Heart Attacks: The Major Cause of Firefighter Line of Duty Death (LODD)

James S. Cole MD, FACC, Cardiologist
Commissioner, Matlacha/Pine Island Fire Control District (MPIFCD)

LODD Caused by Coronary Artery Disease (CAD)

It is now clear, from recent detailed and statistically sophisticated studies[1,2,3], that approximately 50% of all line-of-duty-deaths (LODD) are primarily caused by heart attacks secondary to underlying coronary artery disease (CAD). Although the overall death rate from CAD for firefighters is no higher than the general population, certain line of duty firefighter activities (LODD) greatly increase their risk of death. Statistics indicate that nearly two thirds of firefighter heart attacks are associated with a fire incident (32% during fire suppression, 13% during alarm response and 14% immediately after fire containment). An additional 9% occurred during responses to non-fire emergencies, and 13% during physical training. Only 15% occurred during routine, non-emergency firehouse activities, despite the fact that the majority of time (often 90-95%) firefighters are engaged in such routine activities.

As expected, age was clearly related to LODD, increasing with each decade--2% between ages 20-39 years, 10% between 40-49 years, 25% between 50-59 years and 63% over the age of 60 years. There is also a higher incidence of LODD secondary to heart attacks in all-volunteer Departments, reflecting the average older age of the volunteers.

Mechanisms of a Heart Attack

Almost all heart attacks are caused by a series of events starting with the gradual development of atherosclerosis in coronary arteries[4]. This is a highly variable process resulting from the interplay of multiple risk factors such as circulating cholesterol, stress, elevated blood pressure, diabetes, nicotine, and genetic mediators (heredity) which control arterial wall susceptibility to these risk factors. This process has been identified in some people as early as late teens and early 20's and slowly progresses, over

subsequent decades, throughout the vascular system. Lipid material gradually infiltrates the lining of the arteries, disrupting the surface, resulting in plaque formation, narrowing the arterial lumen, and thereby decreasing the amount of blood that will pass through the artery. However, since coronary arteries are only 2-3 millimeters in diameter, it doesn't take very much atherosclerosis to cause a significant amount of blockage.

During periods of severe physical or emotional stress, several physiologic responses have direct effects on coronary arteries. The heart must pump more blood and oxygen through the body and therefore coronary arteries dilate to provide more blood and oxygen to heart muscle so as to increase its pumping capabilities. If significant plaque formation has developed, the coronary arteries can not dilate (increase in diameter) and heart muscle will not get the needed oxygen. This usually leads to pain (angina) and the individual stops exercising, thereby decreasing the demand and restoring a stable baseline balance. However, if exercise is not stopped and the imbalance in coronary blood flow persists for several minutes, an unstable situation develops in the heart muscle, resulting in ventricular fibrillation (sudden death).

Plaque rupture is another cause of heart attacks. Blood vessels contain a protein that starts the blood clotting process, so that when an artery is damaged, loss of blood will be reduced. Normal arterial linings keep this protein separate from the blood that is going through the artery. However, athrosclerotic plaques may damage this lining. At times of intense stress when coronary arteries are attempting to dilate and blood pressure is rapidly changing, a plaque may rupture, allowing the clotting protein to contact the blood and start a local blood clot that completely obstructs blood flow through the affected artery. The resulting heart muscle damage beyond the obstruction is referred to as a myocardial infarction or more commonly, a heart attack.

It is apparent that if a firefighter has significant underlying coronary atherosclerosis, and is suddenly required to respond to an intense fire event, he (96%) or she (4%) would be in a life threatening situation unknown to either the firefighter or their supervisors.

Prevention of Heart Attacks Causing Firefighter LODD

Early detection of underlying CAD is the cornerstone of prevention. This starts with firefighters reporting any change in symptoms such as inappropriate increase in shortness of breath, chest, arm or neck pain with stress, intermittent palpitations, dizziness or unexplained heartburn. A regular physical examination provides a review of these symptoms, plus an evaluation of risk factors such as diabetes, hypertension, obesity, smoking, abnormal blood lipids or family history of premature CAD. It may also detect physical signs associated with widespread athrosclerosis. Review of the age profile for LODD clearly supports a mandatory diagnostic stress test for all firefighters 50 years or older. If a firefighter has two or more risk factors or physical evidence of athrosclerosis, a stress test should be considered as young as 35-40 years. All firefighters should undergo a maximum treadmill stress test recording EKG data, plus imaging with either nuclear or ECHO techniques. This type of test will provide the highest sensitivity and specificity of all noninvasive tests presently available. Given the rapid increase in CAD deaths above the age of 50 years , the stress test should be repeated every 5 years. If CAD is suspected, a coronary angiogram may be required to definitively establish the diagnosis. Once clearly defined, risk factors should be corrected, CAD treatment initiated and duty modified as indicated by the above evaluation.

Even when none of the above major health problems are present, all firefighters should be involved in the active prevention of CAD, which includes regular aerobic exercise and strength training, proper diet and weight control, and smoking cessation. In addition to reducing the presence and severity of CAD, these activities will greatly improve firefighter performance with less physical and emotional stress during a fire incident.

How to Reduce LODD

The MPIFCD is a rural coastal island district, covering 42 square miles with three duty stations and 27(9 per shift) active, full time, firefighters. We have approached the early detection aspect of the problem using our County Occupational Health Program to obtain regular examinations and stress testing for all our personnel.

We have also set up a fitness center at each duty station which includes a Universal Smith machine (Hoist) and an Elliptical Trainer (Vision Fitness). The total cost for all three stations was $20,000 and provides standardized exercise programs for all firefighters regardless of their duty assignments. The fitness program follows Health Metrics Inc. guidelines provided in the Fitness Coordinators Manual, and is approved by the American College of Sports Medicine. It is based on the initial evaluation and subsequent improvement of aerobic capacity (VO2 max), muscle strength, muscle endurance, flexibility, and body composition(percent fat). The program provides a score, adjusted for age, gender, and altitude so individual comparisons can be made and individual progress evaluated.

"Future research should compare the incidence of LODD before and following wide implementation of risk management programs based on known risk (contributing factors) to LODD." [3] Hopefully we, and other Districts, will contribute to these studies when organized by large national organizations such as NFPA, IAFF, NIOSH, or USFA.

Summary

CAD is the primary cause of firefighter LODD. Data suggests that early detection, modifying risk factors and initiating proper therapy should significantly reduce this problem. An additional benefit should be improved fire fighting capabilities. However, long range studies specifically targeting firefighters will be required to document this favorable outcome.

References

1) Kales, Stefanos, N, et al. "Emergency Duties and Deaths from Heart Disease Among Firefighters in the United States". New England J. of Medicine, 356:1207-1215, 2007.

2) Rosenstock, Linda and Olsen, Jorn. "Firefighting and Death from Cardiovascular Causes".
New England J. of Medicine, 356:1261-1263, 2007.

3) Moore- Merrell, Lori, et al. Contributing Factors to Firefighter Line-Of-Duty Death in the
United States. IAFF Research Publication, Pages 1-56, September 30, 2006.

4) Baljzer, Christopher T. "Acute Myocardial Infarction". Cleveland Clinic CME. May 30,

2002.

About the Author

Dr. Cole is a graduate of University of Iowa Medical School. His internship was at Philadelphia General Hospital and his Internal Medicine residency at Dartmouth affiliated hospitals and the University of Washington, where he held a Cardiology Fellowship.

He has participated in Seattle's initial Medic One Program (1968) and continued with it throughout his career, which included a full time Cardiology Private Practice and a full time faculty position in Cardiology at University of Washington, Baylor College of Medicine, and University of Kentucky.

Dr. Cole was appointed and subsequently elected to the Matlacha / Pine Island (FL) Fire Control District Board of Commissioners. He continues to advise on this Board.

About the Symposium

Reducing Firefighter Deaths and Injuries: Changes in Concept, Policy, and Practice is presented as a public service of the Public Entity Risk Institute (PERI), 11350 Random Hills Rd., Suite 210, Fairfax, VA 22030. Web: www.riskinstitute.org.

* * *