Wanneer is calciumscanning zinvol?

Roos Groen
LUMC, Leiden

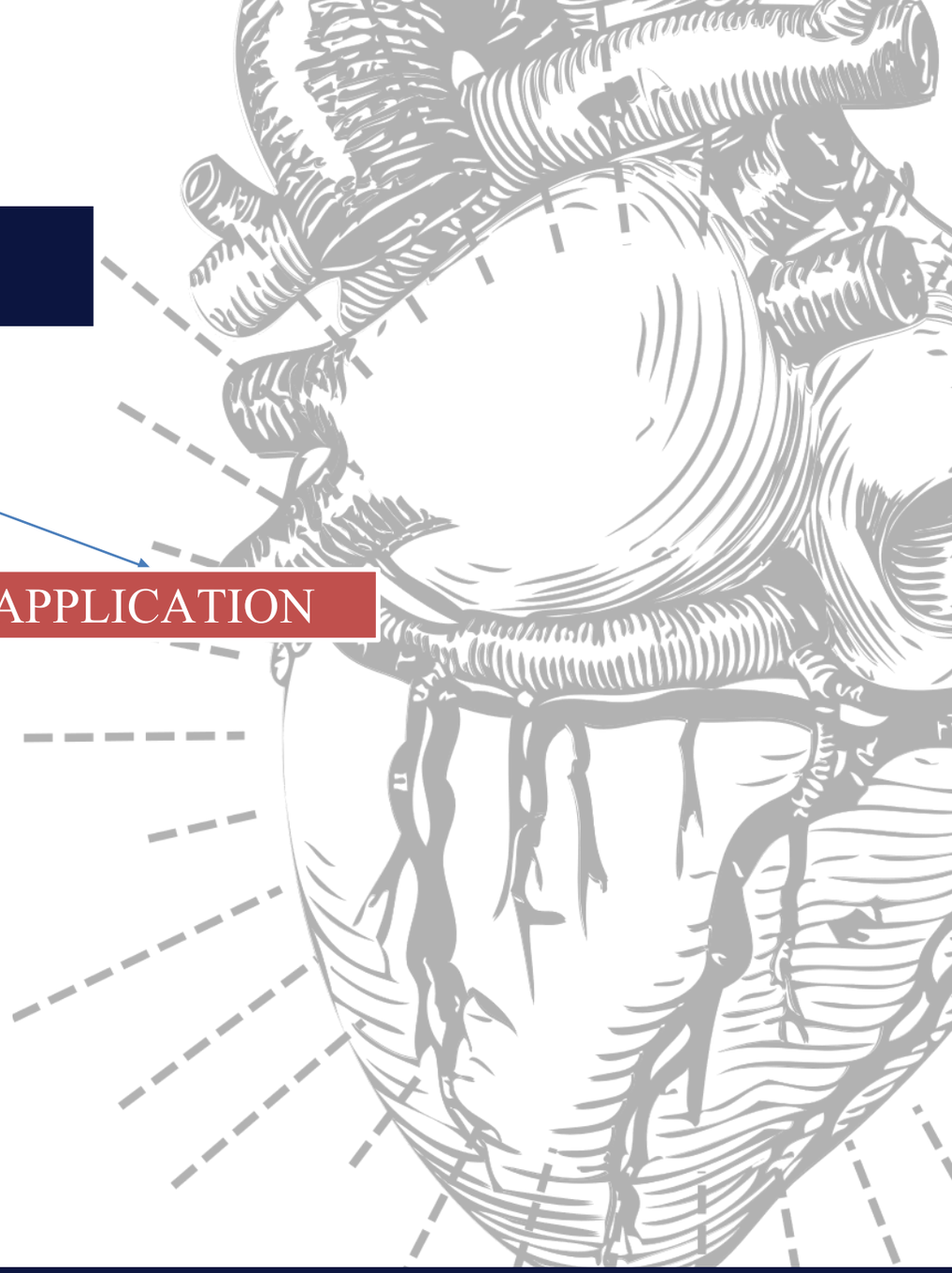
Dutch Atherosclerosis Society
NLA Nederlandse Lipiden Academie
CVGK

Coronary calcium scanning

METHODS

BENEFITS

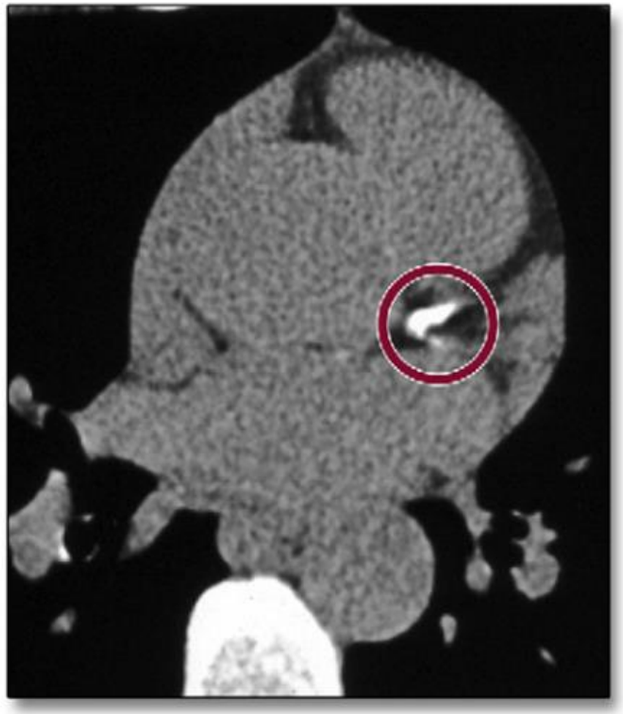
APPLICATION



Calcium scanning

- ECG-gated cardiac non-contrast CT (**The Agatston score**)

Agatston Lesion Score = Lesion Area x Density Weighting Factor
Total Agatston Score = Σ Lesion Scores



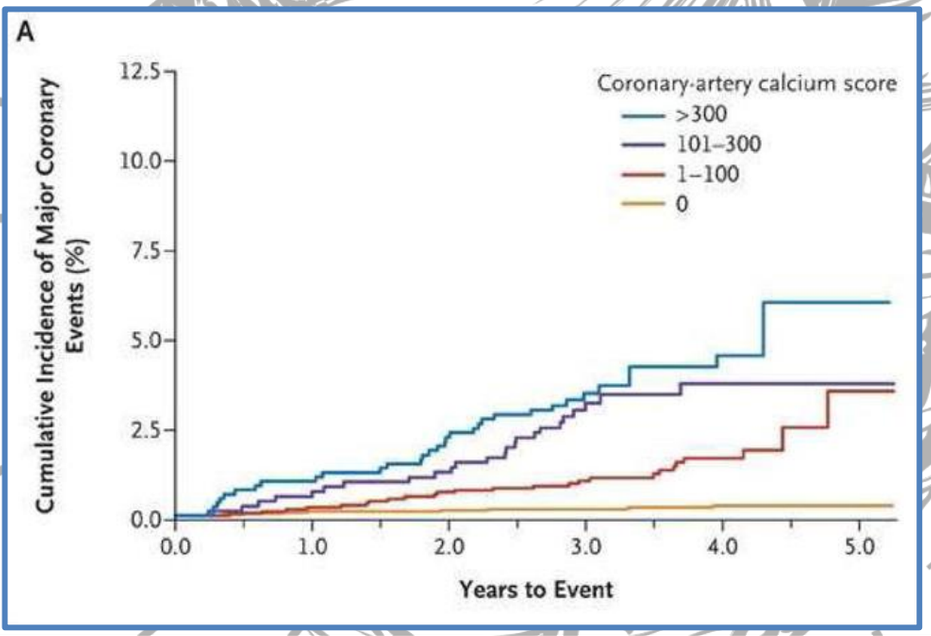
Left Coronary Descending
Area = 15 mm², Peak = HU = 450
Lesion Score = 15 x 4 = 60

Peak Attenuation Weighting Factor	
Hounsfield Units	
130** - 199	1
200 - 299	2
300 - 399	3
>400	4

Right Coronary Descending
Area = 8 mm², Peak = HU = 290
Lesion Score = 8 x 2 = 16

A. Coronary Artery Calcium Gated and Nongated Agatston score

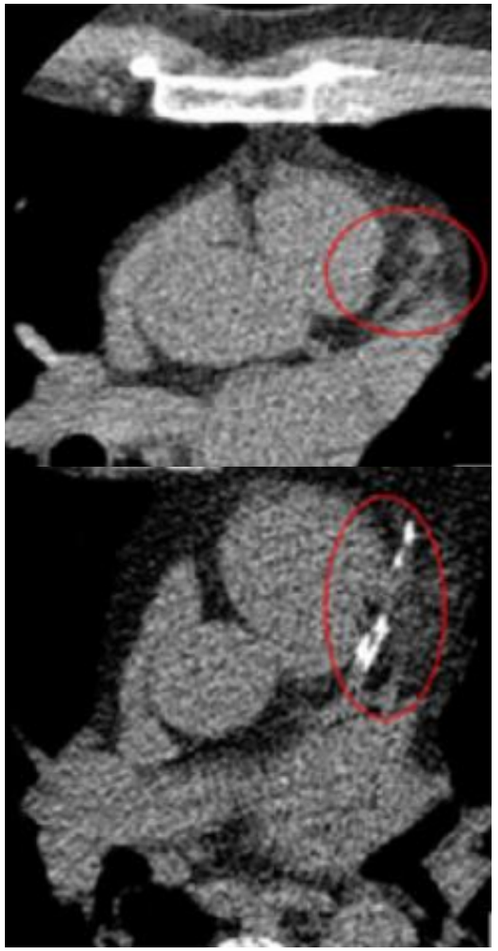
Score	Risk
0	very low
1–99	mildly increased
100–299	moderately increased
≥300	moderate to severely increased



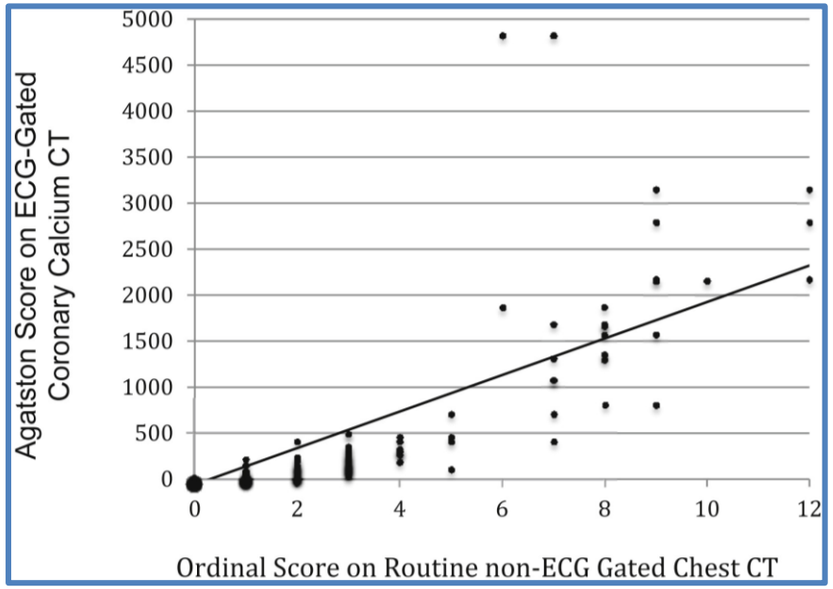
Blaha MJ et al. JACC Cardiovascular imaging. 2017;10 8:923-37.
Hecht HS et al. JCCT 2017; 11(1) 74-84

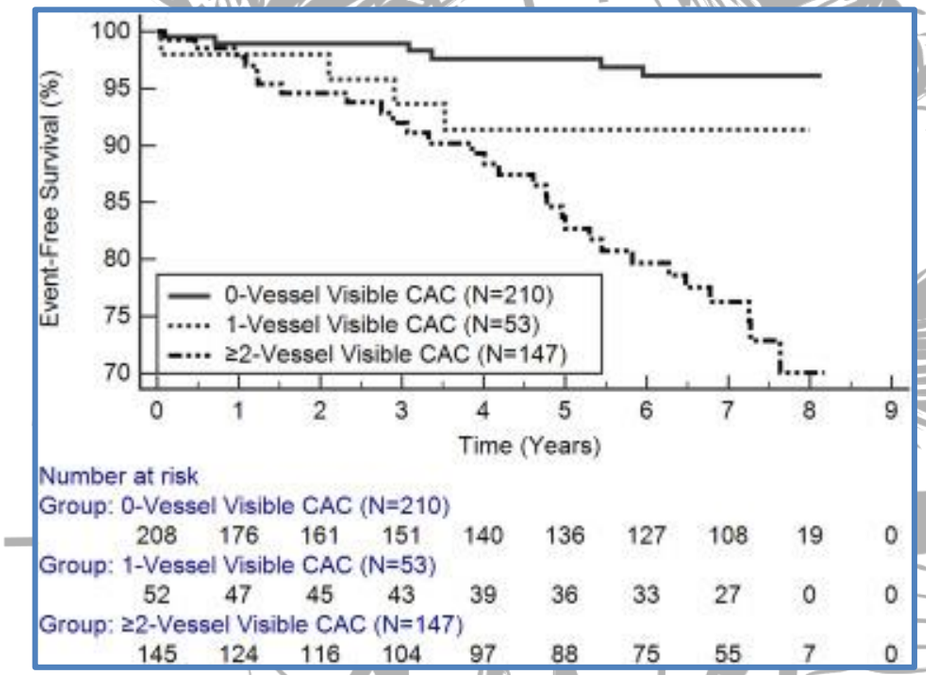
Calcium scanning (retrospective)

- Previously performed non-cardiac CT (**Simple visual evaluation**)



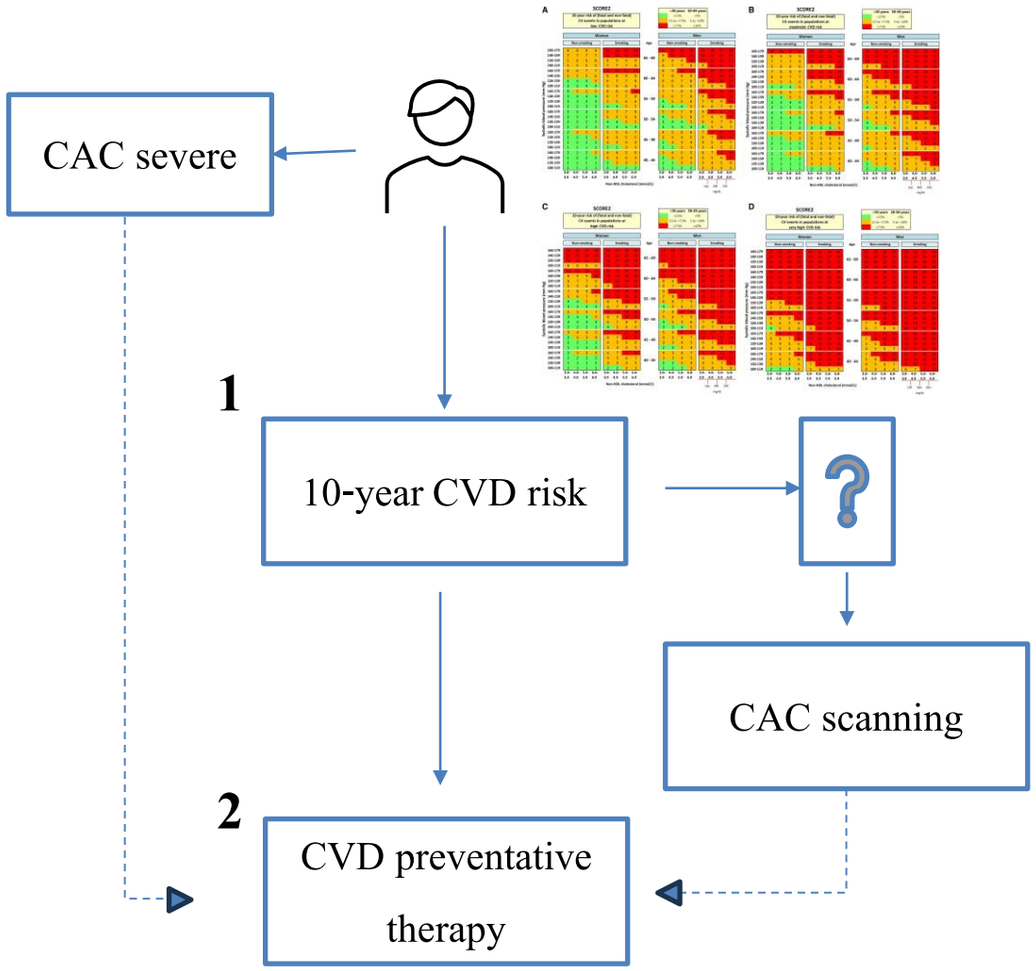
B. Coronary Artery Calcium Ordinal Score (0–12)	
Score	Risk
0	very low
1–3	mild to moderately increased
4–12	moderate to severely increased





Chi JM et al. Current Problems in Diagnostic Radiology 2021;50 54-58
Hecht HS et al. JCCT 2017; 11(1) 74-84
Azour L et al. JCCT 2017; 11(1) 5-18

Calcium score in asymptomatic patients



Guidelines

CAC scoring may be considered to improve risk classification around treatment decision thresholds. Plaque detection by carotid ultrasound is an alternative when CAC scoring is unavailable or not feasible.[103,104]

IIb	B

If risk decision is uncertain:
Consider measuring CAC in selected adults:
CAC = zero (lowers risk; consider no statin, unless diabetes, family history of premature CHD, or cigarette smoking are present)
CAC = 1-99 favors statin (especially after age 55)
CAC = 100+ and/or ≥75th percentile, initiate statin therapy

In de volgende gevallen kan, indien het geschatte risico dicht bij een behandelgrens ligt, aanwezigheid van een van de volgende factoren doorslaggevend zijn om te reclassificeren, waarbij de patiënt in een andere risicocategorie terecht kan komen:

- een positieve familieanamnese voor premature hart- of vaatziekte (hogere risicoscore)
- aanwezigheid van psychosociale risicofactoren (hogere risicoscore)
- de CAC-score, indien bekend (afhankelijk van de uitslag lagere of hogere risicoscore)

Calcium score in symptomatic patients

Table 5 Pre-test probabilities of obstructive coronary artery disease in 15 815 symptomatic patients according to age, sex, and the nature of symptoms in a pooled analysis[44] of contemporary data[7,8,22]

	Typical		Atypical		Non-anginal		Dyspnoea[a]	
Age	Men	Women	Men	Women	Men	Women	Men	Women
30–39	3%	5%	4%	3%	1%	1%	0%	3%
40–49	22%	10%	10%	6%	3%	2%	12%	3%
50–59	32%	13%	17%	6%	11%	3%	20%	9%
60–69	44%	16%	26%	11%	22%	6%	27%	14%
70+	52%	27%	34%	19%	24%	10%	32%	12%

©ESC 2019

CAD = coronary artery disease; PTP = pre-test probability.
[a]In addition to the classic Diamond and Forrester classes,[44] patients with dyspnoea only or dyspnoea as the primary symptom are included. The regions shaded dark green denote the groups in which non-invasive testing is most beneficial (PTP >15%). The regions shaded light green denote the groups with PTPs of CAD between 5–15%, in which testing for diagnosis may be considered after assessing the overall clinical likelihood based on the modifiers of PTPs presented in *Figure 3*.

1

Pre-test likelihood based on symptoms, age and sex

→ Low risk

↓

CAC scanning

2

Dedicated cardiac imaging

Guidelines

Verricht bij lage voorafkans (circa 5- circa 15%) een kalkscore:

- Indien kalkscore = 0, geen verdere beeldvorming.
- Indien kalkscore > 0, verricht CTCA, bij voorkeur aansluitend.

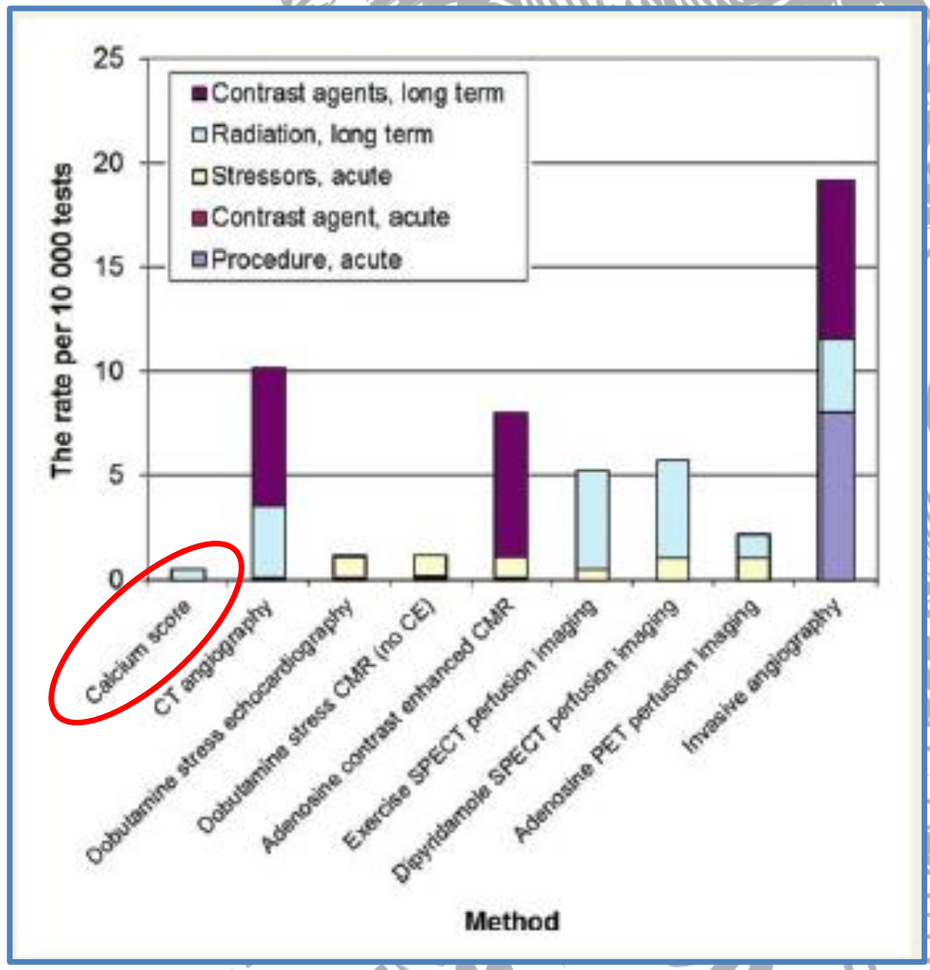
2a	B-R

2. For patients with stable chest pain and no known CAD categorized as low risk, CAC testing is reasonable as a first-line test for excluding calcified plaque and identifying patients with a low likelihood of obstructive CAD.[6-9]

1. Low Test Burden

Very low radiation dose similar to mammography

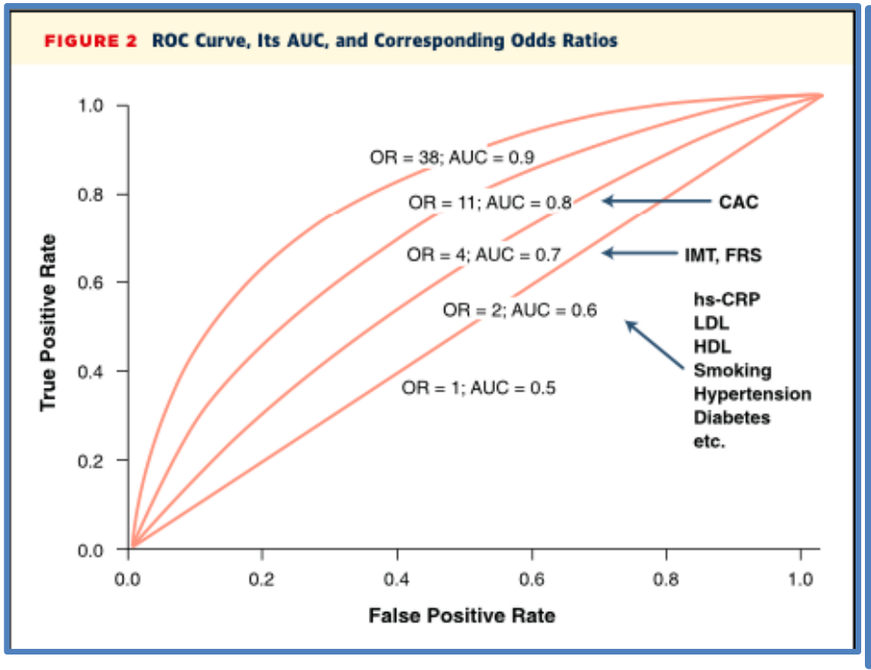
Procedure	Effective doses (mSv)
Calcium score	1–2
CT angiography	3–20 (mean 7)
Tl-201 stress + rest SPECT	22
Tc-99 m tetrofosmin or sestamibi stress + rest SPECT	10
PET perfusion stress + rest (Rb-82, N-13 ammonia, O-15 water)	2.0–2.7
FDG PET viability	4.9
Invasive CAG	2–23 (mean 7)

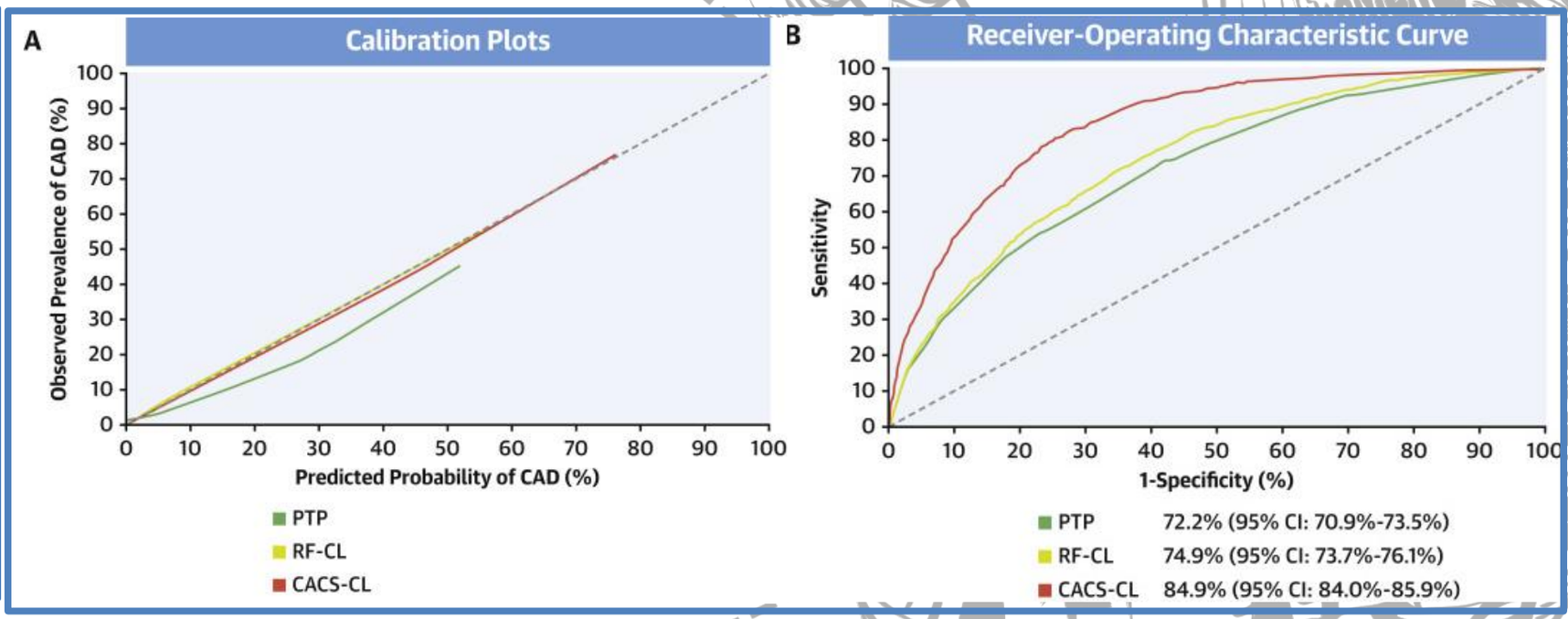


Knuuti et al. Eur Heart J 2014: 35; 633-638

2. High Predictive Power

Predictive superiority to risk factors





3. The Power of Zero

CAC ≤100 excellent 10-year MACE-free survival

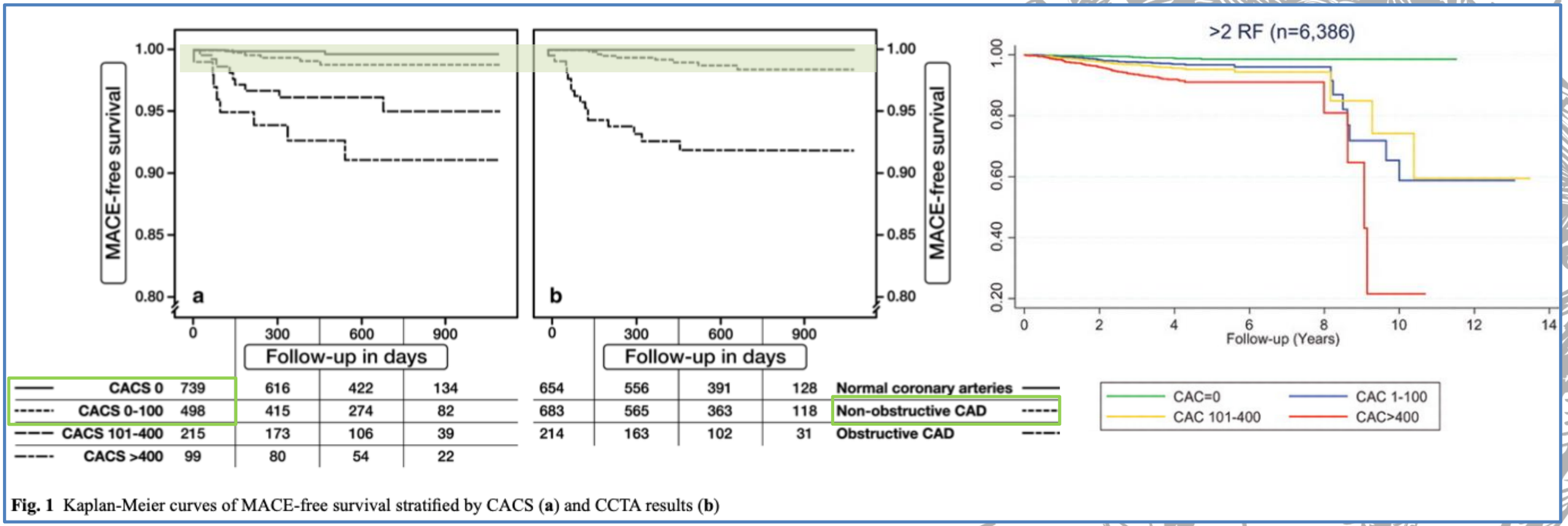


Fig. 1 Kaplan-Meier curves of MACE-free survival stratified by CACS (**a**) and CCTA results (**b**)

Bom et al. Neth Heart J 2016; 24 332-42
Nasir et al. Circ Cardiovasc Imaging 2012; 5: 467-73

4. Tailored cardiac imaging

Gatekeeper for dedicated cardiac imaging

CENTRAL ILLUSTRATION: Proposed Algorithm for Diagnostic Testing in Patients With Suspected Obstructive CAD

Patient with stable chest pain
Age >44 years
No history of CAD

↓

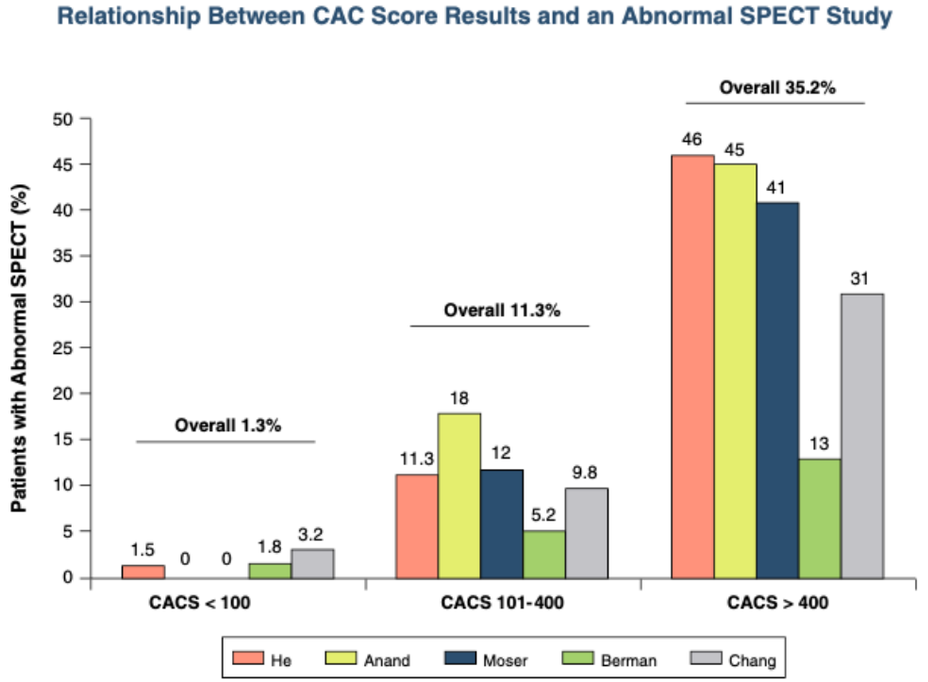
Determine type of chest pain and CAC score

↓

	Type of chest pain	Nonanginal	Atypical	Typical
CAC SCORE	0.1-100	No further testing	No further testing	Imaging test
	100-400	No further testing	Imaging test	Imaging test
	≥400	Imaging test	Imaging test	Imaging test

Rijlaarsdam-Hermsen, D. et al. J Am Coll Cardiol Img. 2020;13(5):1152-60.

FIGURE 4 Summary of 5 Studies Demonstrating the Relationship Between CAC Categories and Abnormal SPECT Scans

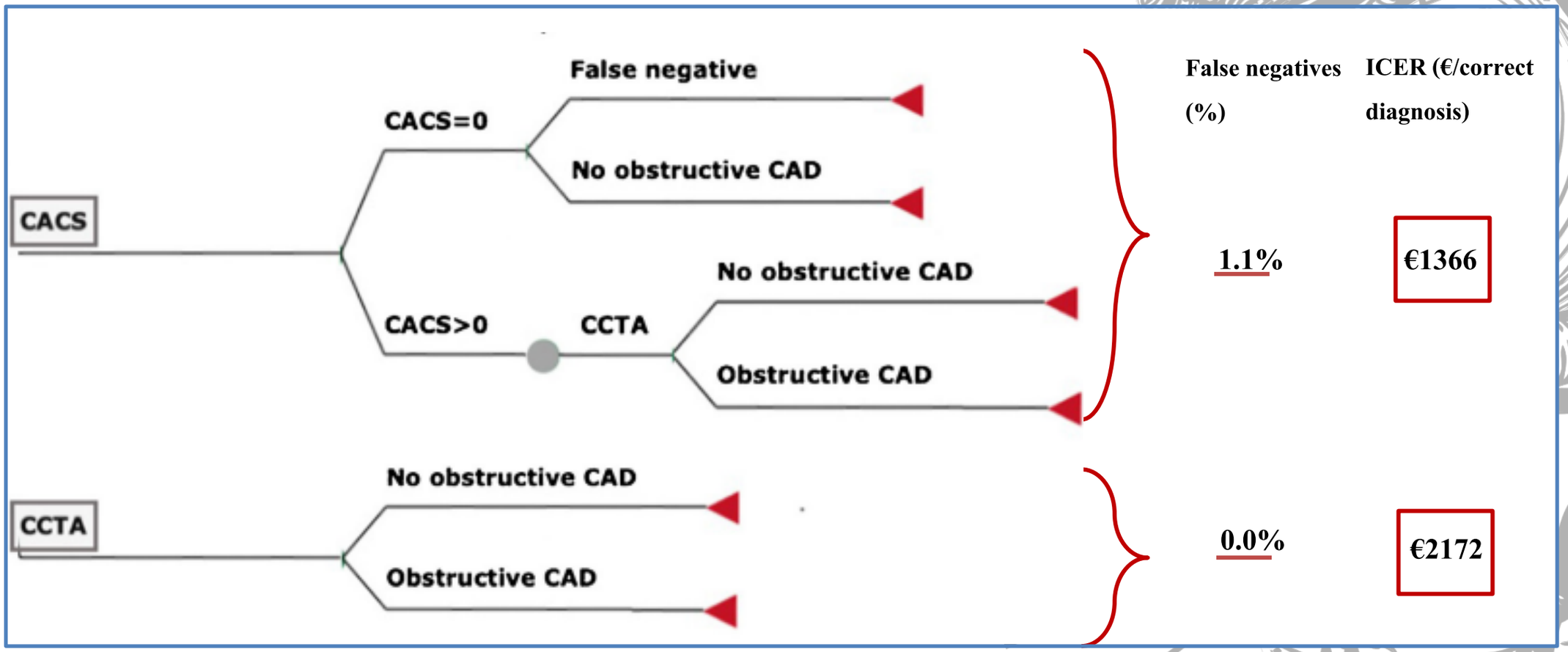


It is only in the CACS >400 group that the pre-test probability is sufficiently high to warrant stress testing. CAC = coronary artery calcium; CACS = coronary artery calcium score; SPECT = single-photon emission computed tomography. Reprinted with permission from Hacker and Becker (45).

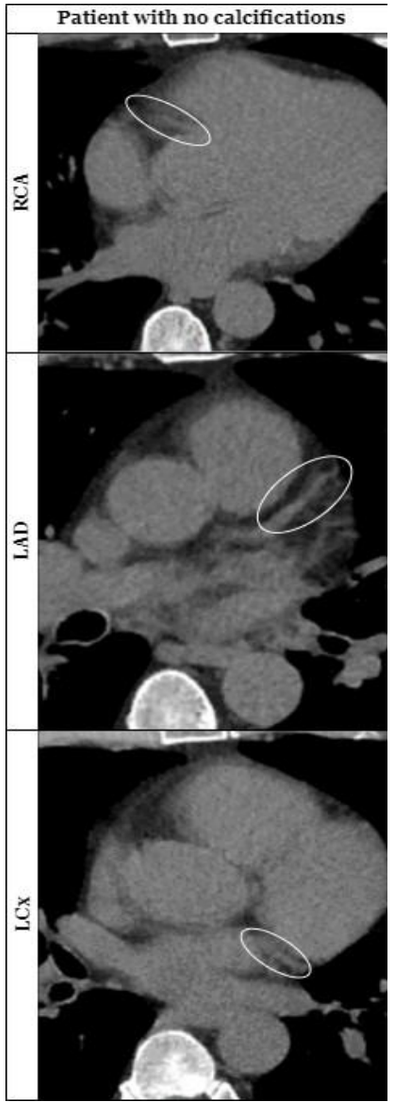
Hecht et al. JACC Imaging 2015; 8: 579-596

5. Cost Effective

Reduced costs for cardiac imaging



6. Patient's understanding of disease



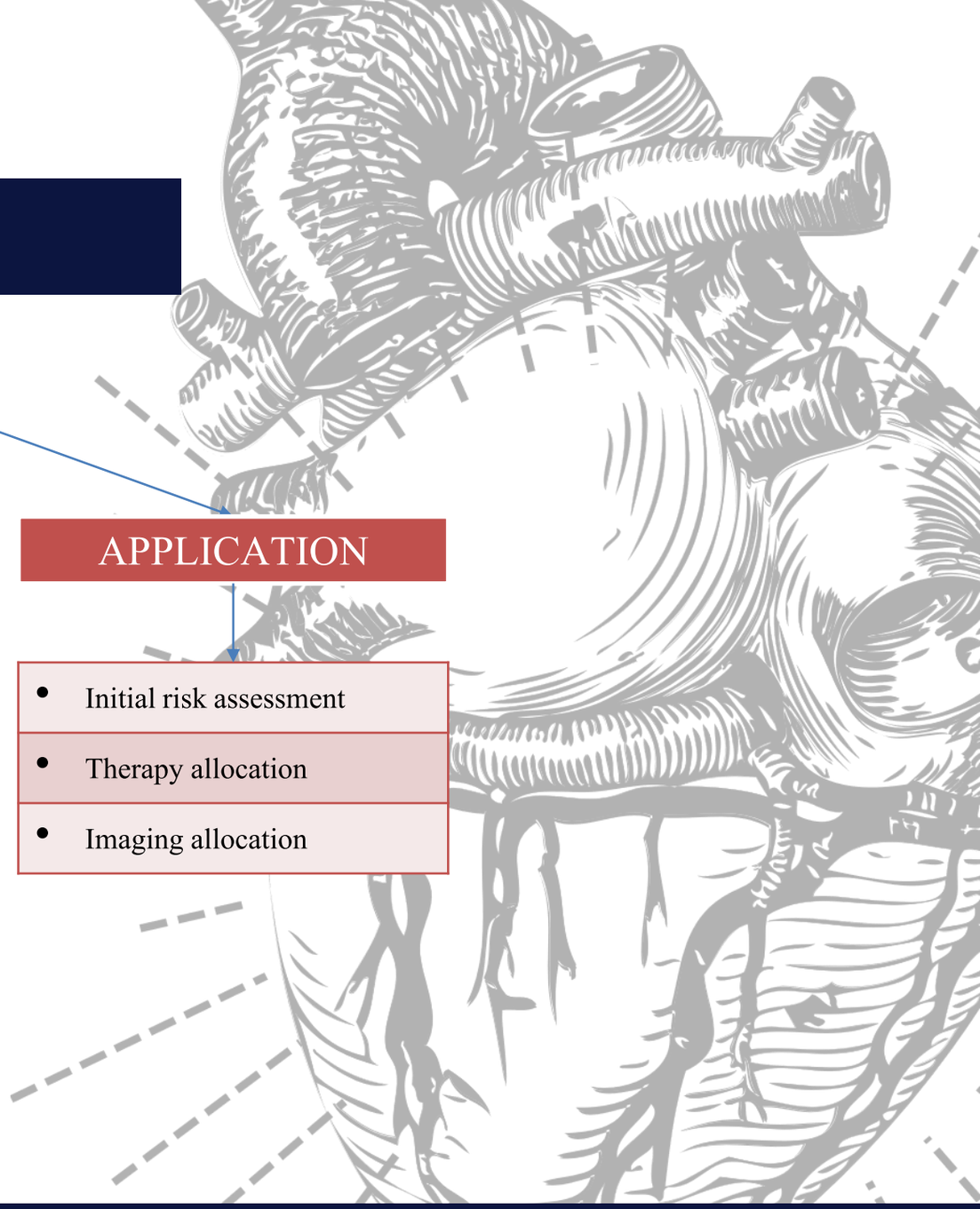
VS

Estimated Arterial Ages and 95% Confidence Intervals by Coronary Artery Calcium Score

CAC	Arterial Age in Years (95% Confidence Interval)
0	39 (32–46)
10	56 (53–60)
20	61 (59–63)
30	64 (62–66)
40	66 (65–67)
50	68 (67–69)
60	69 (68–70)
70	70 (69–71)
80	71 (70–72)
90	72 (71–73)
100	73 (71–74)
200	78 (75–80)
300	80 (78–83)
400	83 (79–86)
500	84 (80–88)
750	87 (83–92)
1,000	89 (84–94)
1,500	92 (87–98)
2,000	94 (88–100)
2,500	96 (89–102)

Groen et al. Int J Cardiol 2024
McClelland et al. Am J Cardiol 2009; 103: 59-63

Coronary calcium scanning



METHODS

- ECG-gated CT
- Non-gated CT
- Agatston score
- Visual evaluation

BENEFITS

- Radiation similar to mammography
- Risk stratification superior to risk factors
- Gatekeeper for additional imaging
- Cost-effective
- Patient’s understanding of disease

APPLICATION

- Initial risk assessment
- Therapy allocation
- Imaging allocation