



Fire Fighter/Paramedic Suffers a Dissection of his Aorta While Participating in Physical Fitness Training – Texas

SUMMARY

On March 29, 2005, a 26-year-old male career Fire Fighter/Paramedic (FF/P) worked an overtime shift as the driver of Station #3's ambulance. The shift lasted 9½ hours, 0700 to 1630 hours, during which time the ambulance responded to three medical emergencies. Shortly after his shift ended, the FF/P started his typical 5-mile jog as part of the Fire Department (FD) physical fitness program. After jogging about ½ mile, he reportedly felt a pop in his chest and a tingling in his legs which made it impossible to run and difficult to walk. An ambulance was summoned, and transported him to the local emergency department, where a dissecting aortic aneurysm was diagnosed. He was transferred via helicopter to a referral medical center for surgical repair. After 15 hours of surgery, the FF/P died in the operating room. The death certificate was completed and the autopsy conducted by the County Medical Examiner who listed the immediate cause of death as "Aortic dissection and its sequelae" with "Hypertensive cardiovascular disease" being another significant condition. It is possible that the heavy lifting during his shift initiated the tear of the aorta. It is also possible that his jogging put additional torque on his aorta resulting in the tear, or that the jogging may have extended the dissection. NIOSH investigators, however, cannot definitively determine whether these events initiated or exacerbated the FF/P's aortic dissection.

It is unlikely the following recommendations could have prevented the FF/P's death. Nonetheless, NIOSH investigators offer these to improve the FD's safety and health programs.

- *Conduct exercise stress tests only on FFs at increased risk for CAD.*
- *Discontinue routine annual electrocardiograms (EKG) unless medically indicated.*

- *Discontinue annual screening chest X-rays (CXR) unless medically indicated.*
- *Restart the FD's screening program for tuberculosis (TB).*
- *Phase-in an annual physical performance (physical ability) evaluation to ensure fire fighters are physically capable of performing the essential job tasks of structural fire fighting.*

INTRODUCTION & METHODS

On March 30, 2005, a 26-year-old male FF/P died 20 hours after suffering a dissecting aortic aneurysm while jogging. NIOSH was notified about this fatality on March 31, 2005 and contacted the FD in May 2005 to gather additional information. On September 12, 2006, an Occupational Physician from the NIOSH Fire Fighter Fatality Investigation Team traveled to Texas to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed the following persons:

- Division Chief for Fire Operations
- Division Chief for Emergency Medical Services (EMS)

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

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- Crew Member on Duty with the FF/P
- President of the International Association of Fire Fighters (IAFF) Local 3731
- The FF/P's wife

During the site visit NIOSH personnel reviewed the following records:

- FD policies and operating guidelines
- FD annual medical evaluations of the FF/P
- Death certificate
- Autopsy report
- Air ambulance report
- Hospital records
- Report of the incident from the State Fire Marshal's Office
- Co-worker statement
- Letter from the former FD Medical Director

INVESTIGATIVE RESULTS

Incident. On March 29, 2005, a 26-year-old male career FF/P worked an extra (overtime) shift as the driver of Station #3's mobile intensive care unit (ambulance). The shift lasted 9½ hours, 0700 to 1630 hours, during which time the ambulance responded to three calls. All three calls were medical emergencies which involved the loading and transport of patients to the local emergency department (ED). Toward the end of his shift the FF/P helped deliver a clothes dryer, weighing about 80 pounds, from an appliance store to Station #2. The FF/P never expressed symptoms or signs of distress during his shift.

At approximately 1830 hours, the FF/P started his typical 5-mile jog around his neighborhood as part of the FD's physical fitness program. After jogging about ½ mile, he reportedly felt a pop in his chest and a tingling in his legs which made it impossible to run and difficult to walk. After crawling through an alley to the street, he was able to attract someone's attention and asked them to call 911.

An ambulance arrived shortly thereafter (about 1900 hours) and found the FF/P conscious, with mild-to-moderate upper back/chest pain, and difficulty walking. By this time his wife had been notified of the situation and she drove around the corner where her husband was being evaluated. She reported that her husband and the ambulance personnel, while concerned about the condition, did not seem overly alarmed. She made arrangements to meet him at the local hospital's ED as the ambulance prepared him for transport.

The FF/P arrived at the ED at approximately 1930 hours. When the FF/P's wife arrived at the hospital's ED at approximately 1945 hours, his condition had deteriorated. His upper back/chest pain had become much more severe and his blood pressure was elevated [160 milliliters of mercury (mmHg) systolic and 100 mmHg diastolic]. Given his family history (mother) of thoracic and abdominal aortic aneurysms, the local ED physician was concerned about a possible aortic dissection. After treating his high blood pressure and back/chest pain with intravenous (IV) medications, a chest CT scan was ordered. This test revealed an extensive aortic dissection involving the entire aorta. Due to the need for emergency surgery, the FF/P was flown by emergency helicopter to the area's tertiary care medical center. The helicopter departed the local hospital at 2157 hours and arrived at the tertiary care center at 2208 hours.

During the evaluation at the tertiary hospital the family considered transporting the FF/P to the hospital where his mother had her aneurysm successfully repaired. But given that this hospital was over 200 miles away and the FF/P's critical situation, the decision was made to perform the emergency operation at that hospital as soon as possible. Surgery to repair the dissection started at 0122 hours on March 30th. After 15 hours of surgery, the FF/P died in the operating room at 1545 hours (as typed on the operative record). This time slightly differs with the time of death listed on the death certificate – 1530 hours.



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Medical Findings. The death certificate was completed and the autopsy conducted by the County Medical Examiner who listed the immediate cause of death as “Aortic dissection and its sequelae” with “Hypertensive cardiovascular disease” being another significant condition. The autopsy was significant for the following findings:

- Extent of the dissection: from proximal left and right coronary artery at the aortic root to the right common iliac artery
- Cardiomegaly (a large heart) – [a finding suggestive of hypertension]
- Concentric left ventricular hypertrophy (an enlargement of the heart’s left ventricle) [a common finding among individuals with hypertension]
- No atherosclerotic coronary artery disease
- Negative blood tests for illicit drugs or alcohol

The FF/P had annual medical evaluations conducted by the FD since 2002. During two of these evaluations the FF/P had slightly elevated blood pressure readings (systolic BP of 138 mmHg in 2004, and diastolic BP of 88 mmHg in 2003). These two readings suggest stage I hypertension.¹ In addition, his exercise stress test done in 2005 as part of the FD annual medical evaluation suggested an exaggerated blood pressure response to exercise (systolic BP of 232 mmHg at peak exercise). While this value was not high enough to be considered a relative indication to stop the test (systolic BP > 250 mmHg),² some researchers would consider it an exaggerated response and a predictor of future hypertension.³ Otherwise, the FF/P’s stress tests were entirely normal (negative for signs of coronary artery disease).

During the FD medical evaluations for the years 2003-2005, the records mention that the FF/P’s mother had a surgically repaired aortic aneurysm. The examining physician recommended “screening” for this condition at the FF/P’s “convenience” and “leisure.” In

2005, the examining physician also noted a possible I/VI systolic heart murmur with a click and recommended follow-up. The FF/P died 6 weeks after this exam, before an appointment could be scheduled. The FF/P never reported any cardiac symptoms to his family or coworkers until this event.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the FD consisted of 44 uniformed career personnel and served a population of 33,000 in a geographic area of 18 square miles. There are two fire stations. Fire fighters work a 24 hour shift followed by 48 hours off.

The FD requires all applicants for the position of FF to be a certified paramedic (or certifiable within 90 days). After passing a written test, applicants are required to pass a physical ability test. If the candidate passes this test, a background check and psychological test is performed, followed by interviews by a FD panel, the Human Resources Director, and the Fire Chief. A conditional job offer is made to qualified candidates pending medical clearance (discussed below). If cleared for full-duty, the employee has a 1-year probationary period. If needed, the probationary employee is sent to the State Fire Academy to become certified as a FF II. The FF/P was certified as a Fire Fighter II, Paramedic, Driver/Operator, Hazmat-awareness, and had 5 years of fire fighting experience.

Pre-placement Medical Evaluations. The FD requires a pre-placement medical evaluation for all new hires, regardless of age. Components of this evaluation include the following:

- History
- Vital signs
- Physical examination
- Body fat measurement via calipers
- Musculoskeletal fitness determined by sit-ups, push-ups, and flexibility (sit and reach)



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- Blood tests: Complete blood count (CBC), Sequential multi-channel analysis with computer-20 (also known as a SMA-20 or metabolic panel), and lipid profile
- Urine drug screen
- Pulmonary function test (spirometry)
- Resting EKG
- Exercise stress test
- CXR
- Audiometry
- Vision test (distant and near vision, color, and peripheral fields)
- Bloodborne pathogens testing (Hepatitis B & C antibody)

These evaluations are performed by the FD contract physician, who makes a determination regarding medical clearance for fire fighting duties and forwards this decision to the FD.

Periodic Medical Evaluations. Periodic medical evaluations are required annually by this FD. Components of this are the same as the pre-placement evaluation except the urine drug screen is not repeated. If an employee is injured at work, the employee is evaluated and must be cleared for return to work by the contract physician. If the employee is returning to work after an illness or a non-occupational injury, the employee's primary care physician makes the return to work determination after being provided with a list of job requirements by the FD. As described earlier, the FF/P's last FD medical examination was in February 2005. He was never restricted for duty.

Fitness/Wellness Programs. The FD has a voluntary wellness/fitness program for all FF. The fitness program involves a free membership to the local health club. Each crew is allowed to exercise at the club for 1 hour during their shift. The wellness program is incorporated into the periodic medical evaluation and includes education on smoking cessation, weight control, high blood pressure, diabetes, and cholesterol.

DISCUSSION

Aortic Dissection. The aorta is the major artery that carries blood from the heart to the rest of the body. The aortic wall is composed of three layers in sequence from the lumen proceeding outwards: the intima, medial, and adventitia. Aortic dissection occurs when the blood enters the medial layer typically after a tear in the intima.⁴⁻⁸ Blood expelled from the heart under high pressure (systole) pushes more blood inside the artery wall, further splitting (dissecting) the aorta. Connective tissue abnormalities of the medial layer facilitates the flow of blood away from the heart and toward the heart.⁴⁻⁸

Typical presentation is the sudden onset of severe chest pain radiating to the back frequently associated with sweating.⁴⁻⁸ Emergency surgical repair is the preferred treatment for ascending aortic dissections (type A) with an overall in-hospital mortality rate of 15% to 20%.⁴⁻⁸ Temporizing medical treatment includes lowering the blood pressure and slowing the heart rate.⁴

Risk factors for aortic dissection are listed in Table 1. Other than probable hypertension, the FF/P was not known to have any of these risk factors. Aortic dissection must be distinguished from aneurysms of the aorta, which are a simple expansion of the blood vessel due to medial weakening.⁴ Dissections can occur in the absence of aneurysms and not all aneurysms result in dissection.

There are many symptoms, signs, and medical tests used to diagnose an aortic dissection. Non-specific signs during the physical examination include the following:

- Comparing the carotid, radial, and femoral pulses⁵
- Comparing the blood pressure between the two arms^{9,10}
- Heart murmur during auscultation (stethoscope)



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Table 1. Risk Factors for Aortic Dissection (Adapted from Chen et. al. 1997)⁴

Male Gender (3:1)
Age > 50 years
Hypertension
Connective tissue disorders (e.g. Marfan's syndrome, Ehlers Danlos syndrome)
Turner's syndrome
Noonan's syndrome
Coarctation of the aorta
Congenital bicuspid or unicuspid aortic valve
History of cardiac surgery, particularly aortic valve surgery
Granulomatous arteritis
Syphilitic aortitis
Pregnancy
Trauma
Cocaine use
Systemic lupus
Relapsing polychondritis

A pulse and blood pressure comparison between the arms was not mentioned in the FD's annual medical evaluation records and was most likely not performed. A heart murmur was noted on the FF/P's last medical evaluation (February 16, 2005), but the possible murmur was not the type typically found with aortic dissection (diastolic murmur of aortic valve regurgitation).^{4,5} In addition, the CXRs and EKGs did not show any abnormalities consistent with an aortic dissection. Given this information and lack of symptoms, it is very unlikely the FF/P had suffered a partial aortic dissection prior to this incident.

NIOSH investigators were unable to find any medical literature supporting use of a screening test (e.g., a chest CT scan or transesophageal echocardiography) to diagnose a thoracic aortic dissection among young, asymptomatic individuals with a family history of aortic aneurysms or aortic dissections. The U.S. Preventive Services Task Force (USPSTF) does

recommend one-time screening for *abdominal* aortic aneurysms by ultrasound in men aged 65 to 75 who have ever smoked, but the panel did not address the issue of thoracic aortic aneurysms or dissections.¹¹

It is possible that the heavy lifting associated with transporting the three patients and carrying the clothes dryer initiated the tear of the aorta resulting in the dissection. Likewise, it is possible that his jogging in some way put additional pressure on his aorta resulting in the tear, or that the jogging may have extended the dissection.¹² NIOSH investigators, however, cannot definitively determine that these events triggered the aortic dissection.

RECOMMENDATIONS

It is unlikely the following recommendations could have prevented the FF/P's death. Nonetheless, NIOSH investigators offer these recommendations to improve the FD's safety and health programs.

Recommendation #1: Conduct exercise stress tests only on FFs at increased risk for CAD.

The 2007 Edition of National Fire Protection Association (NFPA) 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments states "Stress EKG with or without echocardiography or radionuclide scanning shall be performed as clinically indicated by history or symptoms."¹³ Thus, the standard recommends stress test for candidates or members only if "clinically indicated." If a member or applicant has known heart disease or has symptoms suggestive of heart disease, a stress test would probably be clinically indicated. If a member or applicant is asymptomatic and has no risk factors for coronary artery disease (CAD), a stress test is probably not clinically indicated. However, if the asymptomatic member or applicant has CAD risk factors, then a stress test *could* be clinically indicated, depending on the number and type of CAD risk factors.

Three organizations [NFPA, American Heart Association/ American College of Cardiology (AHA/ACC),



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and the Department of Transportation (DOT)] have similar, but not exactly the same, recommendations.^{14,15} These include testing individuals at increased risk for ischemic heart disease based on their risk factors for coronary artery disease (CAD). NFPA 1582 recommends diagnostic (maximal or symptom limiting) stress tests for:

- 1) FFs with positive or questionable positive changes on screening submaximal tests
- 2) FFs with new onset chest pain or other symptoms suggestive of CAD
- 3) FFs over the age of 45 (men) and 55 (women) with two or more CAD risk factors.

NFPA defines CAD risk factors as hypercholesterolemia (total cholesterol greater than 240 mg/dL), hypertension (systolic >140 mmHg and/or diastolic blood pressure > 90 mm Hg), smoking, diabetes mellitus, or family history of premature CAD (heart attack or sudden cardiac death in a first-degree relative less than 60 years old).¹³

Another organization, the U.S. Preventive Services Task Force (USPSTF), does not recommend stress tests for asymptomatic individuals, even those with risk factors for CAD.¹⁶ Rather, USPSTF recommends the diagnosis and treatment of modifiable risk factors (hypertension, high cholesterol, smoking, and diabetes). The USPSTF indicates that there is insufficient evidence to recommend screening middle age and older men or women in the general population but notes that “screening individuals in certain occupations (pilots, truck drivers, etc.) can be recommended on other grounds, including the possible benefits to public safety.”

Recommendation #2: Discontinue routine annual electrocardiograms (EKG) unless medically indicated.

According to NFPA 1582, “periodic resting electrocardiograms have not been shown to be useful but can be reasonable as a member’s age increases.”¹³ The EKG tracing during a stress test is a much better tool

to identify heart abnormalities. Therefore, NIOSH investigators recommend the FD continue the resting EKG as part of its post offer/pre-placement medical evaluation, but discontinue the annual resting EKG performed as a screening test for all FF. These annual resting EKGs represent an unnecessary expense for the FD.

Recommendation #3: Discontinue annual screening CXR unless medically indicated.

According to NFPA 1582, “chest x-rays shall include an initial baseline and shall be repeated every 5 years or as medically indicated.”¹³ CXRs are currently being conducted every year during the FD’s annual medical evaluation. These X-rays expose members to unnecessary radiation and represent an unnecessary expense for the FD. In addition, annual CXRs are not recommended by the OSHA Hazmat standard unless clinically indicated (e.g., respiratory symptoms).¹⁷

Recommendation #4: Restart the FD’s screening program for tuberculosis (TB).

NFPA 1582 recommends annual PPD skin tests for fire fighters to screen for TB.¹³ The Centers for Disease Control and Prevention (CDC) recommends “patient transport staff, including EMS [Emergency Medical Services] be included in a TB surveillance program.”¹⁸ Given the community served by the FD, NIOSH investigators considers FFs in this department will possibly be exposed to persons with TB disease. CDC defines this type of exposure as a “medium risk classification.”¹⁸ CDC recommends baseline and annual testing for TB infection (skin or blood test) for settings classified as medium risk.¹⁸ The CDC and NFPA 1582 provides specific guidance regarding administering, interpreting, and treating positive screening tests.^{13,18} The CDC goes on to describe a comprehensive TB surveillance program including use of N-95 respirators and operating ambulance ventilation systems.¹⁸



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Recommendation #5: Phase-in 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 8-2.1.¹⁹ The FD should conduct annual physical ability tests to ensure the fire fighters are physically capable of performing fire fighting duties.

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