

Most CVD studies of the police in the US were undertaken prior to 1990 and thus less relevant to current understandings of SCD among safety sensitive workers.^{49,50} One study of 312 male and female police officers, compared to age-matched general population free of clinical CVD⁵¹ demonstrated that police officers had elevated levels of age-adjusted CVD risk factors (blood pressure, total cholesterol, smoking prevalence) compared with the population sample.

4.3. The safety-sensitive occupational workforce

Military personnel, many emergency service personnel, and aircrew are usually significantly younger than the population normally associated with coronary or cardiovascular health concerns. This is an important factor when considering applying the published clinical literature on both diseases, and the effectiveness of investigations in detecting pathology, to this different cohort. The use of Bayesian theory is therefore important when considering the occupational population and when applying an evidence base that is based on older individuals who have a substantially higher disease prevalence. It would be expected that many individuals undertaking safety sensitive occupations would fall outside the usual “evidence-base” for decisions made in usual clinical practice.

4.4. Strengths and limitations of existing tests to screen for/investigate CAD

Given the low level of risk that many employers, or regulatory authorities, strive to, careful consideration must be given to whether screening investigations have enough sensitivity to exclude disease associated with a risk of just 1–2%. Additionally, the specificity of a test is also critical given the need to not exclude workers from employment unnecessarily whilst ensuring employers are not being falsely reassured or carrying undeclared risk in excess of that which is acceptable or mandated by the regulations.

4.4.1. Risk scores

Traditional risk scores are widely available and, by highlighting CVD risk factors, are usually first line tools. Unfortunately, risk scores have known limitations in their ability to risk-stratify patients. Evaluation often rely on history, physical exam, and resting electrocardiogram (ECG) alone. History may be unreliable considering potential reporting bias,^{15,52,53} and rest ECG have poor accuracy in detecting ischemic heart disease (54).

In aircrew, current methods employed to screen for high-risk aviators suffer from reduced sensitivity and specificity, regardless of age group or pre-test risk of obstructive CAD^{14,52,54} whilst the application of a Framingham risk model to pilots with a JAA Class 1 certificate in the U.K., demonstrated that 9% of pilots had an estimated 10-year CVD risk >20%.⁵⁴

So, whilst many agree that the routine evaluation of pilots and other safety-sensitive workers is needed to screen for CVD, debate remains regarding the appropriate use of tests and the most appropriate test to detect CVD. The chosen test needs to accurately determine whether an individual has occupationally relevant disease and usually this requires the accurate identification of atheroma more than the identification of obstructive CAD (although the latter is clearly important also).

4.4.2. Exercise ECG

Many agencies that employ safety-sensitive workers utilize exercise stress electrocardiography (exercise ECG) as a first line test in individuals deemed to be at increased risk of cardiovascular disease. This is in a large part because exercise ECG is widely available, relatively inexpensive, and does provide useful prognostic information. The exercise ECG has limitations as a screening tool for obstructive CAD due to its limited sensitivity and specificity. However, it does provide useful risk stratification information, such as BP response to exercise, identification of exercise related arrhythmias, and aerobic fitness. In low-prevalence populations, a good level of aerobic fitness has significant negative predictive value

for aeromedical disposition considerations. However, due to the limited sensitivity of the exercise ECG (60–70%),⁵⁵ an unacceptably high number of individuals with angiographically demonstrable obstructive CAD, will be deemed normal following a false negative test. Exercise ECG will also not identify widespread but non-obstructive CAD. Additionally, the exercise ECG has a very low positive predictive value for future coronary events. For this reason, the Exercise ECG should be discouraged as a stand-alone tool to determine significant CAD in those who undertake safety sensitive employment.⁵⁶

4.4.3. Other non-invasive functional tests

All functional tests have a specificity and sensitivity, to determine obstructive CAD, of approximately 80% at best, and using Bayesian theory and understanding the prevalence of obstructive CAD in the safety sensitive workforce, a positive functional test will often more likely be a false positive than to reflect an obstructive coronary lesion. As with the exercise ECG, functional tests will also not identify widespread but non-obstructive CAD, that may well be occupationally important and confer a MACE event risk above the acceptable 1–2% level required in many safety sensitive roles. False positive tests also potentially lead to further (unnecessary) investigations that may be associated with procedural risks from radiation exposure, intervention or the identification of additional incidental findings that require extensive further investigation. In safety sensitive workers, this may result in removal from work duty and delays in appropriate return with related impact on operational effectiveness and subsequent cost ramifications to both the worker and employee.

4.4.4. Coronary artery calcium (CAC) score

CAC Scoring is a proven independent CAD risk marker, providing improved patient-specific diagnostic and prognostic accuracy over traditional CAD risk factors alone.^{57–59} Reporting of CAC has become standardized in clinical practice utilizing the Agatston method^{60,61} with increasing CAC scores associated with a higher incidence of MACE.^{10,53,57,62}

In the general population CACS provides valuable, patient-specific prognostic data and adds incrementally to a patient-centered discussion of initiation of primary prevention medical therapy.⁵ A zero CACS is associated with very low CHD event rates (0.1%/year) and thus identifies a population of patients in which medical therapies may be deferred.^{59,63–66} Conversely, a CACS >100 identifies a high-risk cohort which, regardless of calculated 10-year ASCVD risk, may benefit from the initiation of statin therapy.^{59,66–68} In addition to identifying patients who are likely to benefit from primary prevention therapies, CACS may also identify asymptomatic patients with silent ischemia as it has been reported that in patients with extremely high CACS (≥ 400), ischemia is present in up to 50% of patients.^{69,70}

As a risk marker, independent of traditional cardiovascular risk factors, CAC allows for the reclassification patients. However, in younger (<45 years of age), potentially fitter, individuals being screened or investigated for CAD a normal CACS may not identify occupational relevant non-calcified CAD, that may have an event risk that is in excess of the employer's regulatory limits.¹¹⁹

4.4.5. Coronary CT angiography (coronary CTA)

Coronary CTA is a non-invasive tool that provides high-resolution imaging of coronary artery anatomy, CAD distribution, and severity comparable to invasive coronary angiography (ICA).^{71–73} Coronary CTA is well-validated in symptomatic patients with low to intermediate pre-test risk for obstructive CAD.^{74,75} Currently, coronary CTA is recommended as the initial test for diagnosing CAD in patients where obstructive CAD cannot be excluded by clinical assessment⁶⁰ and in stable symptomatic patients.⁷⁶ Coronary CTA also can assess plaque morphology and high-risk coronary CTA features should lead to an escalation of medical therapy.^{11,77–79} This ability to thoroughly evaluate non-obstructive plaque for both high-risk characteristics and burden is vital to preventing future CV events.^{4,5,77}