Carotid intima-media thickness, arterial stiffness measurements

Clinical relevance?

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Content

- **Carotid IMT**
  - Measurement
  - Risk relation
  - Added value

- **Arterial stiffness**
  - Measurement
  - Risk relation
  - Added value
Concept: CIMT measurements

- A thick CIMT does not cause a myocardial infarction
  - *Carotid IMT as a measurement of cardiovascular risk*
    - (cumulative exposure of risk factors)
  - *Carotid IMT as a measurement of atherosclerosis*
  - *Carotid IMT as both*

- *Change in CIMT*
  - Does not prevent coronary events
  - Does not prevent stroke
  - Reflects what is going on in the vasculature overall

- *Think first what you need*

Finn et al, ATVB 2009
Common carotid intima-media thickness
Maximum carotid intima-media thickness

O’Leary et al Eur Heart J 2010
Not all CIMT measurements are the same

- So, we have
  - *Left & right carotid*
  - *Common, bifurcation, internal segment*
  - *Near and far wall*
  - *Angles (1-5)*
- Allows for construction: \(2 \times 3 \times 2 \times 5 =\)
- 60 CIMT measurements
- **IT IS ALL CALLED ‘IMT’**
- All with different
  - *Measurement error*
  - *Rate of change over time*
  - *Reflection of atherosclerosis and risk*
  - *Sensitivity for drug therapy*
# Common CIMT and Cardiovascular events

## Contribution to Total USE-IMT Population, % of Total

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
<th>Hazard Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARIC, 1994</td>
<td>31</td>
<td>1.11 (1.08-1.14)</td>
</tr>
<tr>
<td>CAPS, 2006</td>
<td>8</td>
<td>1.10 (0.99-1.23)</td>
</tr>
<tr>
<td>Charlottesville, 2006</td>
<td>1</td>
<td>0.88 (0.56-1.36)</td>
</tr>
<tr>
<td>CHS, 2007</td>
<td>7</td>
<td>1.11 (1.06-1.16)</td>
</tr>
<tr>
<td>FATE, 2011</td>
<td>3</td>
<td>1.20 (1.01-1.42)</td>
</tr>
<tr>
<td>Hoorn Study, 2003</td>
<td>1</td>
<td>1.07 (0.72-1.59)</td>
</tr>
<tr>
<td>KIHD, 1991</td>
<td>2</td>
<td>1.05 (0.96-1.16)</td>
</tr>
<tr>
<td>Malmo, 2000</td>
<td>10</td>
<td>1.10 (1.04-1.17)</td>
</tr>
<tr>
<td>MESA, 2007</td>
<td>13</td>
<td>0.98 (0.89-1.08)</td>
</tr>
<tr>
<td>Nijmegen Study, 2009</td>
<td>3</td>
<td>1.34 (0.94-1.90)</td>
</tr>
<tr>
<td>NOMAS, 2007</td>
<td>2</td>
<td>1.36 (0.99-1.85)</td>
</tr>
<tr>
<td>OSACA2 Study, 2007</td>
<td>1</td>
<td>1.09 (0.96-1.24)</td>
</tr>
<tr>
<td>Rotterdam Study, 1997</td>
<td>8</td>
<td>1.13 (1.06-1.20)</td>
</tr>
<tr>
<td>Tromsø Study, 2000</td>
<td>9</td>
<td>1.04 (0.98-1.10)</td>
</tr>
</tbody>
</table>

\[ I^2 = 12.30\%; \text{Q test for heterogeneity, } P = .24 \]

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Hazard ratio per 0.1 mm increase in CIMT

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[Image: JAMA. 2012;308(8):796-803]
Added value common CIMT

Common Carotid Intima-Media Thickness Measurements in Cardiovascular Risk Prediction
A Meta-analysis

- Individual participant data meta analysis
- 14 population based cohorts
- 45,828 participants with individual data
- 4007 cardiovascular events
  - (CV death, non fatal AMI, stroke)

- Common CIMT added to Framingham score

JAMA. 2012;308(8):796-803
### Net reclassification improvement

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>[0.1 – 1.6]</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>0.8%</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>0.9%</td>
<td>[-0.2 – 1.9]</td>
</tr>
<tr>
<td>Women</td>
<td>0.8%</td>
<td>[-0.2 – 1.6]</td>
</tr>
</tbody>
</table>

**Authors conclusion**

The added value of common CIMT alone in 10-year risk prediction of cardiovascular events, in addition to the Framingham Risk Score, is small and unlikely to be of clinical importance.
CQ1: “What is the evidence regarding reclassification or contribution to risk assessment when high-sensitivity C-reactive protein (hs-CRP), apolipoprotein B (ApoB), glomerular filtration rate (GFR), microalbuminuria, family history, cardiorespiratory fitness, ankle-brachial index (ABI), carotid intima-media thickness (CIMT), or coronary artery calcium (CAC) score are considered in addition to the variables that are in the traditional risk scores?”

5. CIMT is not recommended for routine measurement in clinical practice for risk assessment for a first ASCVD event.

N (No Recommendation For or Against)  Appendix 1  III: No Benefit†  B (12,16,18)

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Lessons From the Past and Promises for the Future for Carotid Intima-Media Thickness

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• Promises for the future
  • CIMT in the young
  • CIMT & plaques in risk classification
  • CIMT in trials as decision tool for and M&M trial
Content

- Carotid IMT
  - Measurement
  - Risk relation
  - Added value

- Arterial stiffness
  - Measurement
  - Risk relation
  - Added value
The stiffness of the arterial wall is determined by various factors.

- **Intra-arterial blood pressure**
- **Tone of the vessel**
  - Function of the endothelium
  - Nerves
- **Intrinsic structure of the vascular wall**
  - Collagen
  - Atherosclerosis
  - Muscular wall
Measurement of arterial stiffness

- Many approaches, many techniques, many definitions
- Pulse waveform analysis and transfer functions
- Pulse wave velocity
- Local
  - Distensibility
  - Compliance
- Pulse pressure
- Ambulatory Arterial stiffness index based on 24h ABPM
Aortic stiffness and cardiovascular events

Figure 3

RR and 95% CI for a 1-m/s Increase in Aortic PWV and Clinical Events

Test for heterogeneity: $I^2=81.1\%, P<0.001$
Test for overall effect: $Z=5.43, P<0.001$

Test for heterogeneity: $I^2=81.3\%, P<0.001$
Test for overall effect: $Z=4.88, P<0.001$

Test for heterogeneity: $I^2=85.5\%, P<0.001$
Test for overall effect: $Z=5.00, P<0.001$
Added value arterial stiffness

• No large studies with sufficient numbers to precisely assess NRIs
Added value arterial stiffness

  - 1367 individuals, 71 events
  - 'PWV-AIx-CSP-CAP-IMT' lead to increase in NRI.
- Sehestedt et al, J Hypertension 2012
  - 1385 Danish subjects, 119 events
  - No additional value of PWV
- Pereira et al, Blood Pressure 2014
  - 1701 Portugese subjects, 47 events
  - Addition of PWV lead to a increase in NRI
- Karras et al, Hypertension 2012
  - 439 CKD patients, 53 events.
  - Addition of stiffness lead to increase in NRI.
Treatment decisions

- Differences between blood pressure lowering drugs in effect on brachial SBP and on central SBP.
- Due to effect on central to brachial amplification
- Beta blockers and diuretics tend to reduce amplification, and thus lesser central SBP decline.

The CAFÉ trial

*(Circulation. 2006;113:1213-1225)*
Recommendation: arterial stiffness

No mentioning of arterial stiffness at all in the report!!
Thank you for your attention

Always be aware of artifacts in the measurement

CIMT and arterial stiffness markers of risk

No right or wrongs, depends on needs

Think first what you need and why