause of death was an intracerebral hemorrhage. The American Heart Association identifies eleven risk factors for stroke.<sup>1</sup> This includes three over which the individual has no control (increasing age [over age 55], male gender, and family history), and eight which are modifiable (prior stroke, high blood pressure, cigarette smoking, diabetes mellitus, carotid artery disease, heart disease, transient ischemic attacks, and high red blood cell counts). However, strokes can be divided into two broad categories: ischemic (result of blockage) and hemorrhagic (result of bleeding).<sup>2</sup> While the risk factors for both types are generally the same, they differ with regard to cholesterol. Recent studies have suggested that high cholesterol levels are associated with ischemic strokes but are protective for hemorrhagic strokes.<sup>3-7</sup> The victim had one non-modifiable risk factor (age) and one modifiable risk factor (high blood pressure) for an intracerebral stroke.

While head trauma can cause intra-cranial hemorrhages, these are typically subdural or epidural, not intracerebral.<sup>2</sup> In addition, neither the victim's wife or his crew members reported any recent episodes of head trauma, nor was there any report of head trauma by the large number of physicians examining and evaluating the victim. Thus, this victim's stroke was not due to head trauma received during the fire response.

While headache can be an early symptom of a stroke, it is a common symptom and certainly not specific for a stroke. Without other symptoms of a stroke (sudden numbness or weakness of the face, arm or leg, especially on one side of the body; sudden confusion, trouble speaking or understanding; sudden



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trouble seeing in one or both eyes; sudden trouble walking, dizziness, loss of balance or coordination), further evaluation at the fire scene or medical referral was not warranted.

Unfortunately, there are no practical screening tests for stroke, particularly intracerebral hemorrhagic strokes. Since the victim was already receiving treatment for his hypertension, even if the Fire Department implemented a comprehensive periodic medical examination as recommended by NFPA 1582, this would not have identified additional risk factors nor prevented his stroke.

## **RECOMMENDATIONS AND DISCUSSION**

The following recommendations address some general health and safety issues. While this list includes some preventive measures that have been recommended by other agencies, they would not have been able to prevent this District Chief's death due to a stroke. These selected recommendations have not been evaluated by NIOSH, but represent published research, consensus votes of technical committees of the NFPA, or fire service labor/management groups.

***Recommendation #1: Fire Fighters should have mandatory annual medical evaluations and periodic physical examinations 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 periodic medical evaluations for fire fighters can be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians,<sup>8</sup> and in the report of the International Association of Fire Fighters/

International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.<sup>9</sup>

***Recommendation #2: Exercise stress tests should be incorporated into the Fire Department's medical evaluation program.***

NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians, and the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative both recommend at least biannual EST for fire fighters.<sup>8,9</sup> The NFPA recommends EST for fire fighters without CAD risk factors at age 40, and for those with one or more risk factors at age 35 based on acute episodes potentially jeopardizing public safety.<sup>8</sup> NFPA considers 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).<sup>8</sup> The EST should then be performed on a periodic basis, at least once every 2 years.<sup>8</sup>

The inclusion of EST as part of NFPA 1582 is controversial due to problems with false negatives (inadequate sensitivity) and false positives (inadequate specificity), particularly for women, young men, and asymptomatic individuals (individuals without symptoms suggestive of angina).<sup>10,11</sup> This has led two expert groups to **not** recommend EST for asymptomatic individuals without risk factors for CAD.<sup>12,13</sup>

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 four groups for EST although they note that the "usefulness/efficacy is less well established by evidence/opinion."<sup>12</sup>





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

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).<sup>13</sup>

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.”<sup>13</sup>

***Recommendation #3: 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, requires a wellness program that provides health promotion

activities for preventing health problems and enhancing overall well-being.<sup>14</sup> 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.<sup>9</sup> The Fire Department and the Union should review these materials to identify applicable elements for their Department. Other large-city negotiated programs can also be reviewed as potential models.

***Recommendation #4: Autopsies should be performed on all on-duty fire fighters whose death may be cardiovascular-related.***

In 1995, the United States Fire Administration (USFA) published the *Firefighter Autopsy Protocol*.<sup>15</sup> This publication hoped to provide “a more thorough documentation of the causes of firefighter deaths for three purposes:

- (1) 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;
- (2) 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
- (3) 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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***Recommendation #5: Provide adequate fire fighter staffing to ensure safe operating conditions.***

This recommendation is not related to this fatality. However, many fire fighters interviewed during this investigation expressed concern that under-staffing was an important safety and health issue. In this Fire Department, an Engine is typically staffed with less than four personnel and a Ladder is staffed with four personnel. However, due to sick leave and vacations, apparatus staffing often falls to three personnel. NFPA 1500 recommends a minimum of four fire fighters be present where only one team (company) is operating in the hazardous area at a working structural fire; two individuals working as a team in the hazard area and two individuals present outside this hazard area for assistance or rescue.<sup>14</sup> In addition, OSHA's revised respiratory protection standard requires employees working in "Atmospheres that are Immediately Dangerous to Life or Health," which includes structural firefighting, to work in a double buddy system.<sup>16</sup> This double buddy system, or "2-in/2-out" rule, is designed to protect fire fighters while conducting interior structural fire fighting operations. Because municipal fire departments are public agencies with public employees, and because Tennessee operates an OSHA-approved State plan, the employer is REQUIRED to comply with this and other OSHA standards. This could be accomplished by any of the following: 1) increasing the number of fire fighters assigned to a company, 2) hiring fire fighters to act as "floaters" to fill in positions vacated by employees who are sick or who are on vacation, 3) staggering vacation days in conjunction with hiring "floating" fire fighters. The basis for this standard is improvement of worker safety while fighting interior structural fires.

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**INVESTIGATOR INFORMATION**

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