BRIEF REPORT

CARDIOVASCULAR RISK FACTORS AND SCREENING MODALITIES IN FIREFIGHTERS

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ABSTRACT: Within the field of primary care, preventative medicine represents a novel approach to medical care that promotes health and well-being while simultaneously attempting to prevent disease, disability and death. Cardiovascular disease is one of the leading causes of medical morbidity and mortality in the United States. Certain lifestyle factors have been linked to increased risk of cardiovascular disease and, as such, are topics of focus for the prevention of cardiovascular disease. Various studies show that firefighters have an increased risk for premature cardiovascular disease compared to the general public. Risk assessment remains a paramount focus for the family physician so screening modalities are needed that accurately depict each patient's risk without performing unnecessary testing. Specific testing modalities that should be considered are coronary artery calcium scoring, carotid artery ultrasound and EKG assessment.

INTRODUCTION

Cardiovascular disease is one of the leading causes of medical morbidity and mortality in the United States.[1] It has been shown in various studies that firefighters have an increased risk for premature cardiovascular disease compared to the general public.[2] Most firefighter deaths are reported to occur during fire suppression encounters, which on average, comprise 1–5% of their professional career time.[2] The odds of cardiac death are nearly 90 times greater during fire suppression than during non-emergency duties.[3] Cardiac-related events accounted for 44% of the on-duty fatalities over the past ten years.[4] These figures indicate that the firefighting itself is not the sole cause for mortality within this particular population. The National Fire Protection Association (NFPA) records and maintains mortality statistics for firefighters in the United States. Statistics from the 1970's up until the past decade show that sudden cardiac deaths on duty have been gradually decreasing but remain the number one cause of firefighter on-duty fatality.[4]

BACKGROUND

Certain lifestyle factors have been linked to increased risk of cardiovascular disease and, as such, are topics of focus for the prevention of cardiovascular disease. Typical risk factors for cardiovascular disease for the general population include age, race, gender, obesity, family history, hyperlipidemia, hypertension, diabetes and tobacco smoking. Some studies have suggested that firefighters have a greater prevalence of these risk factors to explain the increased premature cardiovascular disease.[2] Firefighters with higher blood pressure as compared with controls showed significantly higher cardiovascular risk.[4] When risk factors are adjusted and comparable, firefighters also have an increased risk of left anterior descending (LAD) artery lesions compared to non-firefighter controls.[2] Plaque rupture accounts for most of the cardiovascular death rather than obstructive coronary disease.[1]

Firefighting exposes individuals to hyperthermia, smoke, dehydration, physical exhaustion and mental stress. Combustion of carbon-based materials produces particulate matter and carbon monoxide, which has been shown to increase cardiovascular disease morbidity and mortality when exposed.[6] Premature coronary heart disease (CHD) has been shown to be a common cause of death with firefighters with an average age of death of 44.[1] Serum levels of oxidatively damaged DNA have been shown to be elevated after performing in firefighting courses.[6] These elevated levels within the blood are associated with systemic oxidative stress, which has been linked to increased risk of cardiovascular disease.[6]

When fully suited up, firefighters often wear approximately 50 pounds of equipment. During a 30-minute simulated fire operation, one study found that the maximal heart rate of participants was 177 beats/minute, the core body temperature was measured to increase on average by 0.9°C and body weight could decrease up to 0.6 kg.[2] Studies have shown decreased left ventricular contractility, stroke volume, tachycardia and microvascular vasodilation within 30 minutes of performing fire extinction exercises.[6] Repeated exposure to firefighting has been shown to decrease microvascular function.[2] Reduced microvascular vasodilation, in particular, is associated with increased peripheral resistance, which increases the incidence of hypertension and left ventricular overload.[6] One study found that 80% of firefighters had evidence at autopsy of CHD and

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increased heart size (cardiomegaly/left ventricular hypertrophy) after sudden cardiac death.[3] Early screening protocols certainly would seem appropriate given the increased cardiovascular risk for this population over the general population. Volunteer firefighters have shown to have a larger number of deaths as compared to career firefighters, with sudden cardiac fatality accounting for the majority of deaths.[4]

CURRENT GUIDELINES

Current guidelines follow the NFPA recommendations for medical testing of firefighters. Standard medical testing includes basic blood analysis, urinalysis, infectious disease screening, cancer screening, pulmonary function testing, chest x-ray, electrocardiogram (ECG), vision testing and audiometric examination.[4] These guidelines do not recommend additional screening modalities at this time, however, and do not stratify risk from career vs. volunteer firefighters.

Electrocardiogram screening was one of the earliest modalities engineered to detect abnormal cardiac function. ECGs certainly play a role in the detection of cardiac pathology in the symptomatic individual to either find current or past evidence of myocardial ischemia/dysfunction. In the scope of preventative medicine, one study evaluated the application of ECG during exercise stress testing for the evaluation of ST-depression in asymptomatic firefighters with no prior history of coronary artery disease (CAD).[12] In the evaluation of an exercise stress test, parameters such as exercise capacity, blood pressure, heart rate response, subjective symptoms and ECG analysis during the activity/recovery phase go into the overall analysis. The investigators found that both age and heart rate responses were associated with ST-depression but interestingly, common cardiovascular risk factors, BP response and exercise capacity were not.[12] ST-depression indicates subclinical myocardial ischemia and, if found, may identify individuals who could benefit from early treatment.[13] Elevated average 24-hour heart rate is an indicator of poor sympathetic tone, which has been found to be a consistent finding with on-duty firefighters.[13] Depressed heart rate variability is another marker for mortality and indicates autonomic dysfunction, increasing the risk for fatal arrhythmic events.[13] Other ECG findings which should be targeted as potential risk factors include QT-prolongation, left bundle branch blocks, non-sustained ventricular tachycardia and a widened QRS-T angle.[13]

Of these parameters, studies have shown that the most important factor is the ST-segment reaction for evaluating ischemic heart disease, but often, there may be exercise-induced ST-depression even in the absence of ischemic heart disease (false-positive result).[12] It has been observed that master athletes have a higher incidence of false-positive ST-depression compared to sedentary subjects.[12] It is postulated that this phenomenon is due to increased left ventricular mass with secondary repolarization abnormalities. Firefighters, although not technically classified as "master athletes," certainly have higher exercise capacity and go through intensive training as compared to more sedentary populations. As a result, this screening modality is not currently recommended as a successful preventative screening modality due to its inconsistent accuracy.

Carotid artery ultrasound evaluation of carotid intima-media thickness (cIMT) is another screening modality for the evaluation of cardiovascular disease. Elevated cIMT is specifically useful in identifying both clinical and sub-clinical atherosclerosis. Current ACC/AHA guidelines recommend screening in asymptomatic patients with known or suspected carotid stenosis to detect hemodynamically significant stenosis.[11] The guidelines also recommend that testing may be performed if patients have carotid bruit on examination but are not clearly established for those with symptomatic CAD, peripheral artery disease or atherosclerotic aortic aneurysm.[11] Elevated levels of both triglyceride and LDL are significantly associated with cIMT greater than the seventy-fifth percentile, along with waist circumference and BMI.[11] One study found that CHD risk prediction by carotid ultrasound is best utilized in individuals with intermediate-risk (5–20% estimated ten-year CHD risk).[9]

Coronary artery calcium (CAC) has been shown to better predict future coronary vascular disease (CVD) events over cIMT. One caveat, though for CAC screening, is that age is a significant factor when it comes to identifying plaque. Younger patients with atherosclerosis may not have calcified plaque, causing false-negative results.[9] As a result, there is value in utilizing cIMT with one study identifying plaque in more firefighters with cIMT (36%) over CAC (22%).[9] Further studies are certainly needed to investigate if this screening modality may be used as standard screening within this population and if the detection of subclinical atherosclerosis leads to better overall outcomes.

Coronary artery calcium scoring is an imaging modality used to assess coronary artery plaque burden. The imaging is performed by coronary CT scanning. The test offers a noninvasive way to evaluate the extent of calcified plaque within the coronary arteries. The calculation of a coronary calcium score has been found to be a superior predictor of coronary events over traditional methods such as the Framingham risk factors.[1] The degree of plaque burden is assigned a score that characterizes the degree of plaque and, thus, the risk of atherosclerotic cardiovascular disease (ASCVD) events. Elevated CAC has been associated with higher subsequent rates of CHD and CVD, with a 67.5% increase in cardiac-related death.[7]

Individuals with a CAC score higher than 100 were associated with a five-fold increased risk of CHD mortality and a three-fold increased risk of CVD mortality as compared with a score of 0.7 Individuals classified as lower risk based on the Framingham risk score may be reclassified to higher levels with CAC scores greater than 100 or coronary artery calcium greater than the 75th percentile.[8] Diabetes and tobacco use have been found to be the two strongest predictors for elevated CAC scores.[2] Fasting glucose elevation has been found to be the strongest predictor of the total coronary lesion number and coronary calcium score.[9] Firefighting itself has been associated with a 41-point increase in CAC score.[2] Individuals with a lower likelihood of premature cardiovascular disease typically had a lack of abdominal obesity, higher intake of fruits and vegetables, and higher levels of cardiorespiratory fitness.[2] The American Heart Association and the American College of Cardiology both recommend CAC scoring for intermediate-risk individuals who are undecided regarding initiation of statin

therapy, with intermediate-risk defined as 10-year risk (≥7.5% to <20%) based on ASCVD scoring.[10]

CONCLUSION

Given the increased cardiovascular risk demonstrated by the scientific literature, this high-risk population must receive proper pre-emptive screening and care. Arguably, the current advancements discussed should be considered for universal firefighter health screening. Tailoring screening based on risk factors has been utilized for subsects of the general population and it is the opinion of the authors that occupational risk should be no different. The family physician is in a unique position to deliver this essential service and thus, it is essential for these providers to be up to date with the unique parameters that influence the health of this population.

AUTHOR DISCLOSURES:

No relevant financial affiliations or conflicts of interest.

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