



Fire Fighter Dies During Fire Department Standby - Arizona

SUMMARY

On December 15, 2001, a 48 year-old male career Assistant Chief, was participating in a Fire Department (FD) standby at a local civic event. After he positioned the mini-pumper at a hydrant, he began to unroll the four-inch supply hose. Soon after unrolling the hose he collapsed. A crew member, just arriving at this location, initially thought the victim was checking something under the mini-pumper. The crew member asked the victim what he was doing, but quickly noted he was unresponsive with shallow respirations. After notifying dispatch of the situation, the crew member began cardiopulmonary resuscitation (CPR). Approximately 63 minutes later, despite CPR and advanced life support (ALS) administered on the scene and at the hospital, the victim died. The death certificate listed “probable acute myocardial ischemia” due to “coronary atherosclerosis” due to “diabetes mellitus” as the immediate cause of death and a “history of previous myocardial infarction” as an other significant contributing condition. No autopsy was performed.

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

- ***Provide mandatory preplacement and 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.

- ***Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582.***
- ***Follow provisions in the revised OSHA respiratory protection standard, specifically providing medical evaluations and clearance to wear SCBA.***
- ***Ensure that the mandatory wellness/fitness program is accomplished.***
- ***Perform an autopsy on all on-duty fire fighter fatalities.***

Although unrelated to this fatality, the Fire Department should:

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

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. The program does not seek to determine fault or place blame on fire departments or individual fire fighters. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at www.cdc.gov/niosh/firehome.html or call toll free **1-800-35-NIOSH**



Fire Fighter Dies During Fire Department Standby - Arizona

INTRODUCTION & METHODS

On December 15, 2001, a 48-year-old male Assistant Chief lost consciousness after unrolling a section of four-inch supply hose at a fire hydrant during a Fire Department standby. Despite CPR and ALS administered by crew members, the ambulance crew, and in the emergency department, the victim died. NIOSH was notified of this fatality on December 19, 2001, by the United States Fire Administration. On December 20, 2001, NIOSH contacted the affected Fire Department to initiate the investigation. On January 14, 2002, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Arizona to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed:

- The Fire Chief
- The Union representative
- Crew members

During the site-visit NIOSH personnel reviewed:

- Fire Department policies and operating guidelines
- Fire Department incident report
- Hospital emergency department report
- Fire Department physical examination protocols
- Death certificate
- Past medical records of the deceased

INVESTIGATIVE RESULTS

Incident. On December 15, 2001, the involved Fire Department provided fire apparatus and emergency medical services standby in a local civic event. The victim left his home at approximately 1115 hours driving the mini-pumper (which he had taken home the night before) to the specified staging area. He arrived at a hydrant at approximately 1135 hours and began to unroll a section of four-inch supply hose. A Fire Fighter/EMT (co-worker), driving an

ambulance, neared the scene at approximately 1140 hours, and witnessed the victim unrolling the hose. As the ambulance came closer to the victim's location, he noticed the victim lying on the ground beside the mini-pumper. The crew member initially thought the victim was checking something under the apparatus. After parking the ambulance and walking to the victim (time measured in seconds), the crew member noted the victim was not responding to questions. The crew member made a quick assessment and found the victim unconscious with shallow respirations. After retrieving the medical treatment kit, including oxygen, from the ambulance, he inserted an oropharyngeal airway (OPA) and began assisted ventilations via bag-valve-mask. He went back to the ambulance and notified Dispatch of the situation and requested Engine 1 respond (the other ambulance had responded to another call). After re-assessing the victim and finding him unresponsive, pulseless, and not breathing, the crew member began CPR. Engine 1 with three personnel (Driver/Operator [Fire Fighter-Paramedic (FF-P)], Fire Fighter, and a Fire Fighter cadet) was dispatched at 1153 hours, responded at 1154 hours and arrived on the scene at 1203 hours. Reassessment found the victim to be unresponsive, pulseless, not breathing and CPR in progress. The FF-P connected a cardiac monitor to the victim, revealing ventricular fibrillation (V.Fib.) (heart rhythm not compatible with life) and three defibrillations (shocks) were administered. Each one being unsuccessful at converting his heart rhythm. An attempt at intubation was unsuccessful and the OPA was re-inserted.

The other ambulance (Able One) (Captain/Paramedic and an EMT) arrived on the scene and the victim was loaded onto the stretcher. Advanced life support (ALS) measures, including intravenous medications, were begun. The cardiac monitor again revealed V.Fib. and one shock was delivered. A second attempt at intubation was successful. A fifth shock was delivered and the victim's heart rhythm



Fire Fighter Dies During Fire Department Standby - Arizona

reverted to asystole. An attempt at cardiac pacing was unsuccessful. ALS procedures including CPR continued with no change in patient status. The ambulance departed the scene enroute to the hospital emergency department (ED), arriving at the ED at 1230 hours. Inside the ED, ALS measures continued until 1244 hours, when the victim died and resuscitation efforts were discontinued.

Medical Findings.

The death certificate was completed by the County Medical Examiner, who listed “probable acute myocardial ischemia” due to “coronary atherosclerosis” due to “diabetes mellitus” as the immediate cause of death and a “history of previous myocardial infarction” as an other significant contributing condition. No autopsy was performed.

A carboxyhemoglobin level was not checked due to the victim’s lack of exposure to sources of carbon monoxide prior to his collapse.

Medical records indicate the victim had eight risk factors for coronary artery disease (male gender, age over 45, hypertension, high triglycerides, diabetes mellitus, cigarette smoking, obesity, and lack of exercise). He was receiving prescription medications for his hypertension and diabetes, although he was poorly compliant. He also had known CAD as evidenced by a prior inferior myocardial infarction (heart attack) in 1992 accompanied by a first degree heart block (a minor heart rhythm abnormality). A subsequent cardiac catheterization in 1992 showed a totally occluded right coronary artery, a 95% blockage of his circumflex between the first and second marginal, a small caliber left anterior descending artery with a 10% blockage, and a normal left main coronary artery. The circumflex blockage was successfully opened by angioplasty, and results of an exercise stress test were not available to the NIOSH investigator at the time of this report.

Although the victim had been evaluated for four episodes of chest pain after his angioplasty, none of these resulted in a heart attack or a change in his medical regimen. His co-workers stated he did not express symptoms of angina just prior to this incident.

To reduce the risk of sudden cardiac arrest and heart attacks among fire fighters as well as other medical causes of incapacitation, NFPA has developed its “Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians,” otherwise known as 1582.¹

NFPA 1582 also recommends that, as part of its appendix which is for “informational purposes only,” fire fighters over the age of 35 with risk factors for CAD be screened for obstructive CAD by an Exercise Stress Test (EST).

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the Fire Department consisted of 24 uniformed personnel (17 full-time and seven part-time) and served a population of 11,000 residents for fire response and 30,000 residents for EMS in a geographic area of ten square miles for fire response and 92 square miles for EMS. There is one fire station. Fire fighters work the following schedule: 24-hours on-duty, 24-hours off-duty for three shifts, then are off-duty for 4 days, from 0700 hours to 0700 hours. Part-time fire fighters fill in as needed. The victim worked 8-hour days, Monday-Friday, and was on call the remainder of the time.

Training. The Fire Department requires all new fire fighter applicants to be State-certified Fire Fighter I and II and emergency medical technicians (EMTs), pass a written exam, a physical ability test, an oral interview, and a preplacement physical examination prior to being hired.



Fire Fighter Dies During Fire Department Standby - Arizona

Once hired, fire fighters are placed on one of three shifts. Fire fighters receive recurrent training on each shift. Additional fire fighter training is available at other local fire departments and at the State Fire Academy. There is no State requirement for fire fighter re-certification. Bi-annual recertification is required for EMT/Paramedics. The victim was trained as a Fire Officer, Driver/Operator, EMT, Wildland Fire Fighter, and had 20 years of fire fighting experience.

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

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Vision test
- Audiogram
- Blood tests: complete blood count with differential (CBC), chemistry, lipid, and liver profile
- Urine tests: urinalysis drug screen
- Chest x-ray
- Lumbar spine x-ray

These evaluations are performed by a local medical clinic under contract with the City. Once this evaluation is complete, a decision regarding medical clearance for fire fighting duties is made by the examining physician and forwarded to the FD.

All candidates are required to complete a timed performance evaluation of typical fire fighting duties (physical ability test) (PAT) prior to being hired. No prior medical clearance is given for the physical ability test.

The PAT includes:

- Walk 1 mile within 16 minutes with an SCBA
- 35 bent knee sit-ups within 2 minutes
- 25 push-ups within 2 minutes

- Dummy drag for 100', then carry the dummy
- Advance a charged, 100' section of 2½-inch hoseline back past the water source and then advance the hoseline 100" in the opposite direction within 45 seconds.

Periodic Evaluations

Periodic medical evaluations are not required by this FD. Medical clearance for SCBA use is not conducted by this FD. If an employee is injured at work, he/she must be cleared for "return to work" by their personal physician. In addition, if a fire fighter has a non-occupational injury or medical condition resulting in lost work, the Chief of the FD can require that individual be cleared for "return-to-work" by their personal physician.

There is a mandatory fitness/wellness program. The program includes strength and aerobic exercises. Fitness equipment is available in the station. Wellness programs (diet, nutrition, smoking cessation, diabetes, and hypertension) are not available.

DISCUSSION

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.² Risk factors for its development include age over 45, male gender, family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes.^{3,4} The victim had eight of these risk factors and was diagnosed with coronary artery disease in 1992.

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.⁵ However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.⁶ Heart attacks typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have

Fire Fighter Dies During Fire Department Standby - Arizona

not developed a collateral blood supply.⁷ This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. Since an autopsy was not performed, it cannot be determined if a thrombus was present.

Blood clots, or thrombus formation, in coronary arteries are initiated by disruption of atherosclerotic plaques. Certain characteristics of the plaques (size, composition of the cap and core, presence of a local inflammatory process) predispose the plaque to disruption.⁷ Disruption then occurs from biomechanical and hemodynamic forces, such as increased blood pressure, increased heart rate, increased catecholamines, and shear forces, which occur during heavy exercise.^{8,9}

Firefighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.¹⁰ Firefighting activities are strenuous and often require fire fighters to work at near maximal heart rates for long periods. The increase in heart rate has been shown to begin with responding to the initial alarm and persist through the course of fire suppression activities.¹¹⁻¹³ Even when energy costs are moderate (as measured by oxygen consumption) and work is performed in a thermoneutral environment, heart rates may be high (over 170 beats per minute) owing to the insulative properties of the personal protective clothing.¹⁴ Furthermore, fire fighting can result in severe fluid loss which decreases blood volume and decreases the amount of blood pumped from the heart (stroke volume).¹⁵ Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.¹⁶⁻¹⁹ The victim was wearing his station uniform and unrolling a section of 4-inch supply hose. This is considered a light level of physical exertion.^{20,21}

The physical stress of handling the supply hose and his underlying atherosclerotic CAD contributed to

this fire fighter's "probable" heart attack, subsequent cardiac arrest, and sudden death. The term "probable" is used because autopsy findings (thrombus formation), blood tests (cardiac isoenzymes), or an ECG findings are required to "confirm" a heart attack (myocardial infarction). No autopsy was performed; the victim died prior to the cardiac isoenzymes becoming positive, and he had no heart beat to show the characteristic findings of a heart attack on his ECG. However, he did have a history of a previous heart attack.

NFPA 1582 recommends a yearly physical evaluation to include a medical history, height, weight, blood pressure, and visual acuity test.¹ NFPA 1582 also recommends a thorough examination to include vision testing, audiometry, pulmonary function testing, a complete blood count, urinalysis, and biochemical (blood) test battery be conducted on a periodic basis according to the age of the fire fighter (less than 30: every 3 years; 30-39: every 2 years; over 40 years: every year). The Department requires a pre-placement medical examination for all new hires but not a periodic medical evaluation.

NFPA recommends fire fighters with one or more CAD risk factors get their first EST at age 35; for those without CAD risk factors, at age 40.¹ NFPA considers CAD 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).¹ The EST should then be performed on a periodic basis, at least once every two years.¹ Unfortunately, it has problems with both false negatives (inadequate sensitivity) and false positives (inadequate specificity), particularly for asymptomatic individuals (individuals without symptoms suggestive of angina), young men, and women.^{22,23} This has led other expert groups to **not** recommend EST for asymptomatic individuals without risk factors for CAD.^{24,25}

Fire Fighter Dies During Fire Department Standby - Arizona

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.”²⁴

- 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 1st 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.

Fire suppression activities involve strenuous physical activity; therefore, the ACC/AHA seem to be making a distinction between those already engaged in strenuous physical activity (conditioning), and those **beginning** a strenuous exercise program.

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).²⁵

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.”²⁵

Since the victim had CAD, the performance of an EST is recommended by NFPA 1582. However, the AHA and the USPSTF are less clear about whether an EST should have been performed in this individual. Nonetheless, an EST performed prior to December 2001 in accordance with NFPA 1582 could have identified his CAD, thereby leading to further evaluation and treatment, and possibly the prevention of his sudden cardiac death.

RECOMMENDATIONS

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

Recommendation #1: Provide mandatory preplacement and 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.

The FD currently performs preplacement physical evaluations, which include routine lumbar spine X-rays. While these X-rays may be useful in the evaluation of individuals with existing problems, the American College of Radiology, American College of Occupational and Environmental Medicine, and NIOSH all have concluded that lumbar spine X-rays have no value as a routine screening measure to



Fire Fighter Dies During Fire Department Standby - Arizona

determine those at risk for back injuries.^{26,27} This procedure involves both an unnecessary radiation exposure for the applicant and an unnecessary expense for the Department.

Guidance regarding the content and frequency of preplacement and periodic medical evaluations and examinations for fire fighters can be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians,¹ and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.²⁸ The Department is not legally required to follow either of these standards. Nonetheless, we recommend the City and Union **work together** to establish the content and frequency to be consistent with the above guidelines.

NFPA 1582 and the IAFF/IAFC wellness/fitness initiative both recommend at least biannual EST for fire fighters.^{1,28} They recommend that these tests begin at age 35 for those with CAD risk factors, and at age 40 for those without CAD risk factors. The EST could be conducted by the fire fighter's personal physician, the City physician, or the Department's contract physician. If the fire fighter's personal physician or the contracted physician conducts the test, the results must be communicated to the City physician, who should be responsible for decisions regarding medical clearance for fire fighting duties.

In addition to providing guidance on the frequency and content of the medical evaluation, NFPA 1582 provides guidance on medical requirements for persons performing fire fighting tasks. NFPA 1582 should be applied in a **confidential, nondiscriminatory** manner. Appendix D of NFPA 1582 provides guidance for Fire Department Administrators regarding legal considerations in applying the standard.

Applying NFPA 1582 also involves economic issues. These economic concerns go beyond the costs of

administering the medical program; they involve the personal and economic costs of dealing with the medical evaluation results. NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, addresses these issues in Chapter 8-7.1 and 8-7.2.²⁹

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.

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

Physicians providing input regarding medical clearance for fire fighting duties should be knowledgeable about the physical demands of firefighting and familiar with the consensus guidelines published by NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians. To ensure private physicians are aware of these guidelines, we recommend that the Fire Department provide the private physicians with a copy of NFPA 1582. In addition, we recommend the Fire Department not automatically accept the opinion of the employee's private physician regarding return to work. This decision requires knowledge not only of the employee's medical condition, but also the employee's job duties. Frequently, private physicians are not familiar with an employee's job duties, or guidance documents, such as NFPA 1582. Lastly, we recommend that all return-to-work clearances be reviewed by the Fire Department physician/



Fire Fighter Dies During Fire Department Standby - Arizona

contracted physician. Thus, the final decision regarding medical clearance for return to work lies with the Fire Department with input from many sources including the employee's private physician.

Recommendation #3: Provide fire fighters with medical evaluations and clearance to wear SCBA.

OSHA's Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employees using respiratory protection.³⁰ Such employees include fire fighters who utilize SCBA in the performance of their duties. These clearance evaluations are required for private industry employees and public employees in States operating OSHA-approved State plans. Arizona is a State-plan State, therefore, public sector employers are required to comply with OSHA standards. A copy of the OSHA medical checklist has been provided to the Fire Department.

Recommendation #4: Ensure that the mandatory wellness/fitness program is accomplished.

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, namely obesity and diabetes.³¹ NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, and NFPA 1583, Standard on Health-Related Fitness Programs for Fire Fighters, require a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.^{29,32} In 1997, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) published a comprehensive Fire Service Joint Labor Management Wellness/Fitness Initiative to improve fire fighter quality of life and maintain physical and mental capabilities of fire

fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service program. They produced a manual and a video detailing elements of such a program.²⁸ 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. The Fire Department has a written, mandatory wellness/fitness program. However, compliance with the policy is not ensured. Participation is not always possible due to emergency responses and staffing levels.

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

In 1995, the United States Fire Administration (USFA) published the *Firefighter Autopsy Protocol*.³³ This publication hopes to provide "a more thorough documentation of the causes of firefighter deaths for three purposes:

- to advance the analysis of the causes of firefighter deaths to aid in the development of improved firefighter health and safety equipment, procedures, and standards;
- to help determine eligibility for death benefits under the Federal government's Public Safety Officer Benefits Program, as well as state and local programs; and
- to address an increasing interest in the study of deaths that could be related to occupational illnesses among firefighters, both active and retired."

Recommendation #6: Provide adequate fire fighter staffing to ensure safe operating conditions.

This finding did not contribute to this fatality, but was identified during the NIOSH investigation. One provision in OSHA's Respiratory Protection

Fire Fighter Dies During Fire Department Standby - Arizona

Standard requires adequate staffing be present prior to entering structures with hazards immediately dangerous to life and health (“two in: two out”).³⁰ NFPA 1710 requires that “on-duty personnel be assigned to fire suppression shall be organized into company units and shall have appropriate apparatus and equipment assigned to such companies.”³⁴ Those companies may respond with two apparatus, depending on the seating configuration of the apparatus to ensure four personnel arrive on scene.³⁴ Personnel assigned to the initial arriving company shall have the capability to implement an initial rapid intervention crew (IRIC),³⁴ which requires four personnel (two to enter the structure and two standing by outside). NFPA 1500 recommends that “members operating in hazardous areas at emergency incidents shall operate in teams of two or more.”²² Understaffing causes those members on-scene to work harder and for longer periods of time. Additionally, it requires the use of extra fire companies in order to meet the demand for manpower. Engine and Ladder Companies should be staffed with four personnel at a minimum.

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Fire Fighter Dies During Fire Department Standby - Arizona

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Fire Fighter Dies During Fire Department Standby - Arizona

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INVESTIGATOR INFORMATION

This investigation was conducted by and the report written by Tommy N. Baldwin, MS, Safety and Occupational Health Specialist. Mr. Baldwin is with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component located in Cincinnati, Ohio.