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Preventing Heart Disease via Coronary Artery Calcium Scoring to Make a Definitive Diagnosis of Atherosclerosis

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Abstract

Purpose: Cardiovascular disease is the number one cause of death in the Western world. The purpose of this manuscript is to compare the benefits and deficiencies of coronary artery calcium scanning versus computer generated risk equations in identifying atherosclerotic cardiovascular disease. These two approaches provide significantly different cardiovascular risk assessments and often lead to therapeutic differences in recommendations from the physician to the patient. **Methods:** Pertinent medical literature is reviewed concerning both risk assessment approaches (*i.e.*, coronary artery scanning and computer generated risk equations). The strengths and weaknesses of both approaches are discussed, and recommendations are provided based upon available data. **Results:** Cardiovascular risk equations are simple and readily obtained at no charge by physicians. However, their drawbacks are several, including non-applicability to specific populations, disagreements among different cardiovascular society risk equations, wide ranges of risk outputs (e.g., intermediate 10-year risk is between 5% and 20%), inability to definitively identify coronary artery plaques, and lack of definitive anatomical coronary disease. Alternatively, coronary artery calcium scanning costs approximately $100/scan (if not covered by insurance), requires time and effort by the patient, and exposes the patient to a minimal amount of radiation. However, coronary calcium scanning identifies specific atherosclerotic coronary disease and provides additional information about the anatomical location (*i.e.*, coronary artery) of the atherosclerotic plaque. **Conclusion:** Based on the published literature, coronary artery calcium scanning is the preferred approach for identifying atherosclerotic cardiovascular disease. Although there are minor drawbacks, overall it provides superior clinical information compared with computer generated risk equations.

Keywords

Asymptomatic Cardiovascular Disease, Coronary Artery Calcium Scan, Preventive Medical Therapy, Cardiovascular Risk

1. Introduction

The average delay time that promising new treatments and medical procedures reach the level of patient care is seventeen years [1]. The reasons for this delay are multiple but include the limited widespread availability of new technology and the reluctancy of the medical establishment to change their current medical practice. Coronary artery calcium scanning as a procedure for quantifying cardiovascular risk by identifying atherosclerotic plaques has been available for more than 17 years. Large long-term population-based observational studies were undertaken approximately twenty years ago that have produced consistent, reproducible, and convincing evidence of a strong association between coronary artery calcium scanning and major cardiovascular outcomes in asymptomatic people [2]. Guidelines for utilizing this approach for treatment are available [3].

2. Why Update Recommendations?

Preventing disease is superior to attempting to negate the morbid complications once the disease has become clinically symptomatic. In fact, the majority of financial, personnel, and structure resources are spent on delaying the progression of complications, not on prevention of the disease itself [4]. This conundrum is particularly applicable to cardiovascular disease (CVD) since when a heart attack occurs, 50% of individuals die before ever reaching a treatment facility. The other 50% of individuals undergo numerous procedures and medications to assist their heart to pump sufficient blood to maintain life. Therefore, preventing CVD depends on identifying asymptomatic, early disease in adult individuals before a clinical event occurs. Since cardiovascular insults start in childhood and progress with age, identifying these individuals with asymptomatic, preclinical CVD is critical to preventing future heart attacks and strokes [5].

3. Identifying Asymptomatic CVD

The two principle approaches to identifying asymptomatic CVD are CVD risk assessment (Risk Assessment) and coronary artery calcium scoring (CAC scoring). Other approaches such as cardiac stress testing and CT angiography are usually performed in response to specific clinical indications. The main difference between Risk assessment and CAC scoring is that using the first approach, only the statistical likelihood of having asymptomatic CVD is predicted. Using the second approach of CAC scoring, the presence of significant quantitative, vessel specific cardiovascular disease can be documented. This is important because lesions in the anterior descending coronary artery (the widow maker) spe-

cifically result in enhanced CVD risk. This is the main artery supplying blood to the left ventricle. In every study that has compared these two approaches, CAC scoring has been superior to Risk assessment in predicting CVD events [6]. In fact, CAC scoring has permitted the reclassification of individuals evaluated by a Risk assessment formula (e.g., Framingham risk score) throughout the risk categories ranging from 52% to 66% in the intermediate-risk category, 34% to 36% in the high-risk category, and 12% to 15% in the low-risk category [7]. The reason for this superiority relates to the fact that CAC scoring provides a lifetime assessment of overall coronary artery vascular damage from all noxious insults [8]. In contrast, Risk assessment is limited to a one time computerized input of perceived noxious insults with limited (or none) information concerning specific risk evaluation including quantitative levels of duration, severity, success of specific treatment duration and intervention, etc.

4. Testing Availability

Calculating a Risk assessment is relatively easy for computer literate physicians. However, choosing the best risk calculator for an individual patient may be confusing because there is little agreement on risk factor input between the 21 currently available professional risk guidelines [9]. Obtaining CAC scoring is more time consuming for the patient than for the physician calculating a Risk assessment since a rapid chest CT is required. Since almost all large towns now have a medical CT facility, CAC scoring is readily available to most individuals in the United States. Universal medical insurance coverage for CAC testing is available in New Mexico and Texas and pending in other states.

5. Cost

There is no direct financial cost to calculate a Risk assessment. Indirectly, the physician's time is necessary to interview the patient of all present and past CVD risks that need to be entered into the risk assessment. The direct cost of CAC scoring depends on the facility location of the test. In most cities and towns in the U.S., the average cost is $100 [10].

6. Sensitivity and Specificity

Identifying a universally applicable specific sensitivity and specificity for either the Risk assessment or CAC scoring is very difficult because it depends on the outcome chosen, the population involved, the specific risk program utilized, and the duration of time over which the risk is projected. In addition, neither CAC scoring nor Risk assessment have been subjected to large randomized controlled treatment trials employing a placebo. Understandably, such a study would not be ethically possible today. What is apparent from epidemiological studies is that Risk assessment is not valid for certain populations including various social economic and ethnic groups, whereas CAC scoring is valid [11]. Relative to CAC scoring, the sensitivity for atherosclerotic plaques is not 100% for all CVD be-

cause non-calcified plaques may be present even with a zero CAC score. However, the number of non-calcified plaques and CVD events in this group are minimal [12]. In fact, a zero CAC score provides a five year safe period for almost all individuals [12]. More importantly, if the CAC scoring is positive, then atherosclerotic plaques are definitely present. The higher the CAC score, the greater the risk of a cardiovascular event. Scoring can be readily done by computer and a trained technician.

7. Treatment Options

The great advantage of identifying CVD in the asymptomatic patient by CAC scoring is that many effective therapies are now available. Numerous studies have shown that significantly reducing the known risk factors for CVD has beneficial effects on reducing symptomatic CVD. Even in the standard medical clinic population, aggressive translational medical therapy to improve lifestyle and reduce LDL cholesterol has prevented asymptomatic CVD from progressing to symptomatic CVD [13]. Hyperlipidemia, diabetes, smoking, and hypertension are all amenable to treatment with both lifestyle changes and pharmaceutical agents. However, compliance with these changes can be difficult. CAC scoring has the great advantage over Risk assessment that when the patient knows that he/she has disease specifically in his/her own heart, it often leads to improved compliance with lifestyle and medications [14].

8. Adverse Events

There are no adverse events from Risk assessment. Likewise, adverse events from CAC scoring are minimal. Possible downstream costs and radiation exposure from CAC scanning have been cited by some authors. However, in the only randomized, controlled clinical trial to directly assess downstream costs, no additional costs were observed when compared to the medical costs in the non CAC scoring control group [15]. This result was observed because the diseases that occurred in the non CAC scoring group were identified much later than in the CAC scoring group and therefore required many additional resources to treat. Even the danger of radiation is minimal with CAC scoring. With the newer CT machines, the average radiation dose from CAC scoring is less than 1 millisevert, similar to background radiation when living in Denver for 3 months.

9. Summary

CVD is a public health crisis and the prevalence has not been significantly reduced over the past 20 years. The American Heart Association estimates that the direct cost to the American public is $350 billion/year plus significant morbidity and mortality [4]. The American Heart Association further estimates that this figure will triple by 2030. It is time to re-evaluate the basis for failed therapy at the preventive level and intervene aggressively. CAC scoring is automated, reproducible, not technically challenging, and inexpensive. Aggressive screening

and preventive therapy has occurred for some major diseases (e.g., Covid-19, colon cancer, breast cancer, etc.) but not for CVD, the number one cause of death in the U.S. in 2020 [16]. Aggressive prevention on the basis of CAC scoring should be the preferred choice for improving the CVD health of the adult U.S. population. In a proof of concept observational study, this approach has been shown to be not only feasible, but effective [13].

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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