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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.

Carotid intima media thickness testing provides a noninvasive, ultrasound-based technique to measure the burden of noninvasive atherosclerosis in the carotid artery. The principal evidence supporting the use of the test has been derived from large, research-based cohort studies, which clearly show a relationship between CIMT and incident coronary heart disease (CHD) events. However, like all imaging tests, there is a gap between observational evidence, and evidence guiding the selection of patients for imaging. Concern over this gap has been heightened by rapid growth in the use of cardiovascular imaging amidst unwarranted levels of regional variability in practice. To address rational, clinically appropriate application of CIMT imaging, however within the context of a large existing body of evidence on CIMT, appropriate use criteria have been developed as a formalized process [1] to develop expert consensus on the selection of patients for testing.

> An appropriate imaging study is one in which the expected incremental information, combined with clinical judgment, exceeds the expected negative consequences by a sufficiently wide margin for a specific indication that the procedure is generally considered acceptable care and a reasonable approach for the indication.

1. Appropriate use criteria development

Appropriate use criteria derive from a structured methodology evaluating clinical scenarios in which a patient might be considered for CIMT imaging are developed by an independent writing committee, and then considered by a separate technical rating panel using a modified Delphi technique. The technical rating panel is comprised evenly of individuals with substantial experience and knowledge of the imaging technique, and individuals with other areas of expertise outside of the imaging test under consideration. Technical panel members are provided a bibliography of relevant evidence on the imaging technique prior to entering the rating process. The clinical scenarios undergo a series of 2 rounds of ratings completed individually by the panel with no interaction between panel members. Between the rating rounds, the technical panel members meet for review and discussion of the first round rating results. The scoring for each scenario is evaluated with regard to its statistical distribution. When a rating is noted to have wide dispersion, a clinical scenario is specifically discussed. The technical panel does not have a chairperson, but a moderator from the writing committee who facilitates discussion. The process is not driven by the requirement to reach consensus, with the median rating from the second round constituting the final score for each clinical scenario.

2. Scoring

Technical rating panel members rated each indication on the following scale:

Score	7–9	Appropriate test for specific indication
Score	4–6	Uncertain for specific indication
Score	1–3	Inappropriate test for specific indication

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CIMT clinical scenarios and appropriateness ratings.

		Additional Patient Details	Median appropriateness ranking (category)
Risk assessment in the absence of known coronary heart disease			
1	CIMT for the initial detection of CHD risk	Low risk	**3 (I)**
2		Intermediate risk	**7 (A)**
3		High risk	**5 (U)**
4	CIMT for the initial detection of CHD risk in the setting of 2 or more NCEP risk factors	Low risk	**5 (U)**
5		Intermediate risk	**8 (A)**
6		High risk	**5 (U)**
7	CIMT for the initial detection of CHD risk in patients with metabolic syndrome	<30 years of age	**4 (U)**
8		30–60 years of age	**7 (A)**
9		>60 years of age	**7 (A)**
10	CIMT for the detection of CHD risk in patients with diabetes mellitus	Without a history of CHD	**7 (A)**
11		With known CHD	**3 (I)**
12	CIMT for the detection of CHD risk in men >45 years of age irrespective of CHD risk level		**5 (U)**
13	CIMT for the detection of CHD risk in women >55 years of age irrespective of CHD risk level		**6 (U)**
14	CIMT for the detection of CHD risk in the setting of a family history of premature CHD	Low risk	**6 (U)**
15		Intermediate risk	**8 (A)**
16	CIMT for the detection of CHD risk in patients with a known abnormal coronary calcium score (>100 or above the 75th percentile for age and gender)		**4 (U)**
17	CIMT for the detection of CHD risk in patients with a known CAC score of zero	FRS < 5%	**3 (I)**
18		FRS 5–10%	**5 (U)**
19		FRS 11–20%	**7 (A)**
20	Asymptomatic patient with focal carotid artery plaque on duplex carotid ultrasound		**3 (I)**
21	Asymptomatic patient with >50% stenosis on carotid duplex ultrasound		**3 (I)**
Risk assessment in patients with known CHD			
22	Risk assessment following carotid endarterectomy, imaging the contralateral artery		**3 (I)**
23	Patient on lipid lowering therapy, to evaluate plaque echogenicity		**5 (U)**
24	In a patient with known CHD or other secondary prevention equivalent diagnoses		**3 (I)**
25	In a patient with Transient ischemic attack or stroke as a component of a carotid Doppler evaluation		**5 (U)**
Serial CIMT imaging for monitoring of CHD risk status			
26	In primary prevention	Annually	**3 (I)**
27		After 2 or more years	**5 (U)**
28	In secondary prevention	Annually	**3 (I)**
29		After 2 or more years	**4 (U)**
30	In patients with prior normal CIMT		**3 (I)**
31	In patients with prior abnormal CIMT		**6 (U)**
32	In patients that have reached treatment targets of CHD risk factors		**5 (U)**
33	In patients that have not reached treatment targets of CHD risk factors		**6 (U)**

A, Appropriate; U, Uncertain; I, Inappropriate, CIMT, Carotid intima media thickness; FRS, Framingham risk score; CAC, coronary artery calcium; CHD, coronary heart disease; NCEP, National Cholesterol Education Program.

The following guidance was provided to the technical rating panel:

1. CIMT would be assumed to be performed under acceptable technical standards:
   a. CIMT is performed in accordance with best practice standards and appropriately experienced physicians.
   b. CIMT equipment is available that has the minimal technical capabilities required for the indication to lead to high quality and precise imaging. Typical technical parameters for studies performed on include imaging at 10 mHz, with electrocardiographic gating of image acquisition, digital image storage and appropriate computer software must be available for image analysis.
2. Appropriate use criteria development requires determination of a reasonable course of action for clinical decision making based on a risk/benefit trade-off as determined by individual patient indications. Similarly, if there is no potential for improvement in health status or survival, then the indication was rated in the inappropriate range.
3. All indications should consider the available medical literature. In many cases, literature studies are reflections of the capabilities and limitations of the test in a limited population and provide minimal information about the role of the test in clinical decision making. In contrast, guideline recommendations are often reflections of optimal or specific applications of science as found in the literature. Guideline recommendations may be used to help guide ratings but class of recommendation and level of evidence for a recommendation should not be viewed as translating into a particular score for an indication.
4. The use of testing is assumed to have the potential to impact clinical decision making and to direct therapeutic interventions.
5. Cost should be considered implicitly in the appropriate use determination.

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6. Additional factors may be considered implicitly in the appropriate use determination including the impact of the image on clinical decision making when combined with clinical judgment.
7. For each indication, the rating should reflect whether the test is reasonable for the patient according to the appropriate use definition, not whether the test is better or worse than another. It also should not consider issues of local availability or skill for any modality or attempt in any way to compare two tests to each other.
8. The category of uncertain should be used when insufficient clinical data are available for a definitive categorization or there is substantial disagreement regarding the appropriateness of that indication. The designation of "uncertain" is assumed to not provide grounds for denial of reimbursement.
9. It is assumed that clinicians will use carotid IMT studies in addition to standard methods of risk assessment as presented in the NHLBI report [2] on "Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III (ATP III))".

Absolute risk is defined as the probability of developing CHD, including myocardial infarction or coronary heart disease death, over a given time period. The ATP III report specifies absolute risk for CHD over the next 10 years. CHD risk refers to 10 year risk for any myocardial infarction or cardiac-related death. However, in acknowledgement that global absolute risk scores may be miscalibrated to certain populations (e.g., women, younger men), clinical judgment must be applied in selecting categorical risk thresholds.

- CHD risk – low
  Defined by the age specific risk level that is below average. In general, low risk will correlate with a 10-year absolute CHD risk less than 10%.
- CHD risk – intermediate
  Defined by the age specific risk level that is average or above average. In general, moderate risk will correlate with a 10-year absolute CHD risk between 10 and 20%. Among women and younger age men, an expanded intermediate risk range of 6–20% may be appropriate.
- CHD risk – high
  Defined as the presence of diabetes mellitus in a patient greater than or equal to 40 years of age, peripheral arterial disease or other coronary risk equivalents, or the 10-year absolute CHD risk of greater than 20%.

3. Discussion

Appropriate use criteria define common patient subgroups where expert opinion and the available medical evidence are combined to assess the net benefit of a test or procedure, in this instance CIMT. The technical panel rated 33 clinical scenarios for the clinical application of CIMT among categories including: 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. The intent of these criteria is to guide the rational use of the procedure, namely avoidance of either under- or over-utilization.

Among the potential CIMT indications, a total of 7 were rated as appropriate, 16 were rated as uncertain, and 10 were rated as inappropriate. 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, for which greater evidence is needed on the technical success of serial imaging in clinical settings, in addition to greater understanding of anticipated progression rates, optimal time horizon for repeat testing, and the effect of such an approach on clinical management or outcomes. Inappropriate indications generally were seen among use of CIMT in low risk patients, and high risk patients.

The clinical scenarios included in this report were designed to reflect the most common and important potential applications for CIMT. However, not all potential candidates for CIMT imaging may not strictly fall within these categories such as special patient populations (e.g., children) or conditions (familial hypercholesterolemia). These criteria are expected to be useful for clinicians, health care facilities, and third-party payers engaged in the delivery of cardiovascular imaging services. Their intent is to provide guidance on selected patient scenarios and determine overall patterns of use of CIMT. Although the appropriate use ratings reflect medical literature as well as expert consensus, physicians and other stakeholders should understand the role of clinical judgment in determining whether to order a test for an individual patient. Thus, it is not anticipated that 100% of CIMT indications for a given health care provider or facility will fall within the "appropriate" category. Additionally, uncertain indications often require individual physician judgment and understanding of the patient to better determine the usefulness of a test for a particular scenario. As such, the ranking of an indication as uncertain (4–6) should not be viewed as limiting the use of CIMT. Concordantly, the ratings reflect that the Technical Panel was instructed that the "uncertain" designation was still designed to be considered as a "reimbursable" category.

Implementation of these criteria is highly encouraged through provider education, as increasing emphasis is being placed on imaging appropriateness by laboratory accreditation bodies and other organizations focused on provider quality. Clinicians could use the ratings for decision support or an educational tool when considering the need for CIMT imaging, or within communications regarding referrals for CIMT imaging. It is hoped that payers would use these criteria as the basis for the development of rational payment management strategies, in that services performed for appropriate indications will be considered reimbursable. In contrast, services performed for inappropriate indications should likely require additional documentation to justify reimbursement because of the unique circumstances or the clinical profile which must exist in such a patient. Uncertain ratings are those where the available data vary or are rapidly evolving and thus more research is needed.

The use of ultrasound to measure CIMT is a quantitative test providing measurements of submillimeter arterial structures. Thus, successful application of these criteria for patient selection also requires an understanding and implementation of testing conditions which favor reliable and reproducible imaging results. Thus, CIMT laboratories should assure proper training of the staff, and the implementation and adherence to systems, standardization policies and procedures to foster and document accuracy and reproducibility.

In conclusion, this document presents the current understanding of the net clinical benefit of CIMT imaging within the context of the present literature and expert consensus as judged within the balance of the potential risks and benefits to the patient. 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.

Studies of CIMT validation and reproducibility [3–5].

Guidelines and review [6–9].

Longitudinal CIMT studies [10–18].

Progression/regression of atherosclerosis – Clinical Trials [19–23].

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Appendix A.

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References

[1] Patel MR, Spertus JA, Brindis RG, et al. ACCF proposed method for evaluating the appropriateness of cardiovascular imaging. J Am Coll Cardiol 2005;46(8):1606–13.
[2] Executive Summary of the Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). JAMA 2001;285(19):2486–97.
[3] Hachamovitch R, Di Carli MF. Methods and limitations of assessing new noninvasive tests. Part I: anatomy-based validation of noninvasive testing. Circulation 2008;117(20):2684–90.
[4] Pignoli P, Tremoli E, Poli A, Oreste P, Paoletti R. Intimal plus medial thickness of the arterial wall: a direct measurement with ultrasound imaging. Circulation 1986;74(6):1399–406.
[5] Hachamovitch R, Di Carli MF. Methods and limitations of assessing new noninvasive tests. Part II: outcomes-based validation and reliability assessment of noninvasive testing. Circulation 2008;117(21):2793–801.
[6] Devine PJ, Carlson DW, Taylor AJ. Clinical value of carotid intima-media thickness testing. J Nucl Cardiol 2006;13(5):710–8.
[7] Stein JH, Korcarz CE, Hurst RT, et al. 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. J Am Soc Echocardiogr 2008;21(2):93–111.
[8] Touboul PJ, Hennerici MG, Meairs S, et al. Mannheim carotid intima-media thickness consensus (2004–2006). An update on behalf of the Advisory Board of the 3rd and 4th Watching the Risk Symposium, 13th and 15th European Stroke Conferences, Mannheim Germany, 2004, and Brussels, Belgium, 2006. Cerebrovasc Dis 2007;23(1):75–80.
[9] Greenland P, Abrams J, Aurigemma GP, et al. Prevention Conference V: beyond secondary prevention: identifying the high-risk patient for primary prevention: noninvasive tests of atherosclerotic burden: Writing Group III. Circulation 2000;101(1):E16–22.
[10] Bots ML, Hoes AW, Koudstaal PJ, Hofman A, Grobbee DE. Common carotid intima-media thickness and risk of stroke and myocardial infarction: the Rotterdam Study. Circulation 1997;96(5):1432–7.
[11] Chambless LE, Heiss G, Folsom AR, et al. Association of coronary heart disease incidence with carotid arterial wall thickness and major risk factors: the Atherosclerosis Risk in Communities (ARIC) Study, 1987–1993. Am J Epidemiol 1997;146(6):483–94.
[12] Lorenz MW, Markus HS, Bots ML, Rosvall M, Sitzer M. Prediction of clinical cardiovascular events with carotid intima-media thickness: a systematic review and meta-analysis. Circulation 2007;115(4):459–67.
[13] Chambless LE, Folsom AR, Clegg LX, et al. Carotid wall thickness is predictive of incident clinical stroke: the Atherosclerosis Risk in Communities (ARIC) study. Am J Epidemiol 2000;151(5):478–87.
[14] Newman AB, Naydeck BL, Ives DG, et al. Coronary artery calcium, carotid artery wall thickness, and cardiovascular disease outcomes in adults 70 to 99 years old. Am J Cardiol 2008;101(2):186–92.
[15] O'Leary DH, Polak JF, Kronmal RA, Manolio TA, Burke GL, Wolfson SKJ. Carotid-artery intima and media thickness as a risk factor for myocardial infarction and stroke in older adults Cardiovascular Health Study Collaborative Research Group. N Engl J Med 1999;340(1):14–22.
[16] Folsom AR, Kronmal RA, Detrano RC, et al. Coronary artery calcification compared with carotid intima-media thickness in the prediction of cardiovascular disease incidence: the Multi-Ethnic Study of Atherosclerosis (MESA). Arch Intern Med 2008;168(12):1333–9.
[17] Heiss G, Sharrett AR, Barnes R, Chambless LE, Szklo M, Alzola C. Carotid atherosclerosis measured by B-mode ultrasound in populations: associations with cardiovascular risk factors in the ARIC study. Am J Epidemiol 1991;134(3):250–6.
[18] Kablak-Ziembicka A, Przewlocki T, Tracz W, et al. Diagnostic value of carotid intima-media thickness in indicating multi-level atherosclerosis. Atherosclerosis 2007;193(2):395–400.
[19] Bots ML, Evans GW, Riley WA, Grobbee DE. Carotid intima-media thickness measurements in intervention studies: design options, progression rates, and sample size considerations: a point of view. Stroke 2003;34(12):2985–94.
[20] Chambless LE, Folsom AR, Davis V, et al. Risk factors for progression of common carotid atherosclerosis: the Atherosclerosis Risk in Communities Study, 1987–1998. Am J Epidemiol 2002;155(1):38–47.
[21] Espeland MA, O'Leary DH, Terry JG, Morgan T, Evans G, Mudra H. Carotid intimal-media thickness as a surrogate for cardiovascular disease events in trials of HMG-CoA reductase inhibitors. Curr Control Trials Cardiovasc Med 2005;6(1):3.
[22] Junyent M, Cofan M, Nunez I, Gilabert R, Zambon D, Ros E. Influence of HDL cholesterol on preclinical carotid atherosclerosis in familial hypercholesterolemia. Arterioscler Thromb Vasc Biol 2006;26(5):1107–13.
[23] Junyent M, Zambon D, Gilabert R, Nunez I, Cofan M, Ros E. Carotid atherosclerosis and vascular age in the assessment of coronary heart disease risk beyond the Framingham Risk Score. Atherosclerosis 2008;196(2):803–9.

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