



## **District Chief Suffers Sudden Cardiac Death at Home After Experiencing Symptoms Consistent with Heart Disease at his Station – Illinois**

### **SUMMARY**

On April 18, 2004, a 45-year-old male career District Chief (DC) was relieved from his shift and dropped off at his residence. Approximately 21 hours later, he was found lying on his couch unresponsive, pulseless, not breathing, cyanotic, and mottled. Due to his clinical appearance (deceased), cardiopulmonary resuscitation (CPR) was not begun and no ambulance was requested. The death certificate and autopsy report, both completed by the County Coroner, listed “cardiac arrhythmia” as the cause of death due to “ischemic heart disease.”

The first four recommendations below are preventative measures recommended by other fire service groups to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. The final recommendation addresses a potential safety issue related to this particular event.

- 1. *Include a lipid panel in the Fire Department’s excellent pre-placement medical evaluation program.***
- 2. *Provide mandatory annual medical evaluations to ALL fire fighters consistent with National Fire Protection Association (NFPA) Standard 1582 to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.***
- 3. *Negotiate with the local union to phase in a mandatory fitness and wellness program consistent with NFPA 1583 and/or the Fire Service Joint Labor Management Wellness/Fitness Initiative.***
- 4. *Negotiate with the local union to phase in an annual physical ability test.***
- 5. *Ensure that fire fighters are cleared for duty by a physician familiar with the consensus guidelines published by the NFPA 1582 and***

*knowledgeable about the physical demands of fire fighting.*

### **INTRODUCTION AND METHODS**

On April 18, 2004, a 45-year-old male career DC was found in his home unresponsive, not breathing, and pulseless. Due to his clinical appearance and condition (deceased), Cardio-Pulmonary Resuscitation (CPR) and advanced life support were not performed. On April 22, 2004, NIOSH - Cincinnati contacted the affected Fire Department (FD) to initiate the investigation. On June 29, 2004, an Occupational Nurse Practitioner from the NIOSH Fire Fighter Fatality Investigation Team and a NIOSH visiting scientist from the Occupational Medicine program at the University of Utah traveled to Illinois to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel spoke with the following people:

- Fire Chief
- Crew members
- Local Union President
- Victim’s wife

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](http://www.cdc.gov/niosh/firehome.html) or call toll free 1-800-35-NIOSH



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During the site visit NIOSH personnel reviewed the following records:

- Death certificate
- Past medical records of the deceased
- FD policies and operating guidelines
- FD training records
- Autopsy Report

**INVESTIGATIVE RESULTS**

***Incident.*** On April 18, 2004, at approximately 0700 hours, a 45-year-old male career DC began his 24-hour shift. Shortly after beginning his shift he reported upper back pain radiating to both shoulders and his “esophagus quivering.” The DC, who was described as having a “high pain threshold,” ate lunch normally and exercised that same afternoon. The two emergency calls received that day were both cancelled en route. River rescue training drills began in the mid-morning (0915-1030 hours), but were stopped due to dangerous water conditions. The DC was an “observer” during the portion of the drills actually completed.

That afternoon (around 1400 hours), the DC conducted his typical 1-hour physical exercises (stretching, walking/running on the treadmill, and low impact weight training). At around 1830 hours, he presented to the dispatch center requesting treatment for his back pain. He had been known to suffer from chronic back pain. The DC requested some type of deep tissue massage. After repeated requests, the massage was performed, but provided no relief. He was given non-prescription ibuprofen but it was unclear if he took them.

To attend an Aircraft Fire Fighting class the next day, the DC had scheduled a replacement for approximately 1845 hours. While being transported to his residence by his relief, at 1849 hours, the second emergency call of the day was initiated but cancelled en route. His relief characterized the DC as quieter than usual. He was dropped off at 1900 hours and was last seen alive entering his residence.

The next day, April 19, 2004, at around 1600 hours, two dispatchers went to the DC’s residence after getting no response from repeated telephone calls. After knocking on the door and still getting no response, but seeing the DC’s civilian vehicle, they asked the landlord to open the apartment where they found the DC lying on the couch unresponsive, cold, and rigid. Seeing his clinical appearance and condition, the dispatchers did not initiate CPR. Emergency dispatch (911) was notified; the paramedics found the DC lying on the couch unresponsive, pulseless, not breathing, cyanotic, and mottled. Again, life-saving actions were not attempted. The paramedics called the coroner who pronounced the DC dead at 1743 hours. A cell phone in the DC’s hands showed a missed call on April 18, 2004, at 1930 hours. The forensic pathologist therefore ruled the date of death to be April 18, 2004.

***Medical Findings.*** The death certificate completed by the Coroner listed “cardiac arrhythmia” due to ischemic heart disease as the immediate cause of death. Significant findings from the autopsy, performed by a forensic pathologist, were as follows:

- Marked atherosclerosis with:
  1. 60% narrowing of the right coronary artery
  2. 60% narrowing of the left main coronary artery
  3. 90% narrowing of the left anterior descending coronary artery
  4. 90% narrowing of the circumflex coronary artery
- Recent thrombus in the circumflex coronary artery, resulting in total occlusion
- No evidence of remote myocardial infarction or myocardial fibrosis
- Mild left ventricle hypertrophy with:
  1. Left ventricle thickness 1.6 cm (normal is 0.76-0.88 cm)<sup>1</sup>
  2. Interventricular septum thickness 1.5 cm (normal echographic measurement is 0.6-1.1 cm)<sup>2</sup>
- Cardiomegaly (enlarged heart) weighing 420 grams (normal is less than 400 grams)<sup>3</sup>



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The DC had a one time FD annual medical evaluation in June 2002. All results of this evaluation were normal except for a “borderline” high blood cholesterol [total cholesterol level was 227 milligrams (mg) per deciliter (dL) (borderline is 200-239 ug/dL), normal HDL cholesterol of 45.4 mg/dL, elevated LDL cholesterol of 159.2 ug/dL (normal is 70-130 ug/dL), and a Chol/HDL ratio of 5.0 (normal)]. In February 2003, the DC attended his hazardous materials physical examination. His resting EKG was again unremarkable and he again had “borderline” high blood cholesterol [total cholesterol was 243 mg/dL, HDL cholesterol of 66 mg/dL, LDL cholesterol of 158 ug/dL, and a Chol/HDL ratio of 3.7]. He was cleared for HazMat duties without restrictions.

In December 2002, when the DC saw his private physician his blood pressure was 180/120 millimeters of mercury (mmHg). Subsequent elevated readings led to a diagnosis of hypertension, which was treated with an anti-hypertensive medication. When the 1-year follow-up of his hypertension was conducted in December 2003, his blood pressure was 142/78 mmHg. At autopsy, the DC weighed 183 pounds and measured six feet tall giving a body mass index (BMI) of 24.8 kilograms/meter<sup>2</sup> (kg/m<sup>2</sup>). He was known to exercise regularly by walking, jogging, and weightlifting. He had not complained of heart symptoms days or weeks preceding this untimely death.

**DESCRIPTION OF THE FIRE DEPARTMENT**

At the time of the NIOSH investigation, this FD consisted of 269 uniformed personnel serving a population of 150,000 in a 62 square miles area. There were 11 fire stations. The FD provides limited ALS; all fire fighters hold either Emergency Medical Technician-Paramedic (EMT-P) or EMT-Basic (EMT-B) certification. Fire fighters work the following schedule: alternating 24-hour on-duty and 48-hour off-duty shifts. Shift change occurs at 0700 hours for District Chiefs and 0800 hours for FFs. In 2003, the FD responded to 18,556 emergency calls.

***Training.*** To become a member of the FD, applicants must take a written examination. They then practice a candidate physical ability test (CPAT) created by this FD. The physical ability test is composed of one timed events with eight sections. After practicing this CPAT, they take the timed test. They are then interviewed and ranked. The top applicants are offered employment, then given a physical examination by the occupational health clinic (discussed below). If the applicants fail the physical examination, the offer of employment is rescinded.

Once hired as a probationary employee, candidates must complete an 11-week training course at the department fire fighter academy. Upon academy completion, probationary employees are certified as a Fire Fighter I, Fire Fighter II, technical rescue awareness, vehicle machinery operator, search and rescue, and hazardous materials operations level, and then assigned to one of the fire stations. If they have not completed EMT-P or EMT-B they return to the academy for a 5-week EMT-B class. After serving 12 months in good standing, probationary employees are allowed full membership. Recurrent training occurs daily on each shift. EMT certification must be renewed periodically; no recertification is required for other portions of the fire fighter training. The DC was certified as a Fire Fighter I-II, Driver/Operator, EMT-Basic, Hazardous Materials Operations level, Fire Service Instructor, and Fire Officer I. He had served with this department for over 23 years.

***Pre-placement Evaluations.*** The FD has required a pre-placement medical evaluation for all fire fighter candidates since 1972. The following components have been examined since May 2003, regardless of age. Components of the evaluation include the following:

- A complete medical history
- Physical examination
- Vital signs including height and weight
- Vision testing (acuity, color, peripheral)
- Audiogram
- Blood analysis: serum chemistry, liver profile, and complete blood count



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- Urinalysis (dipstick)
- Illicit drug urine screen
- Chest x-ray
- 12-lead resting electrocardiogram (EKG)
- Spirometry (Pulmonary Function Test)
- Tuberculosis skin test (PPD)
- Hepatitis B screening if vaccination is not complete

These evaluations are performed by the physician in the occupational health clinic, who then makes a decision regarding medical clearance for fire fighting duties. This decision is forwarded to the Fire Chief.

*Periodic Evaluations.* No annual medical evaluations or physical ability tests are required by the FD. Fire fighters are encouraged to receive a complete physical examination at their own expense. The FD, as part of the Occupational Safety and Health Administration (OSHA) regulations, requires annual medical clearance for respirator use. Fire fighters injured on duty, must be cleared for return to work by their personal physician. Strength and aerobic equipment are available at the fire station but there is no mandatory fitness program. The health/wellness program consists of educational programs for smoking cessation, weight control, high blood pressure, diabetes, and cholesterol reduction.

**DISCUSSION**

*Coronary Artery Disease (CAD) and the Pathophysiology of Sudden Cardiac Death.*

In the United States, coronary artery disease is the most common risk factor for cardiac arrest and sudden cardiac death.<sup>4</sup> Risk factors for its development include advancing age, male gender, family history of coronary artery disease, smoking, high blood pressure (systolic >140 millimeters of mercury [mmHg] or diastolic > 90 mmHg), high blood cholesterol (total cholesterol > 240 milligrams per deciliter [mg/dL]), diabetes, and obesity/physical inactivity.<sup>5,6</sup> The deceased had two of these risk factors (male gender and hypertension).

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.<sup>7</sup> However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.<sup>8</sup> Heart attacks, medically known as myocardial infarction (MI), typically occurs with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply.<sup>9</sup> This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. The DC had moderate to severe atherosclerotic disease in his coronary arteries, and a thrombus in one coronary artery. This thrombus confirms that the DC had a heart attack. Cardiac arrhythmias are frequently associated with heart attacks and were probably responsible for his sudden cardiac death.

Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.<sup>10-13</sup> During the DC's shift, there were no emergency incidents, but he participated in, by witness statements, an arduous physical fitness session (walking or running on the treadmill). Depending on the pace of his walk/run, this could represent a mild (walking) to heavy (running) level of physical exertion.<sup>14,15</sup> The physical stress of exercising and his underlying atherosclerotic CAD probably contributed to his heart attack and sudden cardiac death.

*Use of Exercise Stress Tests (EST) to Screen for CAD.*

To reduce the risk of heart attacks, sudden cardiac arrest and other medical conditions among fire fighters, the NFPA has developed the NFPA 1582 guideline entitled *Comprehensive Occupational Medicine Program for FDs*.<sup>16</sup> The 2003 edition recommends a comprehensive medical examination to be performed **annually** on all members. This standard also recommends screening for obstructive CAD by an EST for fire fighters with two or more of the following risk factors for CAD (family history of premature [less than age 60] cardiac event, hypertension, diabetes



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mellitus, hypercholesterolemia [total cholesterol greater than 240 mg/dL or HDL cholesterol less than 35 mg/dL]. These recommendations are similar to those of the American College of Cardiology/American Heart Association (ACC/AHA).<sup>17</sup> According to these criteria, the DC had one CAD risk factor, therefore he would not have been recommended for an EST.

*Other Issues.* The DC had cardiomegaly (enlarged heart) with increased left ventricle and septal wall thickness on autopsy. Although the pathologist characterized all these changes as unremarkable, left ventricular hypertrophy is a common finding among individuals with long-standing high blood pressure or cardiac ischemia (reduced blood supply to the heart muscle).<sup>18</sup> The DC was diagnosed with hypertension in December 2002. He also had severe coronary artery disease (blood flow constriction) in two vessels, therefore cardiac ischemia is a distinct possibility. Although left ventricular hypertrophy is associated with increased risk for a sudden cardiac death, the evidence of a thrombus confirms a heart attack, which probably caused his death.

### RECOMMENDATIONS

The first four recommendations below are preventative measures recommended by other fire service groups to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. The final recommendation addresses a potential safety issue related to this particular event.

***Recommendation #1: Include a lipid panel in the fire department's excellent pre-placement medical evaluation program.***

Although the department has an excellent comprehensive pre-employment medical evaluation, it does not include a lipid panel. NFPA 1582 includes a lipid panel to identify "the candidate's known health problems... and for detecting early signs of illness."<sup>18</sup>

***Recommendation #2: Provide mandatory annual medical evaluations to ALL fire fighters consistent with NFPA 1582.***

The purpose of periodic medical evaluations is to ensure that fire fighters have the 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 and examinations for fire fighters can be found in NFPA 1582, Standard on Comprehensive Occupational Medical Program for FDs,<sup>18</sup> and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.<sup>19</sup> While we recommend these programs, the fire department is not legally required to follow either standard.

Applying NFPA 1582 involves legal and economic issues, so it should be carried out in a **confidential, nondiscriminatory** manner. Annex B of NFPA 1582 provides guidance for FD administrators regarding legal considerations in applying the standard. The 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 FD Occupational Safety and Health Program*, addresses these issues in Chapter 8-7.1 and 8-7.2.<sup>20</sup> The success of medical programs hinges on protecting the affected fire fighter. The department must (1) keep the medical records confidential, (2) provide alternate duty positions for fire fighters in rehabilitation programs, and (3) if the fire fighter is not medically qualified to return to active fire-fighting duties, provide permanent alternate duty positions or other supportive and/or compensated alternatives.

As part of the medical evaluation, the NFPA 1582 and the IAFF/IAFC wellness/fitness initiative both recommend EST for some fire fighters to screen for obstructive CAD.<sup>16,19</sup> NFPA 1582 recommends EST for those fire fighters with two or more CAD risk factors; recommendations are similar to those of the American College of Cardiology/American Heart Association (ACC/AHA).<sup>17</sup> According to NFPA 1582, these CAD risk factors include:

- family history of premature [less than age 60] cardiac event



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- hypertension
- diabetes mellitus
- hypercholesterolemia [total cholesterol greater than 240 mg/dL or HDL cholesterol less than 35 mg/dL
- cigarette smoking<sup>16</sup>

The EST could be conducted by the fire fighter's personal physician or the Department's contract physician. If the fire fighter's personal physician or the contract physician conducts the test, the results must be communicated to the Department physician, who should be responsible for decisions regarding medical clearance for fire fighting duties.

Unfortunately, even if this fire department had conducted annual medical evaluations as suggested by NFPA 1582, it is unlikely to have identified his underlying CAD or prevented his untimely death. However, for all fire fighters with two or more of the CAD risk factors, an EST is still an important component of the annual medical evaluation.

***Recommendation #3: Collaborate with the local union to phase in a mandatory fitness and wellness program consistent with NFPA 1583 and/or the Fire Service Joint Labor Management Wellness/Fitness Initiative.***

Physical inactivity is the most prevalent modifiable risk factor for CAD in the United States. Additionally, physical inactivity, or lack of exercise, is associated with other risk factors: obesity and diabetes.<sup>21</sup> NFPA 1500, *Standard on FD 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.<sup>20,22</sup>

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 FDs 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>19</sup> We recommend the FD and union review these materials to identify applicable elements. Other 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.<sup>23-25</sup> 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 disability pension costs.<sup>26</sup>

***Recommendation #4: Negotiate with the local union to phase in an annual physical ability test.*** NFPA 1500 requires FD members who engage in emergency operations to be annually evaluated and certified by the FD as meeting the physical performance requirements identified in paragraph 8-2.1.<sup>20</sup>

***Recommendation #5: Ensure that fire fighters are cleared for duty by a physician familiar with the consensus guidelines published by the NFPA 1582 and knowledgeable about the physical demands of fire fighting.***

Frequently, private physicians are not familiar with an employee's job duties or with guidance documents such as NFPA 1582. To ensure physicians are aware of these guidelines, we recommend that the FD provide the contract and private physicians with a copy of NFPA 1582. In addition, we recommend the FD carefully evaluate 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. Lastly, we recommend that all return-to-work clearances be reviewed by a FD contracted physician. Thus, the final decision regarding



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medical clearance for return to work lies with the FD with input from many sources including the employee's private physician.

**REFERENCES**

1. Colucci WS and Braunwald E [1997]. Pathophysiology of heart failure. In: Braunwald (ed). Heart Disease. 5th ed. Philadelphia, PA: W.B. Saunders Company, p. 401.
2. Armstrong WF and Feigenbaum H [2001]. Echocardiography. In: Braunwald E, Zipes DP, Libby P (eds). Heart Disease: A Text of Cardiovascular Medicine. 6th ed. Vol. 1. Philadelphia, PA: W.B. Saunders Company, p. 167.
3. Siegel RJ [1997]. Myocardial Hypertrophy. In: S. Bloom (ed). Diagnostic Criteria for Cardiovascular Pathology Acquired Diseases. Philadelphia, PA: Lippencott-Raven, pp. 55-57.
4. Meyerburg RJ, Castellanos A [2001]. Cardiovascular collapse, cardiac arrest, and sudden cardiac death. 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. 228-233.
5. AHA [1998]. AHA Scientific Position, Risk Factors for Coronary Artery Disease. Dallas, TX: American Heart Association.
6. Jackson E, Skerrett PJ, and Ridker PM [2001]. Epidemiology of arterial thrombosis. In: Coleman RW, Hirsh J, Marder VIJ, et al. eds. Homeostasis and thrombosis: basic principles and clinical practice. 4th edition. Philadelphia: Lippincott Williams and Wilkins.
7. Libby P [2001]. The pathogenesis of atherosclerosis. 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. p. 1378.
8. Shah PK [1997]. Plaque disruption and coronary thrombosis: new insight into pathogenesis and prevention. Clin Cardiol 20 (11 Suppl2):II-38-44.
9. Fuster V, Badimon JJ, Badimon JH [1992]. The pathogenesis of coronary artery disease and the acute coronary syndromes. N Eng J Med 326:242-250.
10. 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.
11. 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.
12. Siscovick DS, Weiss NS, Fletcher RH, Lasky T [1984]. The incidence of primary cardiac arrest during vigorous exercise. N Eng J Med 311:874-877.
13. Tofler GH, Muller JE, Stone PH, et al. [1992] Modifiers of timing and possible triggers of acute myocardial infarction in the Thrombolysis in Myocardial Infarction Phase II (TIMI II) Study Group. J Am Coll Cardiol 20:1049-1055.
14. Ainsworth BE, Haskell WL, Leon AS, et al [1993]. Compendium of physical activities: classification of energy costs of human physical activities. Med Sci Sports Exerc 25:1:71-80.
15. American Industrial Hygiene Association Journal [1971]. Ergonomics guide to assessment of metabolic and cardiac costs of physical work. Am Ind Hyg Assoc J 560-564.
16. NFPA [2003]. Standard on comprehensive occupational medical program for FD's. Quincy MA: National Fire Protection Association. NFPA 1582-2003.



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17. American College of Cardiology/American Heart Association [2002]. ACC/AHA 2002 guideline update for exercise testing: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing). Gibbons RJ, Balady GJ, Bricker JT, et al., eds. Bethesda, MD.
18. Dec GW [1998]. Recognition and management of patients with cardiomyopathies. In: Goldman L, Braunwald E, eds. Primary Cardiology. Philadelphia: W.B. Saunders Company, pp. 487-507.
19. IAFF, IAFC [2000]. The fire service joint labor management wellness/fitness initiative. Washington: International Association of Fire Fighters, International Association of Fire Chiefs.
20. NFPA [1997]. Standard on FD occupational safety and health program. Quincy MA: National Fire Protection Association. NFPA 1500-1997.
21. Plowman SA and Smith DL [1997]. Exercise physiology: for health, fitness and performance. Boston, MA: Allyn and Bacon.
22. NFPA [2000]. Standard on health-related fitness programs for fire fighters. Quincy MA: National Fire Protection Association. NFPA 1583-2000.
23. 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.
24. 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.
25. Aldana SG [2001]. Financial impact of health promotion programs: A comprehensive review of the literature. Am J Health Promot 15:296-320.
26. Unpublished data [1997]. City Auditor, City of Phoenix, AZ. Disability retirement program evaluation. Jan 28, 1997.

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