F2005 17

NIOSH Fire Fighter Fatality Investigation and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation December 16, 2005

Driver/Operator Dies Due to a Stroke While Driving a Fire Engine to an Alarm – Tennessee

SUMMARY

On April 20, 2005, a 38-year-old male career Driver/Operator (D/O) responded to an alarm. Finding a falsely activated pull station, his engine company went back into service. Just as another call came in, the engine began to veer off the road. As the D/O collapsed over the steering wheel, the engine's Lieutenant (LT) climbed over the console and stopped the engine. Crew members extricated the D/O and notified Dispatch, who dispatched an ambulance and additional fire department (FD) units. Cardiopulmonary resuscitation (CPR) was performed, advanced life support (ALS) treatment was given, and the D/O was transported to the local hospital's emergency department (ED) for further treatment. Despite these measures, the D/O died. The death certificate and autopsy, completed by the Medical Examiner, listed "acute subarachnoid hemorrhage" due to "rupture of sacular cerebral aneurysm" as the cause of death with "focal coronary artery atherosclerosis" as a significant condition. The NIOSH investigator concluded that the D/O's death was due to a ruptured cerebral aneurysm possibly triggered by some physical exertion earlier in the day and/or responding to the fire alarms.

The following recommendations are unlikely to have prevented this D/O's death. However, if implemented, the FD could reduce the risk of future cardiovascular events among its members.

- ***Provide annual medical evaluations to <u>ALL</u> fire fighters to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.***
- ***Negotiate with the local union to phase in a <u>MANDATORY</u> wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.***
- ***Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are physically capable of performing the essential job tasks of structural fire fighting.***
- ***Provide automated external defibrillators (AEDs) as part of the basic life support equipment for fire apparatus.***
- ***Discontinue lumbar spine x-rays as a screening test administered during the pre-placement medical evaluation.***

INTRODUCTION & METHODS

On April 20, 2005, a 38-year-old male D/O acutely ruptured a previously unknown cerebral aneurysm

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/fire** or call toll free **1-800-35-NIOSH**

while driving an engine to a call. Despite CPR and ALS performed by crew members, EMS personnel, and hospital personnel, the D/O died. NIOSH was notified of this fatality on April 21, 2005, by the United States Fire Administration. NIOSH contacted the affected FD on May 5, 2005, to obtain further information, and on June 6, 2005, to initiate the investigation. On June 20, 2005, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Tennessee to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel met and/or interviewed the following persons:

- Acting Chief of Safety
- Crew members
- D/O's wife

NIOSH personnel reviewed the following documents:

- FD incident report
- FD training records
- FD annual response report for 2004
- FD standard operating guidelines
- Ambulance report
- Hospital records
- Death certificate
- Autopsy report

INVESTIGATIVE RESULTS

On April 20, 2005, the D/O arrived for duty at his fire station (Station 7) at 0700 hours. The D/O was assigned Engine 7 (E7), which was staffed with two fire fighters (FFs), a D/O, and a LT.

Throughout the morning the crew checked the fire apparatus and equipment, then performed station housework (cleaning, sweeping, mopping, etc.). At about 0950 hours, a Battalion Chief requested E7 to transport two 100-foot sections of high pressure large diameter hose (5-inch) to Station 6. The D/O and the LT loaded one section of hose while two other FFs loaded the other section of hose onto the tailboard of E7 and the crew drove to Station 6. After backing E7 into Station 6, the crew carried the sections of hose about 20 feet and placed them in the designated area. The D/O carried one section (weighing about 142 pounds) alone.

About 10 minutes later, at 1042 hours, E7 was dispatched to a fire alarm (an activated pull station) at a commercial structure. During the response, the D/O mentioned to the LT that he had a headache. At the scene, the crew, including the D/O, entered the structure to determine the source of the fire alarm. The crew determined that someone had activated a pull station. Because they found nothing else, the crew exited the structure and E7 went back into service.

At 1100 hours, as E7 neared a housing area, a call was received for an alarm at a school. E7 began to slow down and make a turn, then drove straight ahead. The LT looked over at the D/O and saw the D/O's head was tilted upward and his hands were on the steering wheel at the 3:00 o'clock and the 9:00 o'clock positions. The LT called to the D/O twice but received no response. The D/O then collapsed over the wheel. The LT climbed over the console to stop the engine. Once the engine stopped, the crew removed the D/O from the apparatus and laid him on the ground. Initial assessment found him unresponsive, with no pulse and no respirations. Dispatch was notified and CPR (chest compressions and assisted ventilations via bag-valve-mask and oxygen) was begun. Engine 7 was a basic life support apparatus and carried

some medical equipment, but no automated external defibrillator (AED). All members of E7 were emergency medical technicians (EMTs).

An ambulance was dispatched at 1104 hours, arriving on the scene at 1106 hours. Initial assessment of the D/O by the paramedics revealed he was unresponsive, with no pulse, no respirations, and CPR in progress. He was intubated (breathing tube inserted into his trachea) and placement was verified by auscultation (bilateral breath sounds) and confirmed by end tidal carbon dioxide (CO_2) measurement. A cardiac monitor revealed pulseless electrical activity (heart rhythm incompatible with life). An intravenous (IV) line was placed, cardiac resuscitation medications were administered, and the D/O's heart rhythm reverted to asystole (no heart beat). He was placed onto a backboard and into the ambulance, which departed the scene en route to the hospital at 1124 hours.

The ambulance arrived at the hospital ED at 1133 hours. Initial evaluation in the ED found the D/O to be unresponsive, with no respirations, and no heart beat. He was treated for cardiac arrest possibly due to a pulmonary embolus. His heart rhythm changed to ventricular fibrillation (Vfib), and he was defibrillated four times. Additional cardiac medications were administered, a pulse returned, and he was placed on a ventilator. Blood tests revealed normal cardiac enzyme levels (troponin), suggesting this was not a heart attack. An electrocardiogram (EKG) revealed sinus tachycardia with wide fusion complexes and a nonspecific intraventricular block.

Shortly thereafter, his heart rhythm reverted back to asystole and CPR was re-initiated. Additional cardiac medications were administered and a pulse briefly returned, then the D/O became pulseless again. After 36 minutes of resuscitation efforts in the ED, in addition to the 29 minutes of resuscitation efforts in the field, the D/O was pronounced dead at 1209 hours, and resuscitation efforts were discontinued.

Medical Findings. The death certificate, completed by the Medical Examiner, listed "acute subarachnoid hemorrhage" due to "rupture of sacular cerebral aneurysm" as the cause of death with "focal coronary artery atherosclerosis" as a significant condition. The autopsy, performed by the Medical Examiner on April 21, 2005, included the following findings:

- Sacular aneurysm with rupture, basilar artery
  - Acute subarachnoid hemorrhage, large amount, base of brain
- Coronary artery atherosclerosis, focal and severe
  - Severe narrowing (90%) of the left anterior descending coronary artery
- Negative drug and alcohol tests

The D/O's initial blood pressure (BP) during his pre-placement physical examination in 1995 was elevated (124/100 millimeters of mercury [mmHg]). Later that day and over the next 10 days, the D/O had numerous BP checks, all of which were normal. The initial elevated readings were probably due to "white coat hypertension,"[1] and no further follow up or treatment was needed.

The D/O never complained of any angina-like symptoms or recurrent headaches and seldom needed to visit his primary care physician.

Driver/Operator Dies Due to a Stroke While Driving a Fire Engine to an Alarm – Tennessee

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, this career FD consisted of 1,436 uniformed personnel, served a population of 800,000 in a 340 square mile area, and had 54 fire stations.

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

Employment and Training. The FD requires all fire fighter candidates to complete an application; be at least 18 years of age; possess a high school diploma or equivalent; possess a valid state driver's license; and pass a timed physical agility test (PAT), an oral interview, and a written test. The candidate is then placed on a hiring list based on test score. When vacancies occur, the top candidates must then pass a background check and a physical examination prior to being hired. The newly hired fire fighter receives training at the 6-month Fire Training Academy, which certifies the fire fighter to the Fire Fighter 1/Emergency Medical Technician (FF1/EMT) or the FF/Paramedic level. The FF is placed on shift and works 24 hours on-duty, 24 hours off-duty for three shifts, 0700 hours to 0700 hours, and is then off duty for 96 hours. Subsequent training to the Fire Fighter II level is conducted on shift. All fire fighters are tested by personnel from the State of Tennessee to become certified as a Fire Fighter I or II. There is no State requirement for annual fire fighter recertification. However, hazardous materials (HAZMAT), EMT, confined space, and respiratory protection require annual recertification. The D/O was certified as a Fire Fighter II, a Driver/Operator, an EMT, and in hazardous materials, and had 9 years of fire fighting experience.

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

- A complete medical and occupational history
- Height, weight, and vital signs
- Physical examination
- Blood tests: complete blood count, sickle cell screen, comprehensive chemical screening profile, syphilis screening, hemoglobin electrophoresis
- Urine tests: urinalysis with microscopy, urine drug screen, urine alcohol screen
- Chest X-ray (PA and lateral views) with interpretation and report
- Lumbosacral spine X-ray (AP and lateral views) with interpretation and report
- 12-lead resting electrocardiogram (ECG) with interpretation and report
- Audiometry
- Spirometry
- Snellen vision screen
- Vision test: visual acuity, visual field, color vision
- Pregnancy test (if applicable)
- Pap Smear (if applicable)

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

Periodic Evaluations. Required annual medical evaluations are offered to hazardous materials operations and rescue/special operations members only. A City-contracted physician performs the medical evaluations and forwards the clearance

for duty decision to the City's personnel director, who makes the final determination.

No annual physical agility test is required. There is a voluntary fitness program. Exercise equipment (strength and aerobic) is available in the fire stations. Employees who are injured at work or ill must be evaluated and cleared for return to work by the fire fighter's private physician. The results are reviewed by the City physician. A medical evaluation for clearance to wear SCBA is required if a member has a change in health.

DISCUSSION

Stroke, Subarachnoid Hemorrhage (SAH), and Cerebral Aneurysms. A stroke is defined as the sudden development of a focal neurological deficit.[2] Strokes are broadly grouped into two types: ischemic (reduced blood flow due to an obstruction within a blood vessel) and hemorrhagic (a ruptured blood vessel).[3] Ischemic strokes are three times more common than hemorrhagic strokes.[4] This D/O had a hemorrhagic stroke in the subarachnoid area of the brain due to a ruptured cerebral aneurysm. Although cerebral aneurysms are relatively common (3%-5% of the U.S. population), most do not rupture.[5-7] When they do rupture, however, the mortality rate is high (40%-50%).[8]

Most people are unaware they have a cerebral aneurysm until it ruptures. Rupture is typically manifested as the sudden loss of consciousness that may be preceded by a brief moment of excruciating headache. In about 45% of cases, severe headache associated with exertion is the presenting complaint.[3] The D/O carried a section of hose weighing about 142 pounds and complained of a headache about 15 minutes before his collapse.

Several factors have been associated with hemorrhagic strokes due to a ruptured aneurysm:

- size and location of the aneurysm[6,9,10]
- cigarette smoking[9,11]
- hypertension [9,11]
- heavy use of alcohol[4]
- family history of SAH[12-14]
- female gender[4]
- African-American race [4]
- low level of leisure time physical activity[15,16]

The D/O did not have any of these risk factors.

Physical Activity and SAH. The association between lack of physical activity and ischemic heart disease is well established.[17,18] Given that most strokes are ischemic and that ischemic strokes and ischemic heart disease share a common pathophysiology, the association between the lack of physical activity and strokes should not be surprising.[19,20] Recently, studies have also established a link between the lack of physical activity and hemorrhagic strokes.[15,16]

The relationship between stroke and physical activity typically shows a "U" shaped association (lack of physical activity or very heavy physical activity is associated with increased risk for a stroke while moderate physical activity is protective).[16,19] One possible explanation for this finding is that heavy physical exertion may "trigger" a stroke, as with heart attacks (acute myocardial infarctions).[21-23] This seems plausible from a pathophysiological perspective because blood pressure rises during heavy physical exertion,[24] and elevated blood pressure could trigger the blood vessel to rupture.

Given this information, NIOSH investigators conclude that this D/O's stroke was due to a ruptured aneurysm possibly triggered by the heavy physical exertion required to move a 100-foot section of 5-inch hose weighing about 142 pounds.

Occupational Medical Standards for Structural Fire Fighters. To reduce the risk of sudden cardiac arrest or other incapacitating medical conditions among fire fighters, the National Fire Protection Association (NFPA) developed NFPA 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments*.[25] Because the D/O had no risk factors for coronary artery disease (CAD) or intracerebral hemorrhage, no additional testing would have been recommended.

RECOMMENDATIONS

The following recommendations are unlikely to have prevented this D/O's death. However, if implemented, the FD could reduce the risk of future cardiovascular events among its members.

Recommendation #1: Provide annual medical evaluations to ALL fire fighters to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

Guidance regarding the content and frequency of pre-placement and periodic medical evaluations and examinations for structural fire fighters can be found in NFPA 1582[25] and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) W*ellness/Fitness Initiative*.[26] The FD is not legally required to follow any of these standards.

Applying NFPA 1582 involves economic issues. These economic concerns go beyond the costs of administering the medical program; they involve the personal and economic costs of dealing with the medical evaluation results. NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, Chapter 8-7.1 and 8-7.2[27] addresses these issues.

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

Recommendation #2: Negotiate with the local union to phase in a MANDATORY wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.

Physical inactivity is the most prevalent modifiable risk factor for coronary artery disease (CAD) in the United States. Physical inactivity, or lack of exercise, is associated with other CAD risk factors: obesity and diabetes.[28] NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.[27] NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters*, provides the minimum requirements for a health-related fitness program.[29] In 1997, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) published a comprehensive *Fire Service Joint Labor Management Wellness/Fitness Initiative* to improve fire fighter quality of

life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and create a practical fire service program. They produced a manual and a video detailing elements of such a program.[26]

Large-city negotiated programs can also be reviewed as potential models. Wellness programs have been shown to be cost effective, typically by reducing the number of work-related injuries and lost work days.[30-32] A similar cost savings has been reported by the wellness program at the Phoenix Fire Department, where a 12-year commitment has resulted in a significant reduction in their disability pension costs.[33]

Recommendation #3: Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are physically capable of performing the essential job tasks of structural fire fighting.

NFPA 1500 requires fire department members who engage in emergency operations to be annually evaluated and certified by the fire department as meeting the physical performance requirements identified in paragraph 8-2.1.[27]

Recommendation #4: Provide automated 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 injuries or conditions that commonly occur on scene, such as cardiac arrest.[34] 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.[35] AEDs have caused the cardiac arrest survival rate to increase from 7% (CPR performed only) to 26%.[36] When defibrillation is provided within 5-7 minutes, the survival rate is as high as 49%.[37] 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 carrying defibrillators on ambulances, would allow the FD to provide a greater level of emergency medical care to the public. The FD has medical first responder responsibilities and fire fighters may find themselves in the position of having to provide cardiac resuscitation. The timely use of an automated external defibrillator, even by minimally trained first responders, can increase the likelihood of survival following cardiac arrest.[37,38]

If an AED had been available on Engine 7 at the time of this incident, it would not have changed the outcome. Engine 7 is currently equipped for ALS operations, including manual defibrillation. However, if no paramedic is available, only basic life support supplies can be used by the EMTs.

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

The FD currently performs pre-placement physical evaluations, which include routine lumbar spine X-rays. While these X-rays may be useful in evaluating individuals with existing problems, the American College of Radiology, American

College of Occupational and Environmental Medicine, and NIOSH have concluded that lumbar spine X-rays have no value as a routine screening measure to determine risk for back injuries.[39-41] This procedure involves both an unnecessary radiation exposure for the applicant and an unnecessary expense for the FD.

REFERENCES

1. Kaplan NM [2001]. Systemic hypertension: mechanisms and diagnosis. In: Braunwald E, Zipes DP, and Libby P, eds. Heart Disease. 6th Edition. Philadelphia: W.B. Saunders. pp. 942-943.

2. Spraycar M, ed. [1995]. Stedman's Medical Dictionary. 26th ed. Baltimore, MD: Williams & Wilkins p. 1688.

3. Smith WS, Hauser SL, and Easton JD [2001]. Cerebrovascular diseases. In: Braunwald E, Fauci AS, Kasper DL, Hauser SL, Longo DL, Jameson JL, eds. Harrison's principles of internal medicine. 15th Edition. New York: McGraw-Hill. pp. 2388-2389.

4. Sacco RL, Benjamin EJ, Broderick JP, et al. [1997]. Risk Factors. Stroke 28:1507-1517.

5. Black M and Graham DI [2002]. Sudden unexplained death in adults caused by intracranial pathology. J Clin Pathol 55:44-50.

6. The International Study of Unruptured Intracranial Aneurysms Investigators [1998]. Unruptured intracranial aneurysms - risk of rupture and risks of surgical intervention. N Engl J Med 339(24):1725-1733.

7. Menghini VV, Brown RD Jr, Sicks JD, et al. [1998]. Incidence and prevalence of intracranial aneurysms and hemorrhage in Olmstead County, Minnesota, 1965 to 1995. Neurology 51:405-411.

8. Hop JW, Rinkel GJ, Algra A, et al. [1997]. Case-fatality rates and functional outcome after subarachnoid hemorrhage: a systematic review. Stroke 28:660-664.

9. Juvela S [2003]. Prehemorrhage risk factors for fatal intracranial aneurysm rupture. Stroke 34:1852-1857.

10. Findlay JM [2003]. Editorial comment--Prehemorrhage risk factors for fatal intracranial aneurysm rupture. Stroke 34:1857-1858.

11. Feigin V, Parag V, Lawes CM, et al. [2005]. Smoking and elevated blood pressure are the most important risk factors for subarachnoid hemorrhage in the Asia-Pacific region. Stroke 36:1360-1367.

12. Slowik A, Borratynska A, Pera J, et al. [2004]. II Genotype of the angiotensis-converting enzyme gene increases the risk for subarachnoid hemorrhage from ruptured aneurysm. Stroke 35:1594-1597.

13. Broderick JP, Viscoli CM, Brott T, et al. [2003]. Major risk factors for aneurysmal subarachnoid hemorrhage in the young are modifiable. Stroke 34:1375-1381.

14. Kissela BM, Sauerbeck L, Woo D, et al. [2002]. Subarachnoid hemorrhage. A preventable disease with a heritable component. Stroke 33:1321-1326.

15. Wendel-Vos, GCW, Schuit AJ, Feskens EJM, et al. [2004]. Physical activity and stroke. A meta-analysis of observational data. International J of Epidemiology 33:787-798.

16. Thrift AG, Donnan GA, McNeil JJ [2002]. Reduced risk of intracerebral hemorrhage with dynamic recreational exercise but not with heavy work activity. Stroke 33:559-564.

17. Fletcher GF, Balady GJ, Blair SN, et al. [1996]. Statement on exercise: benefits and recommendations for physical activity programs for all Americans: a statement for health professionals by the Committee on Exercise and Cardiac Rehabilitation of the Council on Clinical Cardiology, American Heart Association. Circulation 94:857-862.

18. Pate RR, Pratt M, Blair SN, et al. [1995]. Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA 273:402-407.

19. Lee IM, Paffenbarger RS Jr. [1998]. Physical activity and stroke incidence. The Harvard Alumni health study. Stroke 29:2049-2054.

20. Batty GD, Lee IM. [2002]. Physical activity for preventing strokes. Brit Med Journal 325:350-351.

21. Willich SN, Lewis M, Lowel H, et al. [1993]. Physical exertion as a trigger of acute myocardial infarction. N Eng J Med 329:1684-1690.

22. Mittleman MA, Maclure M, Tofler GH, et al. [1993]. Triggering of acute myocardial infarction by heavy physical exertion. N Eng J Med 329:1677-1683.

23. Albert CM, Mittleman MA, Chae CU, et al. [2000]. Triggering of sudden death from cardiac causes by vigorous exertion. N Eng J Med 343:19:1355-1361

24. Taylor AJ, Beller GA [1998]. Postexercise systolic blood pressure response: clinical application to the assessment of ischemic heart disease. Am Fam Physician 58:1257-1260.

25. NFPA [2003]. Standard on comprehensive occupational medical program for fire departments. Quincy MA: National Fire Protection Association. NFPA 1582.

26. IAFF, IAFC. [2000]. The fire service joint labor management wellness/fitness initiative. Washington, D.C.: International Association of Fire Fighters, International Association of Fire Chiefs.

27. NFPA [2002]. Standard on fire department occupational safety and health program. Quincy MA: National Fire Protection Association. NFPA 1500.

28. Plowman SA and Smith DL [1997]. Exercise physiology: for health, fitness and performance. Boston, MA: Allyn and Bacon.

29. NFPA [2000]. Standard on health-related fitness programs for fire fighters. Quincy MA: National Fire Protection Association. NFPA 1583.

30. Maniscalco P, Lane R, Welke M, Mitchell J, Husting L [1999]. Decreased rate of back injuries through a wellness program for offshore petroleum employees. J Occup Environ Med 41:813-820.

31. Stein AD, Shakour SK, Zuidema RA [2000]. Financial incentives, participation in employer sponsored health promotion, and changes in employee health and productivity: HealthPlus health quotient program. JOEM 42:1148-1155.

32. Aldana SG [2001]. Financial impact of health promotion programs: A comprehensive review of the literature. Am J Health Promot 15:296-320.

33. Unpublished data [1997]. City Auditor, City of Phoenix, AZ. Disability retirement program evaluation. Jan 28, 1997.

34. NFPA [2000]. Standard for developing fire protection services for the public. Quincy, MA: National Fire Protection Association. NFPA 1201.

35. AHA [2000]. Operation heartbeat. Dallas, TX: American Heart Association.

36. AHA [2000]. Cardiopulmonary resuscitation statistics. Dallas, TX: American Heart Association.

37. Koster RW [2002]. Automatic external defibrillator: key link in the chain of survival. J Cardiovasc Electrophysiol 13(1 Suppl): S92 95.

38. Marenco JP, Wang PJ, Link MS, et al. [2001]. Improving survival from sudden cardiac arrest: the role of the automated external defibrillator. JAMA 285:1193 1200.

39. Gibson ES [1998]. The value of pre-placement screening radiography of the low back. In: Deyo RA, ed. Occupational medicine, state of the art reviews. Philadelphia: Hanley & Belfus, pp. 91-108.

40. Present AJ [1974]. Radiography of the Lower Back in Pre-employment Physical Examinations. Conclusions of the ACR/NIOSH Conference, January 11-14, 1973. Radiology 112:229-230.

41. ACOEM [1979]. Use of routine X-ray Examinations in Occupational Medicine.

INVESTIGATOR INFORMATION

This investigation was conducted by and the report written by:

Tommy N. Baldwin, MS
Safety and Occupational Health Specialist

Mr. Baldwin, a National Association of Fire Investigators (NAFI) Certified Fire and Explosion Investigator, an International Fire Service Accreditation Congress (IFSAC) Certified Fire Officer I, and a Kentucky Certified Fire Fighter and Emergency Medical Technician (EMT), is with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component located in Cincinnati, Ohio.

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

OFFICIAL BUSINESS
Penalty for private use $300

NIOSH

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