Carotid IMT: A Practical How-to Primer

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Professor of Medicine

Disclosure: No conflicts
Carotid Ultrasound Principles

- Straightforward procedure
  - Instrumentation for office-based assessment
- Highly accurate/reproducible
  - Technology assisted
- Predictive of outcomes
  - Incremental, integrates with CV risk
Questions

- In which patients?
- How to perform?
  - Equipment
  - Procedure
  - Training/experience
- How to integrate in clinical decisions?
- How to get reimbursed?
• Methods such as noncontrast CT for the assessment of coronary artery calcium, or carotid ultrasound for the assessment of intima media thickness and plaques improve the coronary heart disease risk assessment.

• In 2010, the American College of Cardiology:
  • CAC and CIMT granted a level 2A recommendation indicating these tests as **reasonable to perform** in the initial assessment of cardiovascular risk in order to refine the risk assessment.
    • “Measurement of carotid artery IMT is reasonable for cardiovascular risk assessment in asymptomatic adults at intermediate risk”.

ACC CV Risk Guideline
ASE/SVM Consensus Statement

Patient Selection

- “Intermediate” risk
  - 10-year Framingham risk of 6-20%
  - Not already at high risk
- Family history of premature CVD in a first-degree relative (men <55, women <65 yo)
- Younger people with severe abnormalities in a single risk factor who are not being treated with medications (e.g., genetic dyslipidemia, heavy smoker)
- Women <60 years old with ≥2 CVD risk factors

Only meta-analysis that pooled individual, patient level data (versus study-level pooling) from 16 prospective cohort studies
- 36,984 patients encompassing 71% of the worldwide data
- 2028 events (MI, stroke, death).
- Baseline CIMT predicted each of these outcomes with hazard ratios from 10-22% for each 0.1mm increase in CIMT.
  - These data were after full adjustment for patient data on all cardiovascular risk factors, demographics, and socioeconomic adjusters.

CIMT: Net reclassification of CHD Risk

• Net reclassification based upon CIMT findings in ARIC:
  • 1 in 8 reclassified to a lower risk group
  • 1 in 9 reclassified to a higher risk group

Nambi and Ballantyne; JACC, 2010

Figure 1: Adjusted coronary heart disease incidence rate per 1,000 person year adjusted by C-IMT categories (<25th percentile, 25th-75th percentile and >75th percentile) with and without plaque
2013 Lipid Guideline

• Downgraded **ALL** methods of detection of residual risk
  • Class 2B recommendation
    • Imaging- CAC scoring
    • ABI
    • Family history
  • Class 3 recommendation- CIMT

• Why?
  • Wrong procedure- CIMT alone, not CIMT and plaque
  • Methodology- IOM methods (RCT, Meta-analysis only)
  • Narrow focus- statin selection only
  • New, proposed pooled risk estimator- ?more accurate
Study-level pooling of 14 population-based cohort studies
- 45,828 individuals.
- The net reclassification improvement was 3.2% in men, 3.9% in women, a finding that the authors assessed as not clinically meaningful.

Weaknesses
- CIMT, not inclusive of plaque
- Less selective approach than the PROG IMT authors, pooling studies in this analysis that were heterogeneous, including those that used very different technical methods for CIMT over the past 2 decades
- They also included many short studies that used different methods of adjudicating events.
- The authors included studies that used CIMT as a method of pharmacologic evaluation (e.g., statin trials) leading to a source of bias in event rates.

**Figure 1. Relation of Common Carotid Intima-Media Thickness With First-Time Myocardial Infarction or Stroke Across Studies**

<table>
<thead>
<tr>
<th>Source</th>
<th>Contribution to Total USE-IMT Population, % of Total</th>
<th>Hazard Ratio (95% CI)</th>
<th>I²</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARIC, 1994</td>
<td>31</td>
<td>1.11 (1.08-1.14)</td>
<td></td>
</tr>
<tr>
<td>CAPS, 2006</td>
<td>8</td>
<td>1.10 (0.99-1.23)</td>
<td></td>
</tr>
<tr>
<td>Charlottesville, 2006</td>
<td>1</td>
<td>0.88 (0.56-1.36)</td>
<td></td>
</tr>
<tr>
<td>CHS, 2007</td>
<td>7</td>
<td>1.11 (1.06-1.16)</td>
<td></td>
</tr>
<tr>
<td>FATE, 2011</td>
<td>3</td>
<td>1.20 (1.01-1.42)</td>
<td></td>
</tr>
<tr>
<td>Hoorn Study, 2003</td>
<td>1</td>
<td>1.07 (0.72-1.59)</td>
<td></td>
</tr>
<tr>
<td>K-HD, 1991</td>
<td>2</td>
<td>1.05 (0.96-1.16)</td>
<td></td>
</tr>
<tr>
<td>Malmo, 2000</td>
<td>10</td>
<td>1.10 (1.04-1.17)</td>
<td></td>
</tr>
<tr>
<td>MESA, 2007</td>
<td>13</td>
<td>0.96 (0.89-1.08)</td>
<td></td>
</tr>
<tr>
<td>Nijmegen Study, 2009</td>
<td>3</td>
<td>1.34 (0.94-1.90)</td>
<td></td>
</tr>
<tr>
<td>NOMAS, 2007</td>
<td>2</td>
<td>1.36 (0.99-1.85)</td>
<td></td>
</tr>
<tr>
<td>OSACAS Study, 2007</td>
<td>1</td>
<td>1.09 (0.96-1.24)</td>
<td></td>
</tr>
<tr>
<td>Rotterdam Study, 1997</td>
<td>8</td>
<td>1.15 (1.06-1.20)</td>
<td></td>
</tr>
<tr>
<td>Tromsø Study, 2000</td>
<td>9</td>
<td>1.04 (0.98-1.10)</td>
<td></td>
</tr>
</tbody>
</table>

I² = 12.30%; Q test for heterogeneity, p = .24

**Hazard Ratio (95% CI)**

**JAMA. 2012;308(8):788-795**
Common Carotid Intima-Media Thickness Measurements in Cardiovascular Risk Prediction
A Meta-analysis

Hester M. Den Ruijter, PhD; Sanne A. E. Peters, MSc; Todd J. Anderson, MD; Annie R. Britton, PhD; Jacqueline M. Delker, PhD; Marinus J. Biekemans, PhD; Gunnar Engström, MD, PhD; Gregory W. Evans, MA; Jacqueline de Graaf, MD, PhD; Diederick E. Grobbbee, MD, PhD; Bo Hedblad, MD, PhD; Albert Hofman, MD, PhD; Suzanne Holewijn, PhD; Ai Ikeda, PhD; Maryam Kavousi, MD, MSc; Kazuo Kitagawa, MD; Akihiko Kitamura, MD, PhD; Hendrik Koffijberg, PhD; Eva M. Lonn, MD; Mathias W. Lorenz, MD; Eliav B. Mathiesen, MD, Gel Nijpels, MD, PhD; Shuhei Okazaki, MD; Daniel H. O’Leary, MD; Joseph F. Palak, MD; Jackie F. Price, MD; Christine Robertson, MRCPath; Christopher M. Rembold, MD; Maria Roswall, MD, PhD; Tsjitske Randek, MD, PhD; Juluka T. Salonen, MD, PhD; Matthias Stoter, MD; Coen D. A. Stehouwer, MD, PhD; Jacqueline C. Wittman, PhD; Karel G. Moons, PhD; Michiel L. Bots, MD, PhD

Context The evidence that measurement of the common carotid intima-media thickness (CIMT) improves the risk scores in prediction of the absolute risk of cardiovascular events is inconsistent.

Objective To determine whether common CIMT has added value in 10-year risk prediction of first-time myocardial infarction or stroke above that of the Framingham Risk Score.

Data sources Relevant studies were identified through literature searches of databases (PubMed from 1990 to June 2012 and EMBASE from 1980 to June 2012) and expert opinion.

Study Selection Studies were included if participants were drawn from the general population, common CIMT was measured in an individual who was followed up for first-time myocardial infarction or stroke.

Data extraction Individual data were extracted from the databases and individual participant data meta-analysis was performed on individuals without existing cardiovascular disease.

Results We included 14 population-based cohorts contributing data for 45,828 individuals. During a median follow-up of 14 years, 227 first-time myocardial infarctions or strokes occurred. We first refitted the risk factors of the Framingham Risk Score and then added the CIMT measurement to estimate the absolute 10-year risk to develop a first-time myocardial infarction or stroke in both models. The C-index of both models was similar (0.757; 95% CI, 0.749–0.764 and 0.759; 95% CI, 0.752–0.766). The net reclassification improvement with the addition of common CIMT was small (0.8%; 95% CI, 0.1%–1.6%). In those at intermediate risk, the net reclassification improvement was 3.6% in all individuals (95% CI, 2.7%–4.6%) and no differences between men and women.

Conclusion The addition of common CIMT measurements to the Framingham Risk Score was associated with small improvement in 10-year risk prediction of first-time myocardial infarction or stroke, but this improvement is unlikely to be of clinical importance.
Carotid intima-media thickness progression to predict cardiovascular events in the general population (the PROG-IMT collaborative project): a meta-analysis of individual participant data

Matthias W. Lorenz, Joseph F. Polak, Marianne Kronmal, Elisabete M. Michels, Henry Viikari, Toni-Pekka Tuomilehto, Dirk Sander, Matthias Pilchert, Alberto L. Catapano, Christine M. Robertson, Stefan Kiechl, Tatjana Rumberger, Moise Despres, Lars Lind, Caroline Schmid, Pradhanesh DashNathpati, Lu Gao, Karthin Ziegler-Kruse, Michael F. Bots, Simon G. Thompson, on behalf of the PROG-IMT Study Group

Summary
Background Carotid intima-media thickness (cIMT) is related to the risk of cardiovascular events in the general population. An association between changes in cIMT and cardiovascular risk is frequently assumed but has rarely been reported. Our aim was to test this association.

Methods We identified general population studies that assessed cIMT at least twice and followed up participants for myocardial infarction, stroke or death. Thirty-two studies contributed to an individual participant data meta-analysis. Excluding individuals with previous myocardial infarction or stroke, we assessed the association between cIMT progression and the risk of cardiovascular events (myocardial infarction, stroke, vascular death, or a combination of these) for each study with Cox regression. The log hazard ratios (HRs) of cIMT progression were pooled by random effects meta-analysis.

Findings Of 22 eligible studies, 16 with 36,964 participants were included. During a mean follow-up of 7.9 years, 1519 myocardial infarctions, 1339 strokes, and 2078 combined endpoints (myocardial infarction, stroke, vascular death) occurred. Yearly cIMT progression was 0.07 mm per year (range 0.05–0.09 mm per year). For mean common carotid artery intima-media thickness progression, the overall HR of the combined endpoint was 0.97 (95% CI 0.94–1.00) when adjusted for age and sex, and 0.95 (95% CI 0.92–1.00) when also adjusted for vascular risk factors. Although we detected no associations with cIMT progression in sensitivity analyses, the mean cIMT of the two ultrasound scans was positively and robustly associated with cardiovascular risk (HR for the combined endpoint 1.16, 95% CI 1.10–1.22, adjusted for age, sex, mean common carotid artery intima-media thickness progression, and vascular risk factors). In three studies including 3439 participants who had four ultrasound scans, cIMT progression did not correlate between occasions (reproducibility correlations between r=−0.06 and r=−0.02).

Interpretation The association between cIMT progression assessed from two ultrasound scans and cardiovascular risk in the general population remains unproven. No conclusion can be derived for the use of cIMT progression as a surrogate in clinical trials.
Invited Commentary

Appropriate use criteria for carotid intima media thickness testing

The Society of Atherosclerosis Imaging and Prevention, Developed in collaboration with the International Atherosclerosis Society

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ABSTRACT

The Society of Atherosclerosis Imaging and Prevention, in collaboration with the International Atherosclerosis Society, conducted an appropriate use review of common clinical scenarios where carotid intima-media thickness testing may be considered. The indications for this review were drawn from common applications or anticipated uses, as well as from current clinical practice guidelines. Thirty-three clinical scenarios were developed by a writing committee and scored by a separate technical panel on a scale of 1–9 to designate appropriate use, inappropriate use, or uncertain use. Clinical scenarios included the clinical application of CIMT for risk assessment in the absence of known coronary heart disease, risk assessment in patients with known CHD, and serial CIMT imaging for monitoring of CHD risk status. Appropriate indications were largely clustered within the detection of CHD risk among intermediate risk patients, metabolic syndrome, and older patients. There were no appropriate indications for serial testing. Inappropriate indications generally were seen among use of CIMT in low risk patients, and high risk patients. This document is intended to provide a practical guide to clinicians and promote optimal use of testing which includes both the avoidance of under and over testing. It is intended that these criteria will be updated as the evidence on CIMT imaging continues to evolve.
## Patient Selection

### CIMT clinical scenarios and appropriateness ratings

<table>
<thead>
<tr>
<th>Risk assessment in the absence of known coronary heart disease</th>
<th>Additional Patient Details</th>
<th>Median appropriateness ranking (category)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CIMT for the initial detection of CHD risk</td>
<td>Low risk</td>
<td>3 (I)</td>
</tr>
<tr>
<td>2. CIMT for the initial detection of CHD risk in the setting of 2 or more NCEP risk factors</td>
<td>Intermediate risk</td>
<td>7 (A)</td>
</tr>
<tr>
<td>3. CIMT for the initial detection of CHD risk in patients with metabolic syndrome</td>
<td>High risk</td>
<td>5 (U)</td>
</tr>
<tr>
<td>4. CIMT for the initial detection of CHD risk in patients with diabetes mellitus</td>
<td>Low risk</td>
<td>5 (U)</td>
</tr>
<tr>
<td>5. CIMT for the detection of CHD risk in men &gt;45 years of age irrespective of CHD risk level</td>
<td>Intermediate risk</td>
<td>8 (A)</td>
</tr>
<tr>
<td>6. CIMT for the detection of CHD risk in women &gt;55 years of age irrespective of CHD risk level</td>
<td>High risk</td>
<td>5 (U)</td>
</tr>
<tr>
<td>7. CIMT for the detection of CHD risk in the setting of a family history of premature CHD</td>
<td>Low risk</td>
<td>6 (U)</td>
</tr>
<tr>
<td>8. CIMT for the detection of CHD risk in patients with a known abnormal coronary calcium score (&gt;1.00 or above the 75th percentile for age and gender)</td>
<td>Without a history of CHD</td>
<td>7 (A)</td>
</tr>
<tr>
<td>9. CIMT for the detection of CHD risk in patients with a known CAC score of zero</td>
<td>With known CHD</td>
<td>3 (I)</td>
</tr>
<tr>
<td>10. CIMT for the detection of CHD risk in patients with &gt;50% stenosis on carotid duplex ultrasound</td>
<td></td>
<td>3 (I)</td>
</tr>
</tbody>
</table>
Typical patient vignette

- 62 year old woman without symptoms of heart disease presents for evaluation of cardiovascular risk factors. The patient’s father died from a myocardial infarction at age 50. She no longer smokes, adheres to a healthy diet and exercises infrequently. Body mass index is 32 kg/m². Blood pressure is 133/82 mm Hg on an anti-hypertensive medication. Lipid profile shows a total cholesterol of 226 mg/dL, triglycerides 179 mg/dL, HDL-C 42 mg/dL, and LDL-C 148 mg/dL. Fasting glucose is 96 mg/dL. High-sensitivity C-reactive Protein is 1.8 gm/dL. The calculated 10-yr Framingham Risk Score is 6%. A CIMT/plaque survey is requested to refine the patient’s cardiovascular risk assessment, and thereby assist the physician with decision making on the selection and intensity of risk reducing therapies.
Questions

- In which patients?
- How to perform?
  - Equipment
  - Procedure
  - Training/experience
- How to integrate in clinical decisions?
- How to get reimbursed?
B-Mode Image of the Carotid Artery Wall

plaque

intima

media

adventitia

Courtesy of W. Riley
CIMT Ultrasound

- Frequency: broadband
  - Newest device 13 MHz
  - Device cost: $40K +
- Specific advantages
  - Clinical
    - Noninvasive
    - No radiation exposure
    - No incidental findings
  - Research
    - Scalable
    - Low entry costs for multicenter investigations
    - Understood by clinicians
CIMT: Progressive improvement in image quality

13 MHz: 2005
Optimal Scanning Protocol

- Traditional Risk Assessment
  - "Intermediate" Risk
  - CIMT and Plaque Survey
    - Normal study
    - Increased CIMT and/or Plaque Present
      - Standard RF approach
      - Intensify treatment
CIMT Ultrasound: Simple

- Far wall
  - Acoustic shadowing in near wall
- Which site?
  - CCA most reproducible
  - ICA/Bulb: more difficult
    - Plaque more common
    - Greater magnitude of change
- Measurement
  - ABD or manual, 1cm length
  - Easy- takes minutes
  - Accurate- .0x mm

Selection of end-diastolic images
  Systolic expansion/IMT thinning

Mean CIMT 1.174 mm

Bulb Lumen
Far wall IMT
Patient: WRAMC, CMT
Gender: Ethnicity: Male, Black
Age at Exam: 53

Image Data
Auto-Calibrated. Pixel Size=0.074951 mm
SonoSite MicroMAXX HFL

Current Measurement Results
Mean IMT: 1.053 mm
Max Region: 1.124 mm @ 1.0 mm
Measurement Extent: 10.118 mm (135 pixels)

Individual Saved Measurement Results (all values in mm)
# Mean (Max)
1 1.053 (1.124@1.0) : Left Anterior CCA-Trace
ASE CONSENSUS STATEMENT

Use of Carotid Ultrasound to Identify Subclinical Vascular Disease and Evaluate Cardiovascular Disease Risk: A Consensus Statement from the American Society of Echocardiography Carotid Intima-Media Thickness Task Force

Endorsed by the Society for Vascular Medicine

James H. Stein, MD, FASE, Claudia E. Korcarz, DVM, RDMS, FASE, R. Todd Hurst, MD, Eva Lonn MD, MSc, FASE, Christopher B. Kendall, BS, RDMS, Emile R. Mohler, MD, Samer S. Najjar, MD, Christopher M. Rembold, MD, and Wendy S. Post, MD, MS,

Madison, Wisconsin; Scottsdale, Arizona; Hamilton, Ontario, Canada; Philadelphia, Pennsylvania; Baltimore, Maryland; and Charlottesville, Virginia

CIMT Instrumentation and Views

State-of-the-art ultrasound system
  - Digital image acquisition and storage, preferably DICOM
  - Phantom scans every 6 months and after any system changes
  - Semiannual routine preventive maintenance

Transducer
  - Linear array
  - Minimal compression (<10:1)
  - Fundamental frequency ≥ 7 MHz
  - Footprint ≥ 3 cm

Display
  - Depth 4 cm
  - Single focal zone
  - Frame rate ≥ 25 Hz
  - High dynamic range
  - Clear 3-lead electrocardiographic signal
  - Annotate images to describe segments, angles, and other findings
  - Carefully adhere to predefined scanning protocol
CIMT Instrumentation and Views

![CIMT Image 1](image1)

![CIMT Image 2](image2)
### Interpretation Steps

1. Review images on high-quality monitor (resolution $\geq 1024 \times 768$ pixels)

2. Review study images for overall image quality, wall thickness, plaque presence

3. Evaluate for presence of carotid plaques
   - Use transverse and longitudinal views to distinguish between plaque presence and imaging artifacts
   - Report location of plaques (near or far wall, segment, side)

4. Select best images of distal 1 cm of CCA far wall from each of 3 angles; review loops, then measure from R-wave gated still frames

5. Measure images in triplicate by tracing far wall blood-intima and media-adventitia interfaces using leading edge-to-leading edge method (Figure 5)
   - Measure 1-cm length
   - Assure that measurements from each angle are within 0.05 mm of others
   - Plaques should be traced as part of CIMT

6. Measurement data should automatically enter report
   - Measured images should be saved digitally to document tracing for later review
   - Images and measurements should be stored in database
   - Report mean CIMT values from far walls of right and left CCAs (mean-mean)
<table>
<thead>
<tr>
<th>Ultrasound background</th>
<th>Sonographers</th>
<th>Readers</th>
</tr>
</thead>
</table>
| Content areas                         | Registered diagnostic cardiac sonographer, medical sonographer, or vascular technician  
Certification in cardiopulmonary resuscitation and institutional emergency procedures  
Pathophysiology of atherosclerosis, histopathologic correlations between ultrasound and healthy and diseased arteries, carotid artery anatomy  
CVD risk assessment and rationale for noninvasive testing with carotid ultrasound  
Clinical use of carotid ultrasound to identify subclinical vascular injury and predict CVD risk, including evidence base from epidemiologic and clinical trials and advantages and limitations of testing  
Scanning technique, instrumentation, protocol selection, and imaging pitfalls, including limited hemodynamic evaluation of stenotic lesions, recognition of common cardiac arrhythmias, and blood pressure monitoring  
Ultrasound principles and quality assurance  
Measurement and reporting Training standards for readers and sonographers | Appropriate credentials and institutional privileges to interpret cardiac and/or vascular ultrasound studies |
| Initial hands-on, supervised training  | Scanning (minimum 8 h, in-person)  
-Protocol, image acquisition, best image  
-Demonstrate knowledge of content areas above  
Reading (minimum 2 h, in-person)  
-demonstrate proficiency with reading program | Scanning (minimum 2 h, in-person)  
-Understand image generation and pitfalls  
-Familiarity with scanning protocol  
Reading (minimum 2 h, in-person)  
-demonstrate proficiency with reading program |
| Follow-up of initial training          | Submit at least 3 paired mock studies for review by an experienced sonographer  
2 sets of images obtained at least 1 day apart, from 3 patient models  
Demonstrate protocol adherence, image quality, and image reproducibility | Submit at least 10 measured scans to a core laboratory with published accuracy and reproducibility data  
-Mean Δ reader core laboratory < 0.11 mm  
-95% of CIMT values within 0.11 mm of core laboratory  
Read at least 25 CIMT studies/y  
Annual testing of intraobserver and interobserver repeatability* |
| Maintenance of certification and quality assurance | Perform least 25 CIMT studies/y  
Annual retesting of repeatability*  
Quarterly detailed, objective feedback  
If inactivity > 2 months, perform two mock studies to show continued competence | Read at least 25 CIMT studies/y  
Annual testing of intraobserver and interobserver repeatability* |
Questions

- In which patients?
- How to perform?
  - Equipment
  - Procedure
  - Training/experience
- How to integrate in clinical decisions?
- How to get reimbursed?
## ASE Consensus Statement

Use of Carotid Ultrasound to Identify Subclinical Vascular Disease and Evaluate Cardiovascular Disease Risk: A Consensus Statement from the American Society of Echocardiography

Carotid Intima-Media Thickness Task Force

*Endorsed by the Society for Vascular Medicine*

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### Appendix 1

Common carotid artery carotid intima-media thickness values and percentiles from large North American cohort studies

<table>
<thead>
<tr>
<th>Age, y/percentile</th>
<th>White male</th>
<th>White female</th>
<th>Black male</th>
<th>Black female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>45</td>
<td>55</td>
<td>65</td>
<td>45</td>
</tr>
<tr>
<td>25th</td>
<td>0.496</td>
<td>0.572</td>
<td>0.648</td>
<td>0.476</td>
</tr>
<tr>
<td>50th</td>
<td>0.570</td>
<td>0.664</td>
<td>0.758</td>
<td>0.536</td>
</tr>
<tr>
<td>75th</td>
<td>0.654</td>
<td>0.774</td>
<td>0.894</td>
<td>0.610</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age, y/percentile</th>
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<th>White female</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>45</td>
<td>55</td>
<td>65</td>
<td>45</td>
</tr>
<tr>
<td>25th</td>
<td>0.524</td>
<td>0.588</td>
<td>0.652</td>
<td>0.472</td>
</tr>
<tr>
<td>50th</td>
<td>0.598</td>
<td>0.684</td>
<td>0.770</td>
<td>0.538</td>
</tr>
<tr>
<td>75th</td>
<td>0.690</td>
<td>0.806</td>
<td>0.922</td>
<td>0.610</td>
</tr>
</tbody>
</table>

*Mean far wall common carotid artery carotid intima-media thickness values from the Atherosclerosis Risk in Communities Study*
### B. Mean far wall common carotid artery carotid intima-media thickness values from the Carotid Atherosclerosis Progression Study (Matthias W. Lorenz, MD, personal communication, December 6)\textsuperscript{20}

<table>
<thead>
<tr>
<th>Age, y/percentile</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>25th</td>
<td>0.515</td>
<td>0.585</td>
</tr>
<tr>
<td>50th</td>
<td>0.567</td>
<td>0.633</td>
</tr>
<tr>
<td>75th</td>
<td>0.633</td>
<td>0.682</td>
</tr>
</tbody>
</table>

### C. Maximum* far wall common carotid artery carotid intima-media thickness values from the Edinburgh Artery Study (F. Gerald R. Fowkes, MBChB, PhD, personal communication, November 2006)\textsuperscript{31}

<table>
<thead>
<tr>
<th>Age, y/percentile</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60-64</td>
<td>65-69</td>
</tr>
<tr>
<td>25th</td>
<td>0.60</td>
<td>0.70</td>
</tr>
<tr>
<td>50th</td>
<td>0.80</td>
<td>0.80</td>
</tr>
<tr>
<td>75th</td>
<td>0.90</td>
<td>1.00</td>
</tr>
</tbody>
</table>
ARIC Coronary Heart Disease Risk Calculator that includes Carotid Ultrasound Information

This risk assessment tool uses information from the ARIC Study. It is designed for adults, 45-65 years old, who do not have heart disease to predict a person's chance of having a heart attack in the next 10 years. To find your risk score, enter your information in the calculator below then click the 'Calculate Risk' button.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are you a cigarette smoker?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cholesterol mg/dL</td>
<td>180</td>
</tr>
<tr>
<td>HDL (Good Cholesterol) mg/dL</td>
<td>50</td>
</tr>
<tr>
<td>Systolic Blood Pressure mm Hg</td>
<td>120</td>
</tr>
<tr>
<td>Carotid Artery Wall Thickness mm</td>
<td>1.3</td>
</tr>
</tbody>
</table>

* See Note below

<table>
<thead>
<tr>
<th>Carotid Plaque?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are you currently taking any medication to treat high blood pressure?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Do you have Diabetes?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent Risk Over a 10 Year Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>2.2%</td>
</tr>
</tbody>
</table>

This means that on average 25.3 of 100 people with this level of risk have a heart attack or die from coronary heart disease (CHD) in the next 10 years. Your risk for coronary heart disease over your lifetime is influenced by your risk factors, and by how well these are controlled.

Optimal levels of risk factors are: Being a non-smoker, total cholesterol less than 200 mg/dL, HDL cholesterol greater than 60 mg/dL, having systolic blood pressure less than 120 mm Hg and not needing treatment for high blood pressure. Click here to find useful information about healthy lifestyles and risk factors for heart attack, stroke, diabetes and heart failure.

This risk assessment tool is not intended as medical advice or to suggest treatment. The ARIC study investigators recommend that you consult with your physician or other healthcare professional for advice.

For details see:

Questions

- In which patients?
- How to perform?
  - Equipment
  - Procedure
  - Training/experience
- How to integrate in clinical decisions?
- How to get reimbursed?
Criteria for development and evaluation of CPT Category I and Category III Codes

• Current codes
  • 0126T- Level 3 code
  • 93880 Duplex scan of extracranial arteries; complete bilateral study
  • 93882 unilateral or limited study

• According to the latest CPT code book, 93880 and 93882 should not be used for a carotid IMT study (currently code 0126T), which is “for evaluation of atherosclerosis burden or CHD risk assessment.”

• Parity with calcium scoring:
  • 75771 Computed tomography, heart, without contrast material, with quantitative evaluation of coronary calcium
# Current Usage of Limited Carotid Ultrasound

<table>
<thead>
<tr>
<th>Site of Care: 93882</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outpatient Facilities</td>
<td>15,760</td>
<td>15,448</td>
<td>15,283</td>
</tr>
<tr>
<td>Freestanding</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Physician Office</td>
<td>157,192</td>
<td>163,984</td>
<td>163,863</td>
</tr>
<tr>
<td>Emergency</td>
<td>664</td>
<td>660</td>
<td>905</td>
</tr>
<tr>
<td>Total Outpatient Episodes</td>
<td>173,616</td>
<td>180,092</td>
<td>180,051</td>
</tr>
</tbody>
</table>

Source: Thomson-Reuters (Aileron)

**IMT Scans As Per AAPP (0126T, 93882)**

<table>
<thead>
<tr>
<th>Site of Care</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012**</th>
<th>2017**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concierge Cash Pay Practices (40 scans a month)</td>
<td>140,000</td>
<td>160,000</td>
<td>200,000</td>
<td>220,000</td>
<td>480,000</td>
</tr>
</tbody>
</table>
Criteria for development and evaluation of CPT Category I and Category III Codes

In developing new and revised Category I codes the CPT Advisory Committee and the CPT Editorial Panel require:

• that the service/procedure has received approval from the Food and Drug Administration (FDA) for the specific use of devices or drugs;

• that the suggested procedure/service is a distinct service performed by many physicians/practitioners across the United States;

• that the clinical efficacy of the service/procedure is well established and documented in U.S. peer review literature;

• that the suggested service/procedure is neither a fragmentation of an existing procedure/service nor currently reportable by one or more existing codes; and

• that the suggested service/procedure is not requested as a means to report extraordinary circumstances related to the performance of a procedure/service already having a specific CPT code.
CPT proposal:
Carotid wall quantitative thickness by ultrasound (intima-media; IMT) with detection of atheroma, bilateral

Status:
- February 2014: Category I code recommended by AMA CPT Editorial Panel
- April 2014: Procedure presented for RVU assignment to RUC panel
- Ongoing 2014: CMS to publish final 2015 rule in November 2014
Atherosclerosis: Clinical Perspectives Through Imaging
Editors: Taylor and Villines
Publisher: Springer
Carotid Ultrasonography for CIMT/Atheroma Detection

- **Who?**
  - Office or facility technique to identify residual risk, primarily in intermediate risk persons

- **How?**
  - Standardized protocol, specific devices
  - Training and experience

- **Clinical management?**
  - Integrate with CV risk factors for adjusted risk assessment - management follows.

- **Reimbursement?**
  - CPT code offers promise for 2015