Coronary heart disease accounts for 27% of all deaths in the United States.[1] Established major risk factors for coronary heart disease (CHD) have been identified by the National Cholesterol Education Program (NCEP) Expert Panel and include elevated serum levels of low-density lipoprotein (LDL) cholesterol and total cholesterol, and low serum levels of high-density lipoprotein (HDL) cholesterol. Other risk factors include a history of cigarette smoking, hypertension, family history of premature CHD, and age. Pathology studies have demonstrated that levels of traditional risk factors are associated with the extent and severity of atherosclerosis. However, at every level of risk factor exposure, there is substantial variation in the amount of atherosclerosis, presumably related to genetic susceptibility and the influence of other risk factors. Therefore, there has been interest in identifying a technique that can improve the ability to diagnose those at risk of developing CHD, as well as measure disease progression, particularly for those at intermediate risk.

Ultrasonographic measurement of carotid intima-medial (also called intimal-medial or intima-media) thickness (CIMT) refers to the use of B-mode ultrasound to determine the thickness of the two innermost layers of the carotid artery wall, the intima and the media. Ultrasonographic measurement of CIMT has been investigated as a proxy for progression of atherosclerosis and is proposed for use in identifying and monitoring subclinical CHD.
Regulatory Status

In February 2003, SonoCalc® (SonoMetric Health, LLC) was cleared for marketing by the FDA through the 510(k) process. The FDA determined that this software was substantially equivalent to image display products from existing ultrasound systems. Subsequently, several other devices have been approved through the 510(k) process.

Note: this policy does not address carotid artery ultrasound for the evaluation of a cerebrovascular condition suspected on the basis of abnormal signs or symptoms, which is considered a standard of care.

MEDICAL POLICY CRITERIA

Ultrasonographic measurement of the carotid artery intima-media thickness is considered investigational for screening, diagnosis, and management of atherosclerotic disease.

SCIENTIFIC EVIDENCE

Currently, screening and monitoring for coronary artery disease in clinically asymptomatic individuals is achieved through administration of standard risk assessment measures (including family history and non-invasive testing). Measurement of carotid intima-medial (or intimal-media) thickness (CIMT) is primarily meant to assess risk for future disease, and therefore can be evaluated as a prognostic measure. Within this context, assessment of the proposed use of ultrasonographic measurement of carotid intima-media thickness (CIMT) must fulfill three parameters:

1) Establish technical feasibility, typically assessed with two types of studies, those that compare test measurements with a gold standard and those that compare results taken with the same device on different occasions (test-retest). Normally conducted in the pre-clinical setting, the focus of this parameter is on test reproducibility and establishment of the test protocol.

2) Demonstrate diagnostic performance (sensitivity, specificity, positive and negative predictive values) of the test compared with the gold standard.

3) Evaluate clinical outcomes based on the performance of the test versus the standard of care. While in some cases, new diagnostic tests can be adequately evaluated using technical and diagnostic performance, when a test identifies a new or different group of patients with a disease, randomized trials are needed to demonstrate the impact of the test on net health outcomes.

Literature Appraisal

Diagnostic Utility (Analytical and Clinical Validity)

The current literature consists of several systematic reviews, meta-analyses, and case series related to technical feasibility, and large longitudinal cohort studies conducted in the research setting.

Systematic Reviews and Meta-analyses
Three systematic reviews\(^{[2-4]}\) and 3 meta-analyses\(^{[5-9]}\) analyzed the ability of CIMT measurement to identify coronary artery disease in asymptomatic patients and predict first-time myocardial infarction (MI) or first-time stroke. The inclusion criteria for the studies included in these reviews varied. However, the results consistently reported that, while CIMT is a predictor of cardiovascular risk, the addition of CIMT measurement did not significantly improve risk prediction over conventional cardiovascular risk factors. In addition, most of the reviewed studies were conducted in the research setting and therefore cannot be used to draw conclusions on the applicability of CIMT measurement in the clinical setting for asymptomatic patients at large.

**Randomized Controlled Trials (RCTs)**

There are no RCTs evaluating the analytical or clinical validity of ultrasonographic measurement of CIMT.

**Nonrandomized Studies**

- A 2014 retrospective analysis of 184 children and adolescents reported excellent reproducibility of CIMT measurements when the same methodology was applied.\(^{[10]}\) However, there was significant variation throughout the cardiac cycle. The authors concluded that standardized CIMT measurements that use electrocardiographic timing are needed for this patient population. Polak et al. reported 7.8 years follow-up of 6255 individuals free of CAD, stroke, and atrial fibrillation at baseline.\(^{[11]}\) Subjects were from a multiethnic community based cohort with mean age 62.2 years at baseline. The aim of the study was to determine whether CIMT and common carotid artery diameter were predictors of ischemic stroke. There were 115 first-time ischemic strokes during the follow-up period. The authors reported that common carotid artery diameter was independently associated with first-time incident ischemic stroke but CIMT was not. Technical feasibility was addressed in a 2010 study on inter-reader differences in measuring CIMT.\(^{[12]}\) Among 5 readers with 6 months to 6 years of experience reading CIMT images, significant differences were seen in the measurement of 26 CIMT images, whose final measurements ranged from 0.57–0.78 mm. This range corresponds to as much as a 21 year vascular age discrepancy in the same image, a high degree of error. The authors suggest improved training of CIMT readers, or the development of an IMT edge-reader before this technology is adopted in the clinical setting.

- An observational study among 320 Spanish patients compared CIMT measurements with traditional risk assessment measures (age, hypertension and systolic blood pressure).\(^{[13]}\) Although CHD risk was reclassified for 18% of participants based on CIMT, implications for clinical management and effect on health outcomes were not reported.

- In the Atherosclerosis Risk in Communities (ARIC) study, a large observation study conducted in the research setting, the authors evaluated risk factors associated with increased CIMT in 15,800 subjects.\(^{[14]}\) CIMT had a graded relationship with increasing quartiles of plasma total cholesterol, LDL cholesterol, and triglycerides. CIMT was also correlated with the incidence of coronary heart disease (CHD) in a subgroup of patients enrolled in the trial after 4 to 7 years of follow-up.\(^{[15]}\) The researchers defined and compared extreme carotid IMT (i.e., \(\geq 0.1\) mm) to non-extreme IMT (i.e., < 0.1mm) and found a relationship between CIMT and CHD events. Nevertheless, this definition of extreme IMT has yet to be tested in the clinical setting.
Several other studies have used CIMT measurements as outcome measures.[16-27] Due to limitations such as the lack of a shared diagnostic CIMT measurement protocol, lack of head-to-head comparisons with gold standard diagnostic tests for CHD, and unknown impact of CIMT measurement on clinical decision-making and primary health outcomes, these studies do not add to the understanding of the net effect of this testing on the diagnosis and treatment of CHD.

More recent studies reported that including carotid plaques in CIMT increased the predictive value of cardiovascular risk over CIMT assessed only in plaque-free sites.[28-31] However, the meta-analysis by Lorenz found no difference in the main results between studies that included CIMT with carotid plaque and plaque-free CIMT.[5] The systematic review by Peters found adding carotid plaque to the traditional CIMT model increased the c-statistic from 0.01 to 0.06.[2]

The BioImage study enrolled 5808 asymptomatic individuals from the United States to compare 3-dimensional carotid ultrasound with CT scans of the coronary arteries in their ability predict atherothrombotic events.[32] Carotid ultrasound was used to calculate carotid plaque burden (cPB), and CT scans were used to evaluate coronary artery calcification (CAC). After a median of 2.7 years of follow-up, both cPB and CAC were found to be independent predictors of major cardiovascular events, defined as cardiovascular death, MI and ischemic stroke, with hazard ratios of 2.36 (95% CI, 1.13 to 4.92) and 2.99 (95% CI, 1.48 to 6.05), respectively for individuals in the highest tertile. Both cPB and CAC score led to significant net reclassification compared with conventional risk factors, with net reclassification indices of 0.23 and 0.25, respectively.

A recent prospective cohort study by Moreo et al. assessed the value of adding CIMT to other potentially predictive parameters to enhance the prediction of coronary artery disease (CAD) in 247 patients with CAD and 184 patients without CAD.[33] The predictive parameters assessed in CAD vs non-CAD patients included blood pressure, CIMT, carotid pulse wave velocity (cPWV), semiquantitative score of cardiac calcifications, global myocardial longitudinal strain (GLS), and rest Doppler flow velocity on the left anterior descending (LAD) coronary artery. The patients with CAD had significantly higher blood pressure, cIMT, cPWV, score of calcium, and LAD velocity than non-CAD patients. All ultrasound parameters significantly predicted CAD. Stepwise logistic regression concluded that the only combined predictors of CAD were score of calcium, cIMT, and LAD velocity.

Clinical Utility

Randomized Controlled Trials (RCTs)

There are no RCTs investigating the clinical utility of measuring CIMT for cardiac risk stratification.

Nonrandomized Study

In a 2011 study by Johnson and colleagues, 355 patients, aged 40 years with 1 or more cardiovascular disease risk factor, received carotid ultrasound screenings to prospectively determine whether abnormal results would change physician and patient behaviors.[34] Results were considered abnormal in 266 patients (CIMT greater than the 75th percentile or the presence of carotid plaque). Self-reported questionnaires were completed before the carotid ultrasound, immediately after the ultrasound and 30 days later to determine behavioral changes. Physician behavior in prescribing aspirin and cholesterol medication changed significantly (p < 0.001 and p < 0.001, respectively) after identification of abnormal carotid ultrasound results. Abnormal ultrasound results predicted reduced dietary sodium (odds ratio...
and increased fiber intake (OR, 1.55; P = .022) in patients but no other significant changes. Health outcomes were not evaluated in this study and the short-term follow-up limits interpretation of results.

Conclusion

Evidence from large, prospective cohort studies has established that CIMT is an independent risk factor for cardiovascular disease. The evidence on reclassification of cardiovascular risk offers a potential indirect chain of evidence to improve outcomes. If CIMT were able to reclassify patients into risk categories that have different treatment approaches, then clinical management changes may occur that lead to improved outcomes. However, there is no direct evidence on the clinical utility of measuring CIMT for cardiac risk stratification, and systematic reviews have concluded that the ability of CIMT to reclassify patients into clinically relevant categories is modest and may not be clinically important. The uncertainty around the ability to reclassify patients into clinically relevant categories with CIMT limits the potential for CIMT to improve health outcomes.

Clinical Practice Guidelines

American College of Cardiology and the American Heart Association (ACC/AHA)

The 2013 update of the ACCF/AHA evidence-based clinical practice guideline for the assessment of cardiovascular risk recommends against CIMT measurement in asymptomatic patients (Class III recommendation; Level of evidence B, defined as a recommendation that the procedure is not useful/effective and may be harmful based on evidence from a single RCT or nonrandomized studies). This is a reversal of the 2010 version of this guideline which indicated that CIMT measurement might be reasonable in certain patients. This change was based on new evidence reviewed during the update.

U.S. Preventive Services Task Force (USPSTF)

Based on the systematic review conducted for the USPSTF, the Task Force “concludes that the current evidence is insufficient to assess the balance of benefits and harms of using…[CIMT]…to screen asymptomatic men and women with no history of CHD to prevent CHD events.” The USPSTF identifies the following research need: “The predictive value…of carotid IMT…should be examined in conjunction with traditional Framingham risk factors for predicting CHD events and death.”

Summary

Although studies have mainly been in agreement that carotid artery intima-medial thickness (CIMT) is associated with risk of coronary heart disease (CHD), the degree to which this information informs clinical decision making has not been established. At the present time there are no scientific studies that directly and experimentally test the hypothesis that measurement of CIMT results in improved patient outcomes. Protocols relating to risk adjustment based on CIMT have not been established, and there is no specific guidance on how measurements of CIMT should be incorporated into risk assessment and risk management. Prospective randomized controlled trials on this technology are needed to answer these questions. Because the existing data are insufficient to determine the impact of this technology on net health outcomes (CHD events and long-term survival), measurement of CIMT for screening, diagnosis, and management of cardiovascular disease is considered investigational.
REFERENCES


**CROSS REFERENCES**

[Computed Tomography to Detect Coronary Artery Calcifications](#), Radiology, Policy No. 6

<table>
<thead>
<tr>
<th>CODES</th>
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<tr>
<td></td>
<td>93895</td>
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**Note:** CPT 93880 (duplex scan of extracranial arteries; complete bilateral study) should not be used to identify carotid intima-media thickness studies.