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Associate Professor of Radiology
Associate Professor of Medicine
• Courtesy to Franz von Ziegler, MD
  • Univ. of Munich, Germany

• Coronary Calcium Scoring and
• Risk Assessment
Why Do We Need New Tests?

- Coronary Heart Disease (CHD): No. 1 – Killer!
- > 50% of death in diabetic patients due to CHD
- primary manifestation of CHD:
  - 55% Angina pectoris
  - 25% myocardial infarction
  - 20% sudden coronary death

No prior diagnosis!
No prior clinical symptoms!!!

Goal: risk stratification and detection of CHD before (!) it causes symptoms
Calcium is just a surrogate marker for coronary artery disease, isn't it?

Calcified plaque is an American Heart Association (AHA) type Vb atheroma that takes an individual from having risk factors for atherosclerosis to having documented disease!
### Table 2

**Traditional and Emerging Risk Factors and Arterial Assessment Techniques**

<table>
<thead>
<tr>
<th>Traditional risk factors</th>
<th>Emerging risk factors</th>
<th>Arterial assessment techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>LDL phenotype</td>
<td>Pulse pressure</td>
</tr>
<tr>
<td>Gender</td>
<td>Lipoprotein(a)</td>
<td>Arterial stiffness</td>
</tr>
<tr>
<td>Family history</td>
<td>Homocysteine</td>
<td>Ankle-brachial index</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>hs-CRP</td>
<td>Endothelial function</td>
</tr>
<tr>
<td>HDL cholesterol</td>
<td><em>Chlamydia</em> titer</td>
<td>Carotid artery IMT</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>ACE genotype</td>
<td>EBCT</td>
</tr>
<tr>
<td>Cigarette smoking</td>
<td>Fibrinogen</td>
<td>MRA</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LV hypertrophy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HDL, high-density lipoprotein; LV, left ventricular; LDL, low-density lipoprotein; hs-CRP, high-sensitivity C-reactive protein; ACE, angiotensin-converting enzyme; IMT, intima-media thickness; EBCT, electron beam CT; MRA, magnetic resonance angiography.
## PROCAM Score

### Age (years)

<table>
<thead>
<tr>
<th>Age Range</th>
<th>LDL-Cholesterol (mg/dl)</th>
<th>HDL-Cholesterol (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-39</td>
<td>&lt;100</td>
<td>0</td>
</tr>
<tr>
<td>40-44</td>
<td>100-129</td>
<td>2</td>
</tr>
<tr>
<td>45-49</td>
<td>130-139</td>
<td>3</td>
</tr>
<tr>
<td>50-54</td>
<td>140-159</td>
<td>5</td>
</tr>
<tr>
<td>55-59</td>
<td>&gt;=160</td>
<td>8</td>
</tr>
<tr>
<td>60-65</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Systolic Blood Pressure (mm Hg)

<table>
<thead>
<tr>
<th>Blood Pressure Range</th>
<th>LDL-Cholesterol (mg/dl)</th>
<th>HDL-Cholesterol (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;120</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>120-129</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>130-139</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>140-159</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>&gt;=160</td>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>

### Estimated Risk of Cardiovascular Events within 10 Years

- **< 10%** = low risk
- **10% - 20%** = intermediate risk
- **> 20%** = high risk
Diagnostic Threshold
Comparison to Framingham- and PROCAM-Score

ROC-Curve
Prediction of MI

Diagnostic threshold:
- Framingham score 0.63
- Procamscore 0.65
- Volumescore 0.81

P < 0.05

Current Non Invasive Diagnostic Tests

- EKG
- Treadmill
- Echocardiography
Invasive vs. Non-invasive Modalities

non-invasive
- Stress EKG
- Stress Echo
- SPECT
- PET
- Coronary CT – Calcium Screening

invasive
- IVUS
- Cath

0% 20% 45% 60% 70% 90%
- normal
- II-III
- IV
- Va
- Vb
- Vc

Erbel et al., HERZ 1996
Cardiac Computed Tomography

- coronary stenosis detection
- angiography of bypasses
- plaque imaging
- coronary stents

Coronary Calcium Scoring

- prognostic value
- coronary stenosis
- progression of atherosclerosis
- plaque burden

Coronary Angiography

- coronary stenosis detection
- angiography of bypasses
- plaque imaging
- coronary stents
Coronary Calcium Scoring (CS)

• [http://cardiacimaging.ufl.edu/training/](http://cardiacimaging.ufl.edu/training/)
• [www.cctaboardreview.com](http://www.cctaboardreview.com)
Coronary Calcium Scoring
Coronary Calcium Scoring
Agatston-Score

Calcified Plaque area [mm²]

CT-Numbers depending on plaquedensity

- 130-200 HU = # 1
- 201-300 HU = # 2
- 301-400 HU = # 3
- > 400 HU = # 4

high variability reduced reproducibility depends on slice thickness
Volume Score and Calcium Mass

**Volume Score**

= isotropic interpolation between axial slices

- 3-dimensional modality
- independent of slicethickness
- lower interscan-variability, than Agatston score

**Calcium Mass**

= calibration with calcium standard mass

- 3-dimensional modality
- theoretically no interscan-variability
  (multicenter-trials with different scanners)
ELECTRON BEAM CT (EBCT)
COMPARISON OF CALCIUM SCORES WITH EBCT V MDCT


6814 pts (MESA) scanned by EBCT & MDCT

- Agatston scores, calcium volumes, & interpolated volumes measured
- Agreement between EBCT & MDCT was 96% in detecting coronary artery calcification
- Motion & misregistration artifacts more prevalent with MDCT
- Noise artifacts more common with EBCT
- Volume-based scores slightly more reproducible with either technology
- In general, Ca scoring can be performed with equivalent reproducibility with EBCT or MDCT scanning & reading protocols are standardized
- Overlapping image sections, shorter triggering intervals, & using volume scores are all steps that may lead to increased reproducibility (were not done in MESA)
Volume score: Correlation between EBCT and MSCT

\[\text{EBCT ln(volume score +1)}\]

\[\text{MSCT ln(volume score +1)}\]

\[n = 367\]

\[r = 0.84\]

EBCT: 345  402

MSCT: 362  478

\[p = 0.34\]
Coronary Calcium Scan Protocol

- tube voltage: 120 kV
- tube current: 200 mAs
  (4D care dose on)
- collimation: 30 x 0.6
- slice thickness 3.0 mm
- increment 1.5
- axial slices
- B 36f - Kernel

Native Scan

No contrast agent
Less radiation
Quick and easy to handle
TYPES OF CALCIUM QUANTIFICATION

- Agatston score is nonlinear and sensitive to changes based on a single pixel.

- **Initially designed for EBCT technology** (not MDCT).

- Volume score introduced to improve reproducibility, but does not always represent true volume of calcification.

- Calcium mass should be more reliable regardless of system and protocol used.

- Larger studies needed !.
Coronary Calcification and Atherosclerosis

• non-invasive marker of coronary atherosclerosis

• sensitive parameter of early stages of disease
### Normogram CS (Hoff et al Am J Cardiol 2001)

**Men (25,251)**

<table>
<thead>
<tr>
<th>years</th>
<th>&lt; 40</th>
<th>40-44</th>
<th>45-49</th>
<th>50-54</th>
<th>55-59</th>
<th>60-64</th>
<th>65-69</th>
</tr>
</thead>
<tbody>
<tr>
<td>25. Percentile</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>13</td>
<td>32</td>
</tr>
<tr>
<td>50. Percentile</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>15</td>
<td>48</td>
<td>113</td>
<td>180</td>
</tr>
<tr>
<td>75. Percentile</td>
<td>3</td>
<td>9</td>
<td>36</td>
<td>103</td>
<td>215</td>
<td>410</td>
<td>566</td>
</tr>
<tr>
<td>90. Percentile</td>
<td>14</td>
<td>59</td>
<td>154</td>
<td>332</td>
<td>554</td>
<td>994</td>
<td>1299</td>
</tr>
</tbody>
</table>

**Women (9,995)**

<table>
<thead>
<tr>
<th>years</th>
<th>35-39</th>
<th>40-44</th>
<th>45-49</th>
<th>50-54</th>
<th>55-59</th>
<th>60-64</th>
<th>65-69</th>
</tr>
</thead>
<tbody>
<tr>
<td>25. Percentile</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>50. Percentile</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>75. Percentile</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>23</td>
<td>57</td>
<td>145</td>
</tr>
<tr>
<td>90. Percentile</td>
<td>3</td>
<td>4</td>
<td>22</td>
<td>55</td>
<td>121</td>
<td>193</td>
<td>410</td>
</tr>
</tbody>
</table>
Atherosclerosis and coronary artery disease is a condition of middle-age and older adults?

Coronary Artery Risk Development in Young Adults (CARDIA):
Individuals with a mean age of 45 years (range, 38 to 50 years), 19% had advanced atheromatous coronary artery disease


The Pathobiological Determinants of Atherosclerosis in Youth (PDAY)

Approximately 19% of 30- to 34-year-old men and 8% of 30- to 34-year-old women had atherosclerotic stenosis ± 40% in the LAD

• Potential of Preventive and Therapeutic Screening: Frequency of Atherosclerosis
Prognostic Value of Coronary Calcification

• http://cardiacimaging.ufl.edu/training/
• www.cctaboardreview.com
The frequency of calcium deposits is significantly different in patients suffering events, the average number of calcium deposits is significantly higher in those with acute myocardial infarction (AMI) compared to those with stable angina ($p < 0.0005$).
Everyone gets calcified plaque — can't we just ignore it in old people?

The Rotterdam Coronary Calcification study:
N=1,795 older asymptomatic individuals for a mean 3.3 years (mean age, 71 years; range, 62 to 85 years) followed and correlated the incidence of cardiac events with the presence of coronary artery calcification.


Vliegenthart and colleagues reported that the relative risk of coronary events was:
3.1% (95% confidence index [CI], 1.2 to 7.9) for calcium scores of 101 to 400,
4.6% (95% CI, 1.8 to 11.8) for calcium scores of 401 to 1000, and
8.3% (95% CI, 3.3 to 21.1) for calcium scores greater than 1000 compared with calcium scores of 0 to 100.
Follow-up Study of asymptomatic individuals
n = 1288 (men = 743), timeperiod 4.6 ± 1.8 years

Group I: no sudden coronary death (SCD), no myocardial infarction (MI), no PTCA, no stroke

Group II (Score < 100)

Group III (Score > 100)

Relative risk of future PTCA in dependence of Calcium score:

Coronary calcium doesn't work in women and minorities!

**Multi-Ethnic Study of Atherosclerosis (MESA):**

assessed calcium as a predictor of coronary events in four ethnic groups:
Whites (38.6%), blacks (27.6%), Chinese Americans (11.9%), and Hispanics (21.9%) (...

Adjusted risk of a coronary events:
- Increased by 7.73% among participants with calcium scores between 101 and 300
- Increased by 9.67% among those with scores above 300 (p < 0.001 for both comparisons)

Among the four racial and ethnic groups, a doubling of the calcium score increased the risk of a major coronary event by 15% to 35% and increased the risk of any coronary events by 18% to 39%

The areas under the ROC curves for predicting major coronary events and any coronary event were higher when the calcium score was added to the standard risk factors

ASYMPTOMATIC PATIENTS – Events

- Studied 8855 asymptomatic low- moderate-risk pts (30-76yo); Followed for mean 37 months
- Events: death, MI, revascularization (soft)
- CA Ca detected in 74% men & 51% women
- 224 confirmed events during follow-up
- Association between Ca and all events (except hard events & women)
- Ca independently associated with cardiac events (RR greater than that of traditional RF’s)

**TABLE 1. Event Rates for Men and Women With Detectable CAC Compared to No Detectable CAC**

<table>
<thead>
<tr>
<th></th>
<th>CAC Present</th>
<th>No CAC</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total No.</td>
<td>3065</td>
<td>1086</td>
<td></td>
</tr>
<tr>
<td>Hard events, %</td>
<td>1.6</td>
<td>0.3</td>
<td>0.001</td>
</tr>
<tr>
<td>Soft events, %</td>
<td>4.5</td>
<td>0.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>All events, %</td>
<td>6.1</td>
<td>0.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total No.</td>
<td>754</td>
<td>730</td>
<td></td>
</tr>
<tr>
<td>Hard events, %</td>
<td>0.5</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Soft events, %</td>
<td>2.8</td>
<td>0.7</td>
<td>0.002</td>
</tr>
<tr>
<td>All events, %</td>
<td>3.3</td>
<td>1</td>
<td>0.002</td>
</tr>
</tbody>
</table>

ASYMPTOMATIC PATIENTS-Prognosis

- Studied 676 asymptomatic pts referred for EBCT
- 10122 pts screened by EBCT for Ca score nomograms
- Assessed Ca score in predicting hard events
- Ca score>0 associated with 3%/yr event rate; 0.12% if 0
- Univariate analyses demonstrate that age, smoking, DM, and Ca score predictive of events
- Multiple logistic regression analyses showed Ca score alone was best predictor of events
- Ca score added prognostic information to traditional RF's

St. Francis Heart Study

n = 4,903 asymptomatic individuals

- Follow-up 4.3 years
- End points:
  1. Sudden coronary death, myocardial infarction
  2. Bypass-Surgery, PCI
  3. Stroke
  4. Surgery due to peripheral artery disease

Cutoff: Agastonscore ≥ 100

Arad et al. JACC 2005
Prognostic value for overall mortality in 10,377 asymptomatic individuals

Shaw L et al. Radiology 2003
Ruling out of CHD
In the ED!

- http://cardiacimaging.ufl.edu/training/
- www.cctaboardreview.com
CS in 1,764 symptomatic individuals

UTILITY OF CA SCORE IN THE EMERGENCY DEPARTMENT

- Study of 192 pts ≥30yo presenting to ED with CP & non-diagnostic ECG
- Average F/U 50±10 months
- 0.6% annualized event rate for Ca Score 0
- 13.9% for pts with Ca Score>400
- Regression analysis showed Ca Score to be associated with greater risk of CV event independent of age, gender, race, and other RF’s
- Previous studies had limited
- F/U; This study had 7yr F/U

Gergiou et al. JACC 2001;38:105-110
UTILITY OF CA SCORE IN THE EMERGENCY DEPARTMENT

- May be appropriate in low-to-intermediate risk pts with negative enzymes & equivocal ECG.
- High sensitivity & negative predictive values
- NPV for both short (1 month)- & long (7 yr)- follow-up
- *Score of 0 allows for early discharge without admission to floor or observation unit and subsequent stress testing?!*
- Potential to be cost effective if applied to proper patient population / age!
- More data required!
Progression of Atherosclerosis
- Monitoring of Therapy -

• http://cardiacimaging.ufl.edu/training/
• www.cctaboardreview.com
Is the presence of coronary artery calcium 
Not static and stable ?

Woman's Health Initiative

1,064 women (mean age 55 years) were randomized to receive estrogen hormone replacement therapy (HRT) or a placebo for a mean 7.4 years of treatment. HRT had a protective effect:

- 42% reduction in calcified plaque among women randomized to receive HRT
- 61% reduction in plaque in those with at least 80% adherence to the study medication

CS-follow-up after Statin-Therapy

Scan 1: 444 mm³
Scan 2: 428 mm³

Follow-up 14 months:

<table>
<thead>
<tr>
<th>Statin</th>
<th>Progression score</th>
</tr>
</thead>
<tbody>
<tr>
<td>no therapy</td>
<td>26 %</td>
</tr>
<tr>
<td>Cerivastatin (LDL &gt; 130 mg/dl)</td>
<td>9.5 %</td>
</tr>
<tr>
<td>Cerivastatin (LDL &lt; 100 mg/dl)</td>
<td>- 1.0 %</td>
</tr>
</tbody>
</table>

Achenbach S et al. Circulation 2002
Calcium and Plaque burden Progression, Outcome, Regression

• http://cardiacimaging.ufl.edu/training/
• www.cctaboardreview.com
Calcium vs. Plaque

- $Y = -0.67 + (0.90 \times X)$
- $r = 0.86$
- $p < 0.0001$  \(N = 40\) patients
- total of 222 coronary segments examined

- Schmermund et al AJC 1998; 81: 141-146
Prognosis as well as the Cause of Symptoms?

Cumulative Survival in Patients With Moderate (>50%) Plaque by CCTA

Conclusion

• Calcium-Score = 0: low likelihood of significant stenosis

• high Calcium-Score in asymptomatic patients does not mean high risk of high grade stenosis
  no cath-lab indication
  ► no screening modality for having significant CHD

• Calcium-Scoring as a prognostic tool
  better than conventional risk factor assessment
  high predictive value in case of MI or Coronary Death

• useful tool for risk assessment in patients of intermediate risk
• BETTER PROGNOSTIC PREDICTOR THAN AGE!
NEW STUDIES IN PROGRESS OR PUBLISHED

- Heinz Nixdorf RECALL Study: 4200 pts 45-75yo
- Prospective study of EBCT, carotid intima-media thickness, ABI, and other RF’s in risk assessment for hard CV events
- MESA
- Dallas Heart Disease Prevention Project
- Epidemiology of Coronary Calcification Study in Olmsted County, Minnesota
- Prospective Army Coronary Calcium Project in Washington, D.C.
• Additional References
### CS in 1,764 Symptomatic Individuals

<table>
<thead>
<tr>
<th>Score = 0</th>
<th>no sign. CHD (&gt; 75%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sens.</td>
</tr>
<tr>
<td>&lt; 60 y</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>99%</td>
</tr>
<tr>
<td>female</td>
<td>100%</td>
</tr>
<tr>
<td>&gt; 60 y</td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>100%</td>
</tr>
<tr>
<td>female</td>
<td>100%</td>
</tr>
</tbody>
</table>

Risk Assessment

Good correlation Score / MI based on whole population

$R = 0.73-0.84$

for individual patient:

Sensitivity max. 71 %
Specificity max. 58 %

No efficient therapy possible!
Comparison to Framingham score and Procam score:

Risk scores of patients with myocardial infarction (n = 73)

CAC in stable vs. unstable disease

- 2,163 consecutive symptomatic patients
- 1,354 men, 809 women, age 62.5 ± 10.5 years
- conventional angiography and calcium screening

![Graph showing CAC scores in different groups](image)

Fig 5. Mean CAC scores in patients with different coronary artery diseases (acute vs chronic).
Plaque burden as assessed by CT-Angiography

SAP vs. AMI

<table>
<thead>
<tr>
<th></th>
<th>SAP</th>
<th>AMI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 19)</td>
<td>(n = 21)</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>68.5 ± 9</td>
<td>64.3 ± 8</td>
</tr>
<tr>
<td>Men</td>
<td>17 (89%)</td>
<td>18 (86%)</td>
</tr>
<tr>
<td>Women</td>
<td>2 (11%)</td>
<td>3 (14%)</td>
</tr>
</tbody>
</table>

FIGURE 3. Average plaque area occupied by noncalcified plaques (NCP), mixed plaques (MP), spotty calcium (Ca), and heavy calcified plaques (CA) in the AMI and SAP groups.
CAC as a marker for plaque burden?

Histopathologic Correlation:
Calcium area was roughly 20% of total plaque area

Rumberger et al. Circulation 1995

versus

<table>
<thead>
<tr>
<th>IVUS</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumen area (mm²)</td>
<td>8.6</td>
<td>8.4</td>
<td>8.3</td>
<td>7.4</td>
<td>8.3</td>
</tr>
<tr>
<td>External elastic membrane area (mm²)</td>
<td>18.6</td>
<td>15.3</td>
<td>17.2</td>
<td>13.3</td>
<td>16.2</td>
</tr>
<tr>
<td>Plaque + media area (mm²)</td>
<td>10.0</td>
<td>6.9</td>
<td>8.9</td>
<td>5.9</td>
<td>7.9</td>
</tr>
<tr>
<td>% Diameter stenosis</td>
<td>54</td>
<td>43</td>
<td>63</td>
<td>43</td>
<td>28.5</td>
</tr>
<tr>
<td>% Surface stenosis</td>
<td>58</td>
<td>42</td>
<td>50</td>
<td>44</td>
<td>48.9</td>
</tr>
<tr>
<td>Plaque Remodeling</td>
<td>Soft</td>
<td>Soft and calcified</td>
<td>Soft</td>
<td>Ruptured</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MSCT</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Plaque location</td>
<td>LAD</td>
<td>Right</td>
<td>LAD</td>
<td>LAD</td>
<td>Circumflex</td>
</tr>
<tr>
<td>Soft</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>&gt;40% lumen stenosis</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Eccentricity</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Other coronary artery status</td>
<td>Normal</td>
<td>Normal</td>
<td>Circumflex intermediate plaque</td>
<td>Normal</td>
<td>LAD and right intermediate plaque</td>
</tr>
</tbody>
</table>

Caussin et al. Am J Cardiol. 2003
Age and Gender Distribution of CS

Hoff et al. Am J Cardiol 2001

n = 35,246
Relative risk of future PTCA in dependence of cardiovascular risk factors compared to calcium score:

- * = p < 0.05
- Sample sizes: n = 142, n = 352, n = 598, n = 312, n = 397, n = 299

St. Francis Heart Study
n= 4,903 asymptomatic individuals
Calcium Screening in ER-Department

- follow-up of 192 symptomatic patients (104 men, 88 women), age 53 ± 9 years
- follow-up period 50 ± 10 month (range 1 – 84 month)
- endpoints: hard cardiovascular events

Table 2. Electron Beam Tomography for Hard and All Coronary Events at Various Calcium Score Thresholds

<table>
<thead>
<tr>
<th>Threshold</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Overall Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard Events</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;0</td>
<td>1.00</td>
<td>0.47</td>
<td>0.26</td>
<td>1.00</td>
<td>0.55</td>
</tr>
<tr>
<td>&gt;4 (median)</td>
<td>0.97</td>
<td>0.51</td>
<td>0.27</td>
<td>0.99</td>
<td>0.58</td>
</tr>
<tr>
<td>&gt;332</td>
<td>0.63</td>
<td>0.81</td>
<td>0.39</td>
<td>0.92</td>
<td>0.79</td>
</tr>
<tr>
<td>All Events</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;0</td>
<td>0.97</td>
<td>0.55</td>
<td>0.48</td>
<td>0.97</td>
<td>0.68</td>
</tr>
<tr>
<td>&gt;4 (median)</td>
<td>0.93</td>
<td>0.59</td>
<td>0.55</td>
<td>0.95</td>
<td>0.69</td>
</tr>
<tr>
<td>&gt;332</td>
<td>0.47</td>
<td>0.83</td>
<td>0.55</td>
<td>0.78</td>
<td>0.72</td>
</tr>
<tr>
<td>≥50%</td>
<td>0.88</td>
<td>0.60</td>
<td>0.49</td>
<td>0.92</td>
<td>0.69</td>
</tr>
<tr>
<td>≥75%</td>
<td>0.64</td>
<td>0.72</td>
<td>0.49</td>
<td>0.82</td>
<td>0.69</td>
</tr>
</tbody>
</table>

NPV = negative predictive value; PPV = positive predictive value.

Georgiou et al. JACC 2001
Coronary calcifications in dependence of cardiovascular risk factors: