NVvLG

Nederlandse Vereniging voor
Lucht- en Ruimtevaartgeneeskunde

Opsporen van coronairlijden bij cliënten met een laag risico in een risicovol beroep

Voorkomen van het ongeval?

drs. Erik Frijters
Senior Vliegerarts, AME, DAvMed

CARDIOEXPERT

Tweede CardioExpert Symposium Luchtvaart Cardiologie

Potentiële belangenverstrengeling	Geen
Voor bijeenkomst mogelijk relevante relaties met bedrijven	Koninklijke Luchtmacht FXT Medical Services NVvLG
Sponsoring of onderzoeksgeld Honorarium of andere (financiële) vergoeding Aandeelhouder Andere relatie, namelijk …	Geen vermeldingen

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Sprekersinformatie

Erik Frijters

2008 – heden: Vliegerarts Koninklijke Luchtmacht
Hoofd Operationele Training en Toepassing
Vliegmedische keuringen MIL/CIV
Consultatie
Onderwijs
Aeromedevac, Search and Rescue
Aircraft Accident Investigation
Research (AEOLUS / F-35 / NATO HFM / PhD)

Academische Opleidingen:
2008: Erasmus Medisch Centrum Rotterdam
2018: MSc Aerospace Medicine, Kings College London
2022 - heden: PhD kandidaat UMCU

Uitzendingen: 2011 Afghanistan, 2015 Mali, 2016 Mali

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Contents

- Recent Incidents and the 1% Rule
- Incidence of MACE higher in-flight?
- SUSPECT study
- Risk scores
- Case Report
- Discussion

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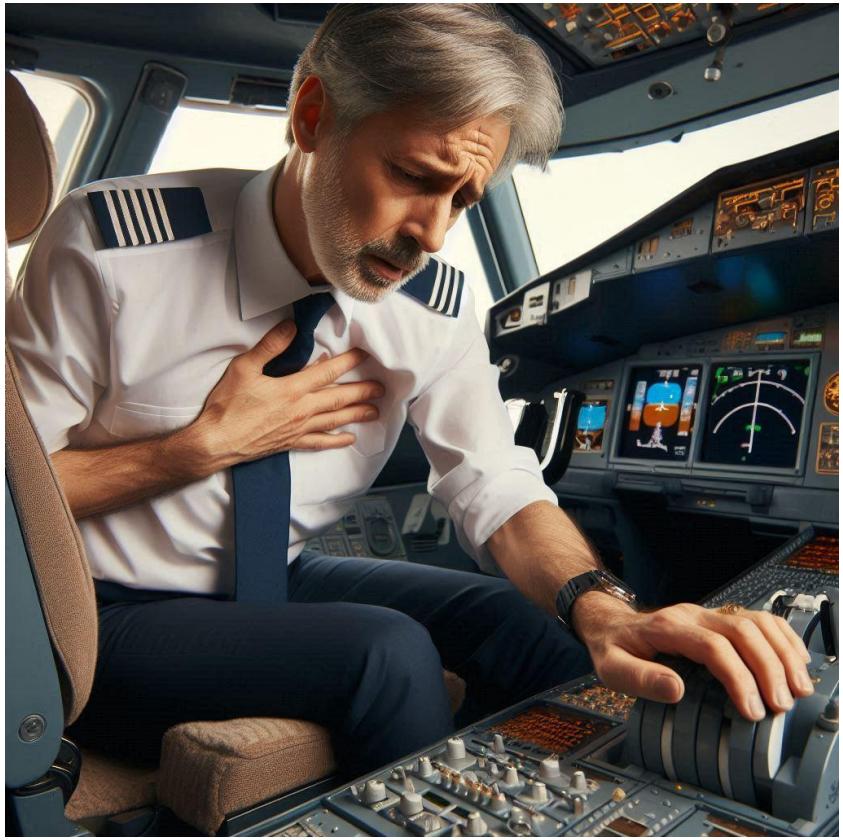
Recent Incidents



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THE STANDARD

NEWS SPORT BUSINESS LIFESTYLE CULTURE GOING OUT HOMES & PROPERTY COMMENT

NEWS | UK

EasyJet pilot collapses at controls forcing emergency landing on UK-bound flight from Egypt to Manchester

Panic erupted on board as cabin crew abandoned their drinks trolleys and rushed to the front of the aircraft

SAMI QUADRI
11 FEBRUARY 2025

An EasyJet flight to Manchester was forced to make an emergency landing in Greece after the pilot collapsed at the controls.

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News > World News

FLIGHT HORROR Pilot Ivan Andaur, 56, dies after collapsing in toilet onboard Boeing 787 he was flying from Miami to Chile

Jon Rogers

Published: 18:16, 16 Aug 2023 | Updated: 12:52, 21 Aug 2023

A PILOT has died after collapsing in a toilet onboard a Boeing 787 while flying from Miami to Chile.

Ivan Andaur, 56, was flying flight LA505 from Miami International Airport to Santiago, Chile, on Sunday night when he began to feel ill.

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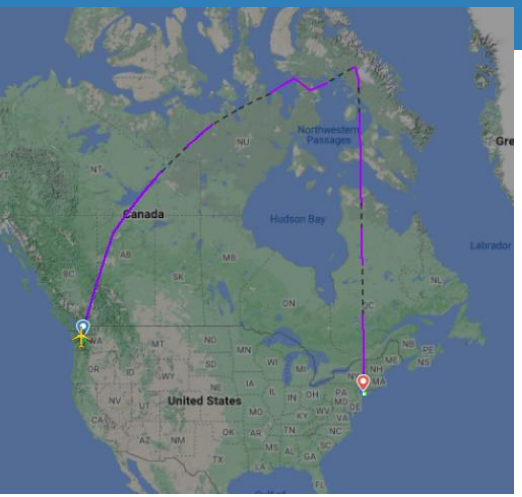

sky news

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Plane makes emergency landing after pilot dies on Turkish Airlines flight

The Airbus A350's crew tried to revive the 59-year-old after he lost consciousness, but he was confirmed dead before the plane landed. A spokesperson said he had no known prior health problems.

By Daniel Binns, news reporter

Thursday 10 October 2024 15:24, UK

File pic: iStock

The 59-year-old pilot was identified as İlçehin Pehlivan

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FLIGHT HORROR Pilot dies moments before take-off as he collapses of sudden heart attack while passing through boarding gate

Sarah Hooper | Tahir Ibn Manzoor
Published: 10:46, 19 Aug 2023 | **Updated:** 10:51, 19 Aug 2023

A YOUNG pilot fell ill and died suddenly moments before a routine flight from Pune from Nagpur airport, officials have said.

Captain Manoj Subramanyam, 40, reportedly collapsed at the boarding gate and was transported to hospital where he was pronounced dead.

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Off-duty pilot on Southwest flight steps in to help after pilot suffers in-flight medical emergency

By Pete Muntean, CNN

2 minute read · Updated 8:55 PM EDT, Thu March 23, 2023

An off-duty pilot stepped in to help after a Southwest pilot became ill during a flight, the airline said.
Kevin Dietsch/Getty Images

(CNN) — An off-duty pilot who was a passenger on a Southwest Airlines flight stepped in to help the flight crew after one of the on-duty pilots had a medical emergency mid-flight.

The incident began not long after Flight 6013 to Columbus, Ohio, took off from Las Vegas Wednesday, Southwest Airlines said. One of the pilots “needed medical attention,” the airline said.

Simple Flying

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Delta Boeing 777 Flight Forced To Divert As Pilot Gets Incapacitated

By Jay Singh — Published May 26, 2020

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A Delta Boeing 777 made a rare appearance in Moncton, Canada, after the first officer became incapacitated midflight. The May 21st flight was one of Delta's special cargo-only flights operating between Frankfurt and Chicago. Shortly after the aircraft completed its transatlantic crossing, the incident occurred.

Boeing 777 diverts due to an incapacitated pilot

The Aviation Herald reports that the incident occurred on flight DL3343 from Frankfurt to Chicago on May 21st. Just after completing the transatlantic crossing, the first offer suffered a medical emergency while in the cockpit. The captain called in the relief first officer, and the aircraft diverted to Moncton. Once on the ground, the pilot was able to get to a hospital.

It took 15 minutes to get the Boeing 777 on the ground in Moncton safely. This made

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USDOT Accepts American Airlines' New Flagship Suite...

USDOT Approves IAG's LEVEL To Fly To The US: Codeshare...

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So… what about the 1% rule?

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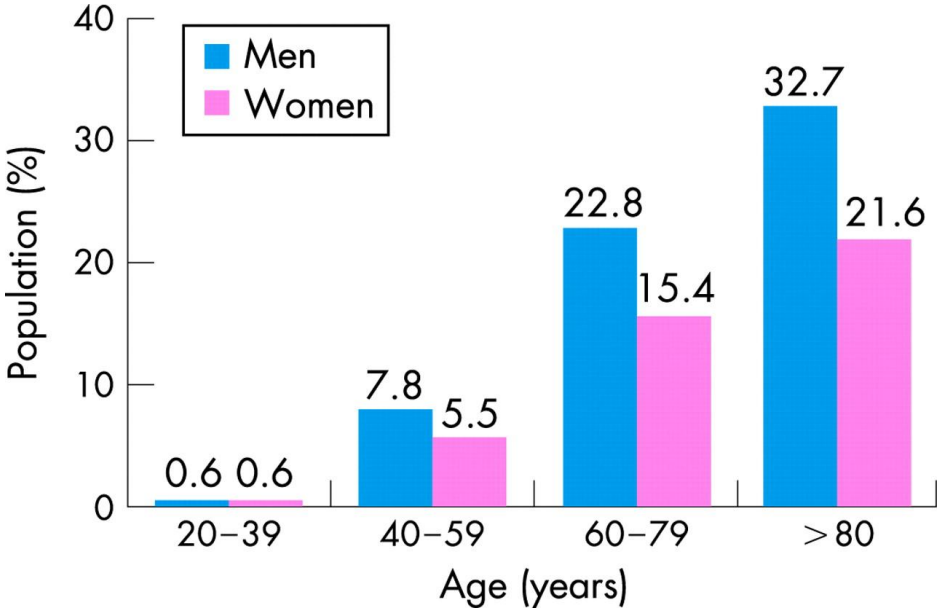
The 1% rule



Prevalence of ischaemic heart disease in the USA by age and gender. The prevalence of ischaemic heart disease is lower in women than in men in most classes of age. From the Heart Disease and Stroke Statistics—2007 Update

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Higher incidence of major adverse cardiac events in-flight?

YES?

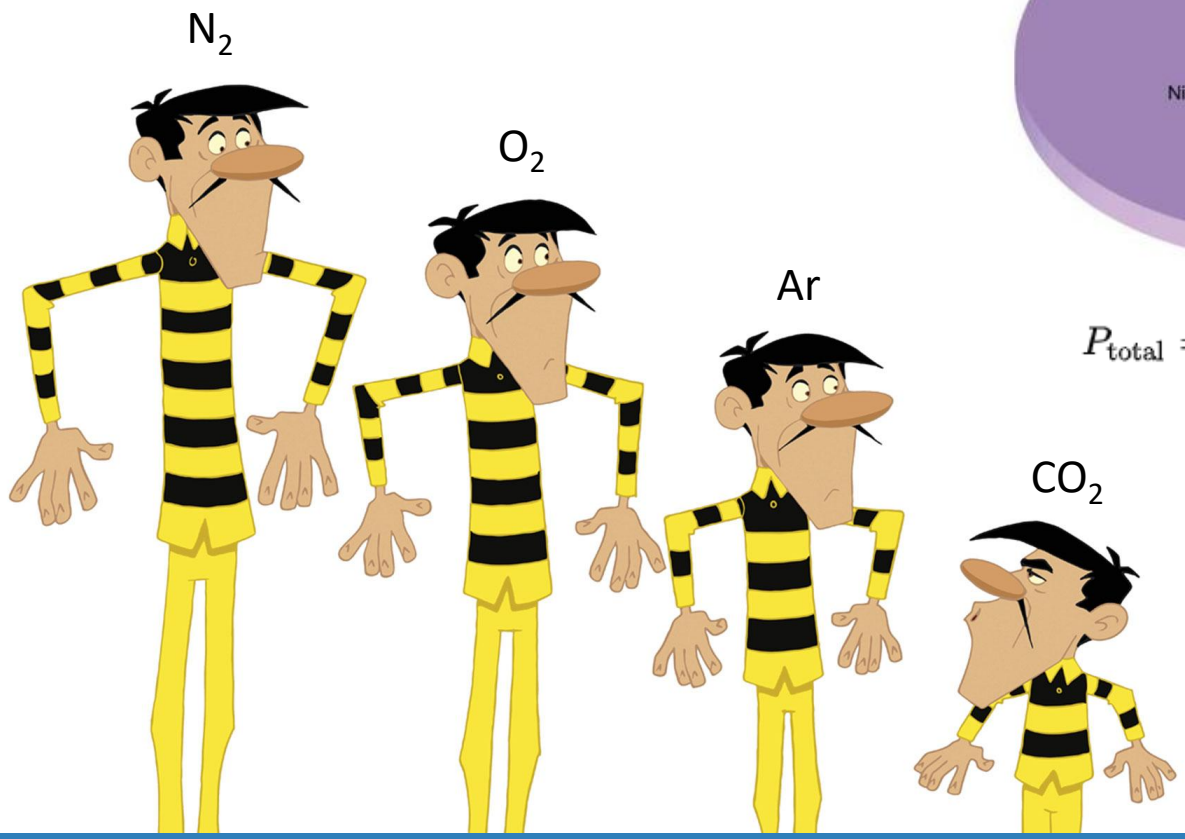
NO?

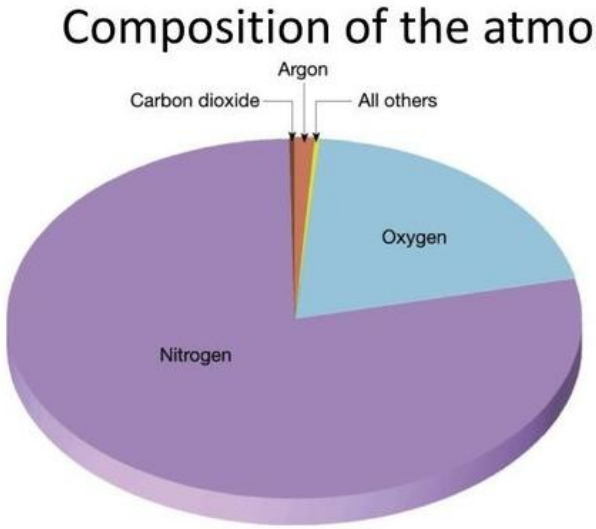
MAYBE?

Boyle's Law (1662)

$$pV = \text{constant}$$

Dalton's Law (1802)





$$P_{\text{total}} = P_1 + P_2 + P_3 + \ldots + P_n \equiv \sum_{i=1}^{n} P_i$$

Henry's Law (1803)

Dissolved gas

Henry's constant

$$C = kP_{gas}$$

Laws combined…

Pressure cabin airplane (~8000 feet)

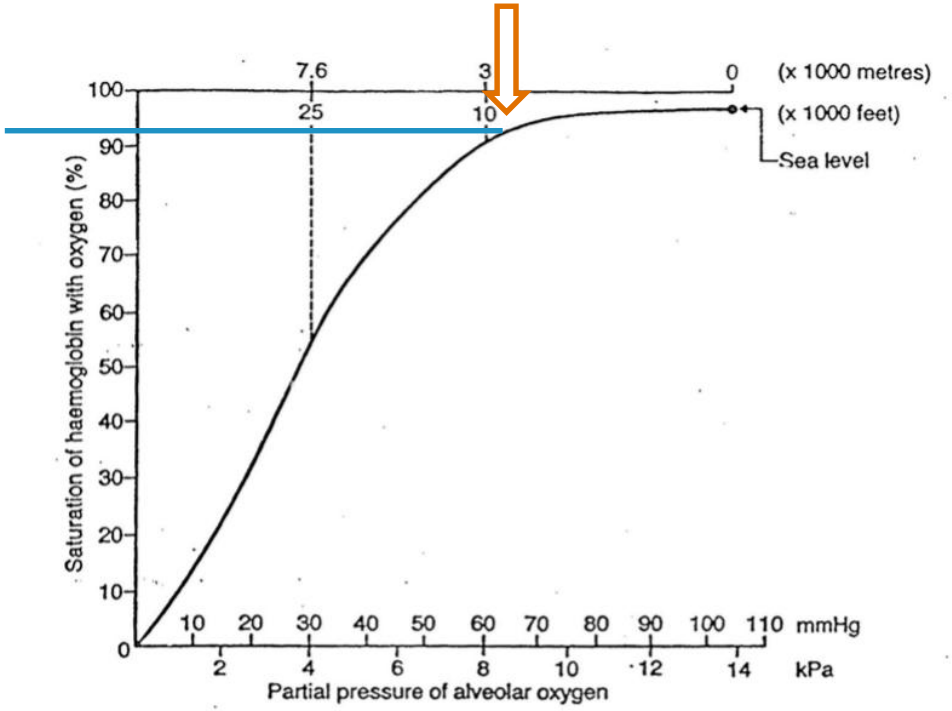
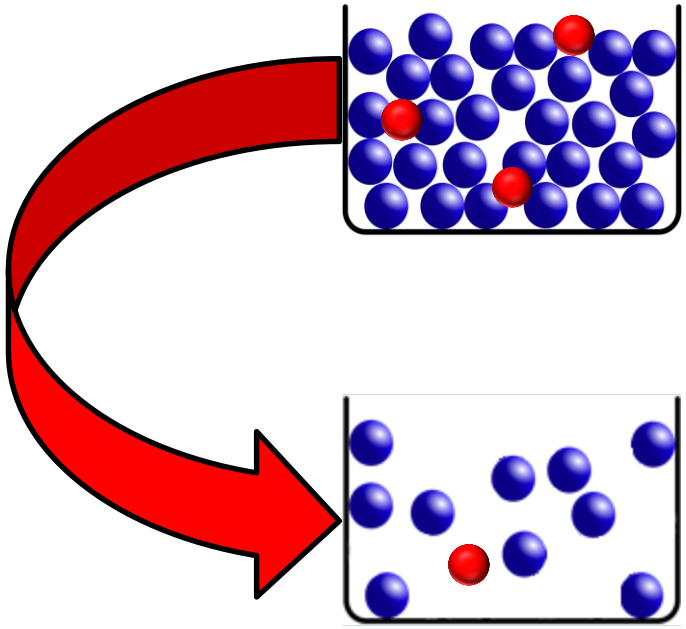


Figure 1. Oxyhemoglobin Dissociation Curve



Military stresses of flight: G-Forces!


Gz 1.4
11-21-2017 10:2

SUSPECT study

Screening for Coronary Artery Disease USing Primary Evaluation with Coronary CTA in Aviation Medicine

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UMC Utrecht

SUSPECT study rationale

Risk for medical incapacitation must be <1%

➢ In 25% of cases, myocardial infarction/sudden death is the first symptom of CAD!

Aeromedical examination to prevent incapacitation:

- Audiogram
- Pulmonary Function Testing
- Labs, incl cholesterol
- Resting ECG
- Ophtalmological Exam
- Physical Exam

➢ Exercise ECG with VO_2max

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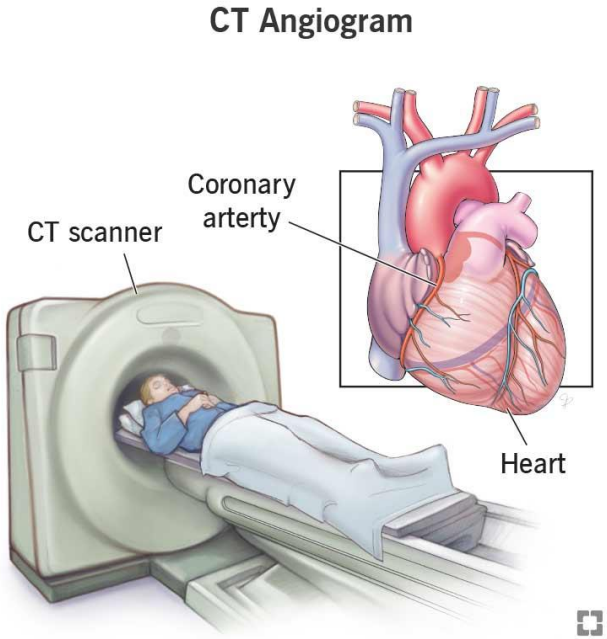
SUSPECT study rationale

- Military Aircrew = low-risk population, with a high-risk occupation

CT as a one-time screening tool for aircrew?

CTA to detect <u>aeromedically relevant</u> CAD:

- CACS ≥100
- Any stenosis ≥50%
- A left main stenosis >30%
- An aggregate stenosis ≥120%



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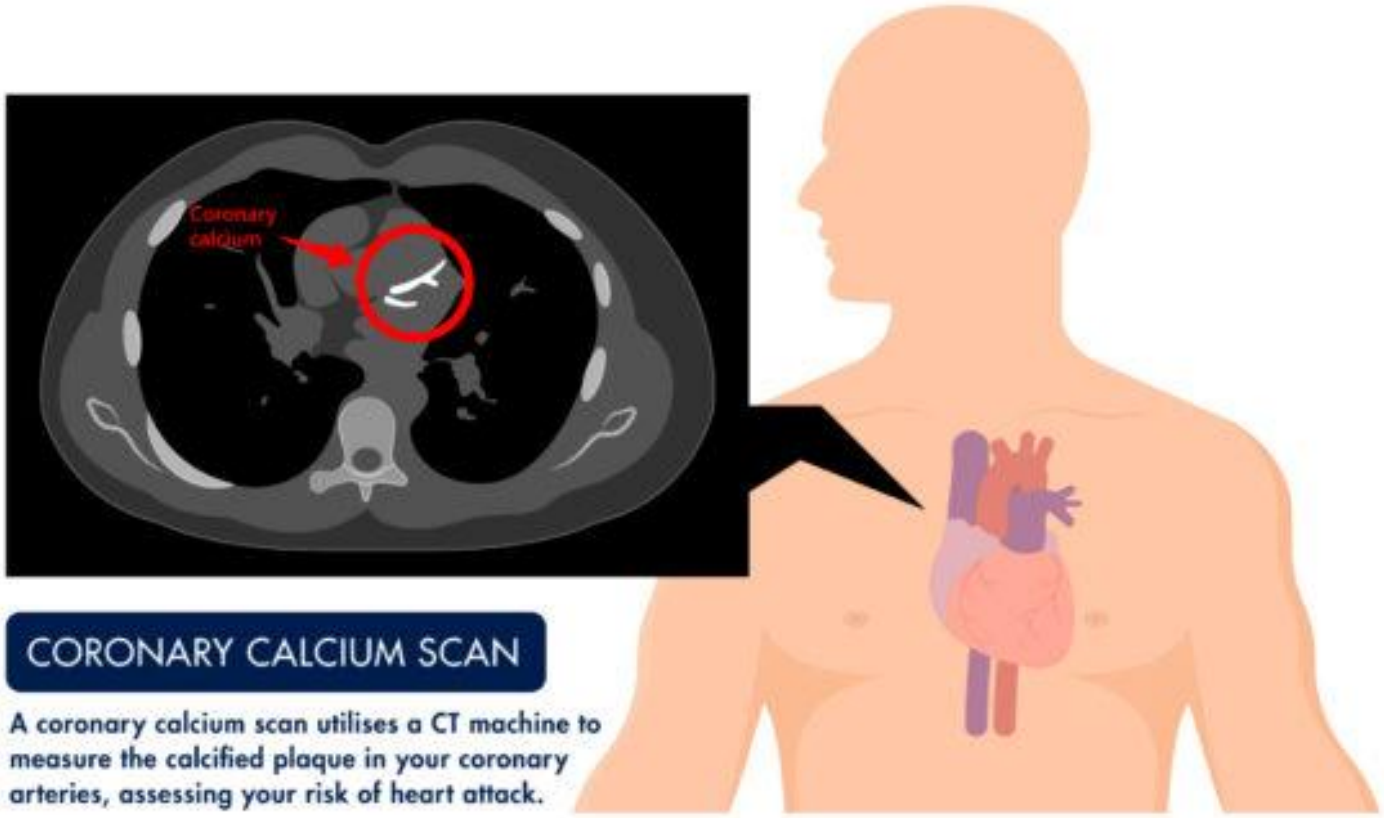
SUSPECT – CT Calcium Scoring



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50 yo pilot

Coronary artery calcium score (CACS)
Agatston score: 449 (98th MESA percentile)



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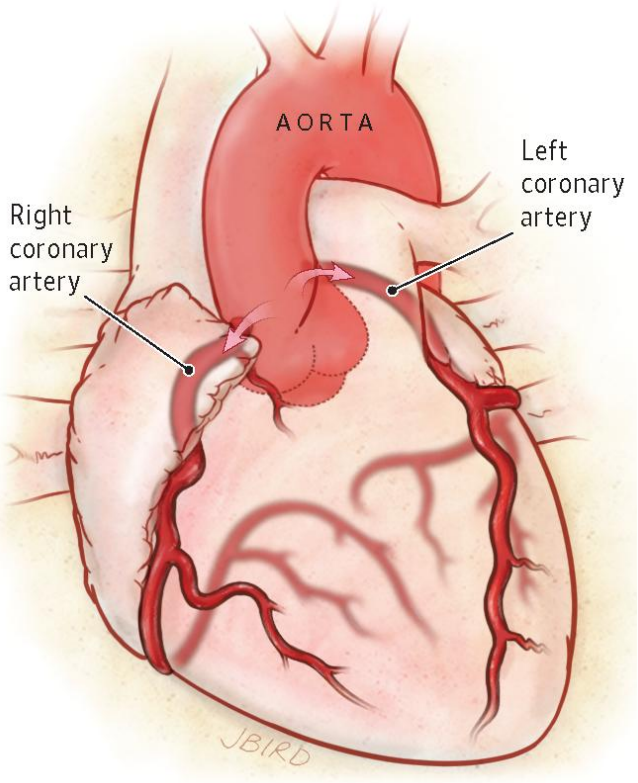
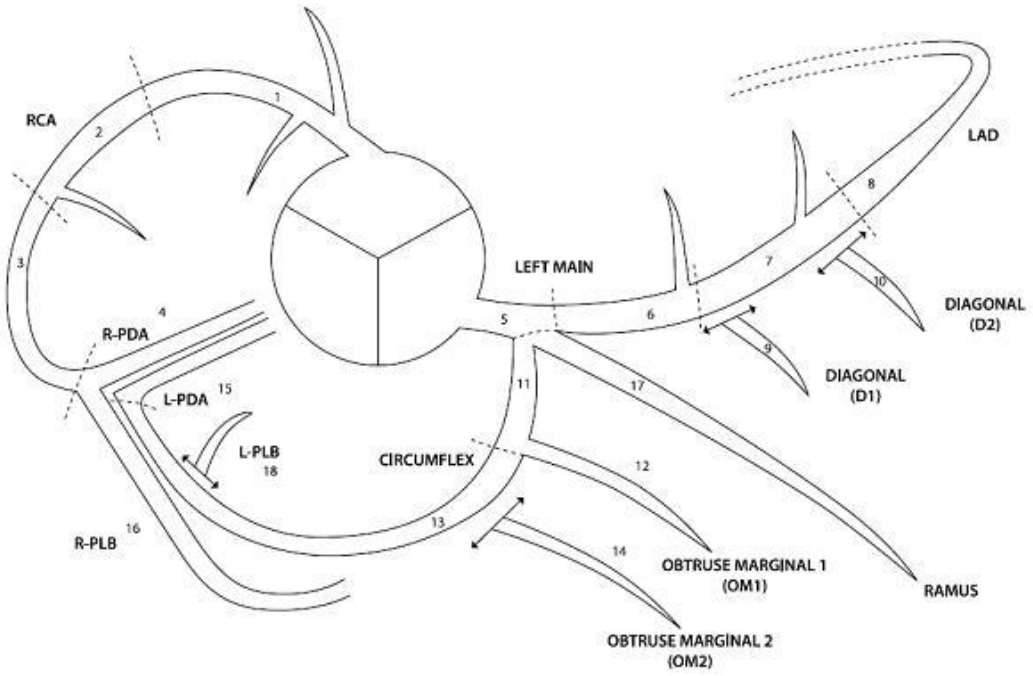
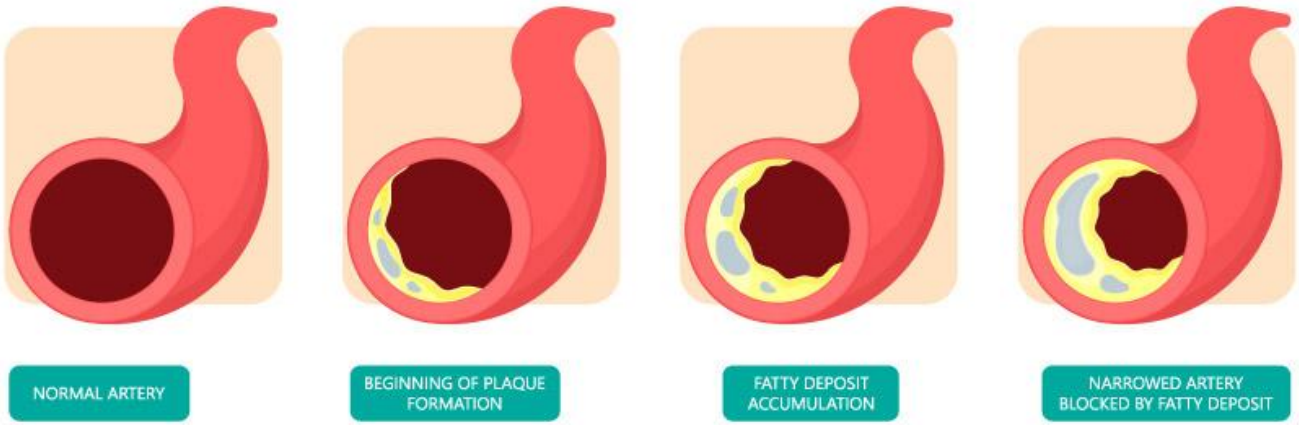
SUSPECT – CT Angiography: stenosis grade & plaque features





Coronary Artery Disease - Reporting and Data System (CAD-RADS)

1. Calcium Score



0	NO CALCIUM DEPOSIT
1-10	LOW RISK
11-99	MILD CALCIUM DEPOSIT
100-399	MODERATE CALCIUM DEPOSIT
> 400	HIGH RISK, CHANCE OF HEART ATTACK WITHIN A YEAR

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1. Calcium Score

- Calcium = plaque

> *"Long-term endurance athletes will develop CAC and predominantly calcific plaques that cannot be explained by typical mediators of coronary artery disease"*

- So, no calcium = no plaque..?

Aengevaeren VL, Mosterd A, Braber TL, Prakken NHJ, Doevendans PA, Grobbee DE, Thompson PD, Eijsvogels TMH, Velthuis BK. ***Relationship between lifelong exercise volume and coronary atherosclerosis in athletes.*** *Circulation. 2017;136;138–148. doi: 10.1161/CIRCULATIONAHA.117.027834.*

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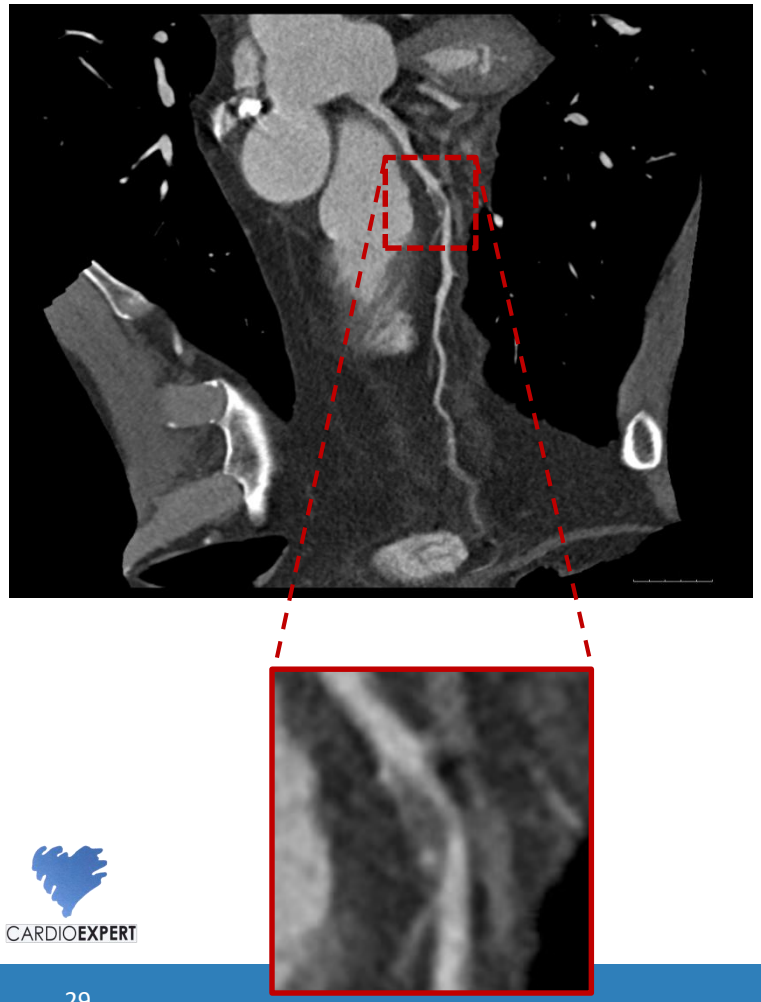
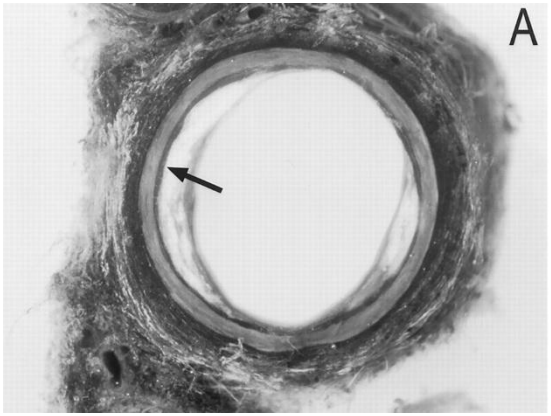
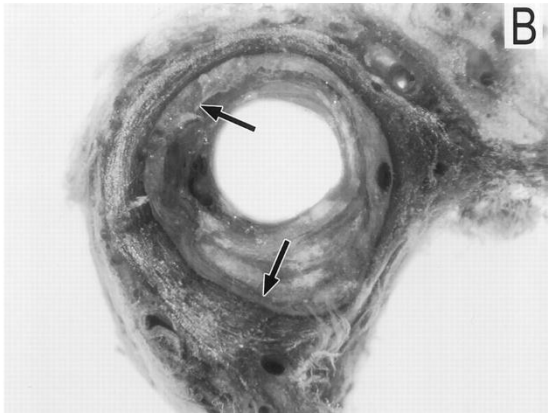
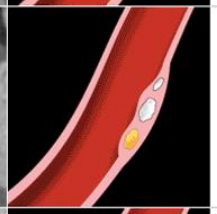
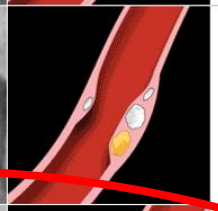
2. Stenosis grade





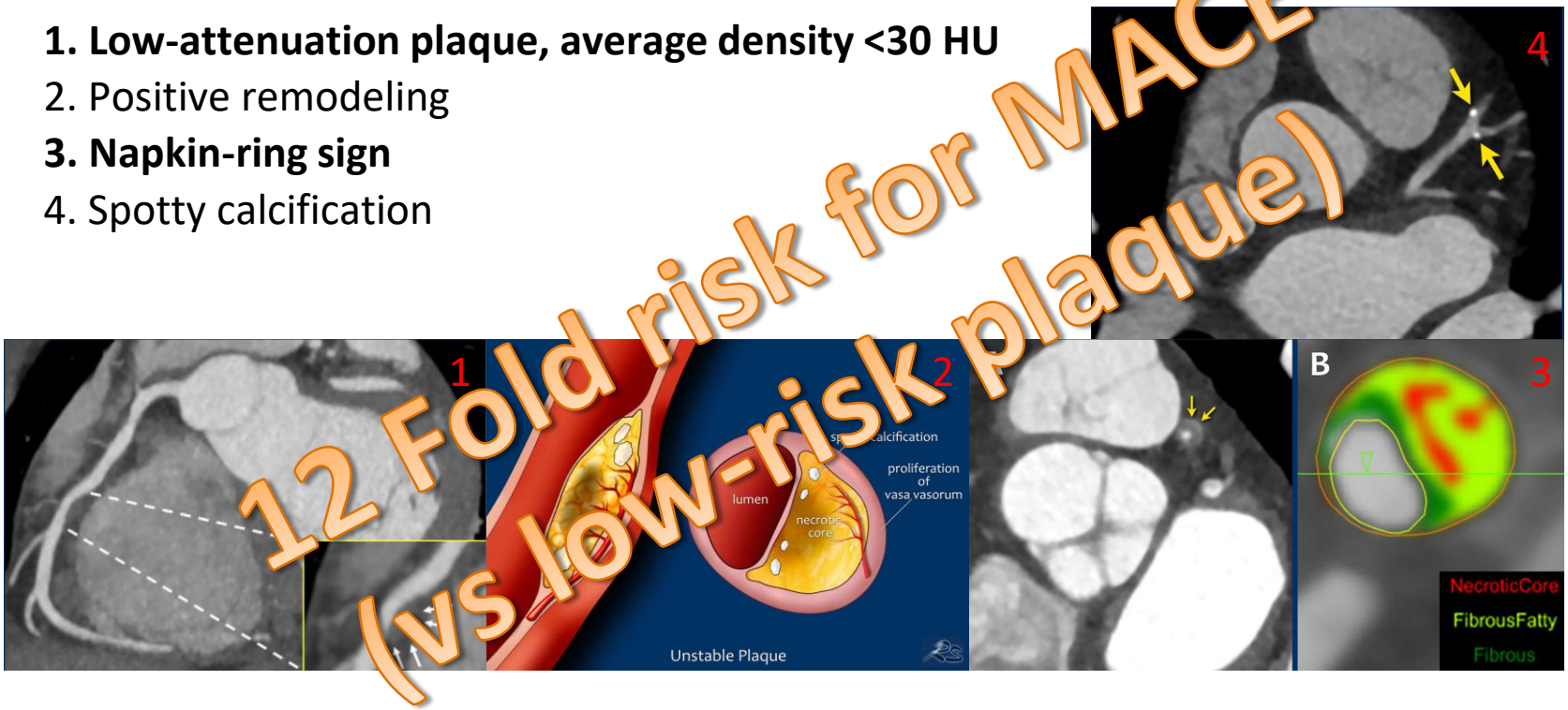


Pasterkamp G, Schoneveld AH, van Wolferen W, Hillen B, Clarijs RJ, Haudenschild CC, Borst C. ***The impact of atherosclerotic arterial remodeling on percentage of luminal stenosis varies widely within the arterial system. A postmortem study.*** *Arterioscler Thromb Vasc Biol. 1997 Nov;17(11):3057-63. doi: 10.1161/01.atv.17.11.3057. PMID: 9409293.*

Cad-Rads	Stenosis	CT imaging	Illustration	Additional Tests
Cad-Rads **0**	0% No stenosis			None
Cad-Rads **1**	1-24% Minimal stenosis			None
Cad-Rads **2**	25-49% Mild stenosis			None
Cad-Rads **3**	50-70% Moderate stenosis			Consider functional assessment
Cad-Rads **4**	A: 70-99% stenosis in 1 or 2 vessels B: >50% stenosis in the left main or >70% stenosis in 3-vessels			A: Consider functional assessment or ICA B: ICA is recommended
Cad-Rads **5**	100% total occlusion			ICA and/or viability assessment

3. Presence of High-Risk Plaques

1. **Low-attenuation plaque, average density <30 HU**
2. Positive remodeling
3. **Napkin-ring sign**
4. Spotty calcification



HU: Hounsfield Units

Adapted from Radiology Assistant,
Csilla Celeng, Richard Takx, Robin Smithuis and Tim Leiner

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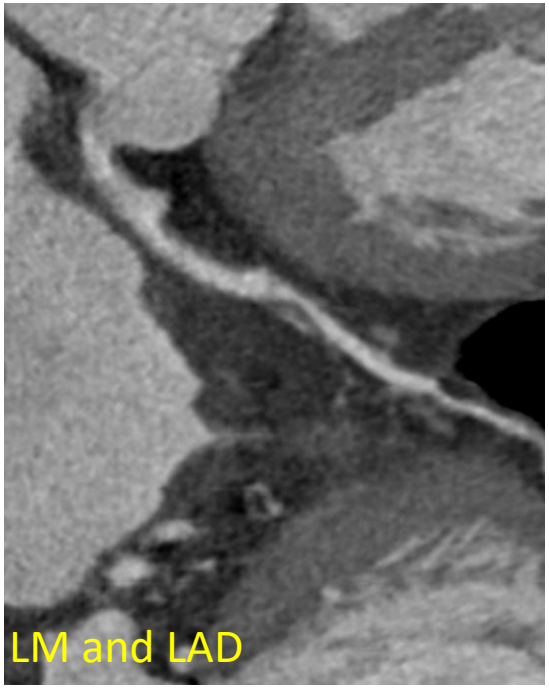
49 yo pilot

Coronary CT angiography
Atherosclerosis LAD with >50% stenosis



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SUSPECT study results

Non-contrast CT results	
CACS 0 AU	135 (64.3%)
CACS >0–99 AU	55 (26.2%)
CACS ≥100–399 AU	15 (7.1%)
CACS ≥400 AU	6 (2.9%)
CT angiography results	
CAD-RADS 0	98 (46.4%)
CAD-RADS 1	74 (35.1%)
CAD-RADS 2	29 (13.7%)
CAD-RADS 3	5 (2.4%)
CAD-RADS 4A	5 (2.4%)
CAD-RADS 4B	0 (0%)
CAD-RADS 5	0 (0%)
Individuals with plaque	113 (53.5%)
Calcified/Mixed/Non-calcified	47%/32%/21%
Mean Segment Involvement Score† (range)	3.3 (1-12)
CAD-RADS HRP modifier*	15 (7.1%)
Presence of HRP features:	44 (21.0%)
Positive remodelling	23 (52.3%)
Spotty calcification	30 (68.2%)
Low-attenuation plaque	6 (13.6%)
Napkin-ring sign	1 (2.3%)
Clinically relevant CAD	25 (11.8%)
Aeromedically relevant CAD#	27 (12.8%)

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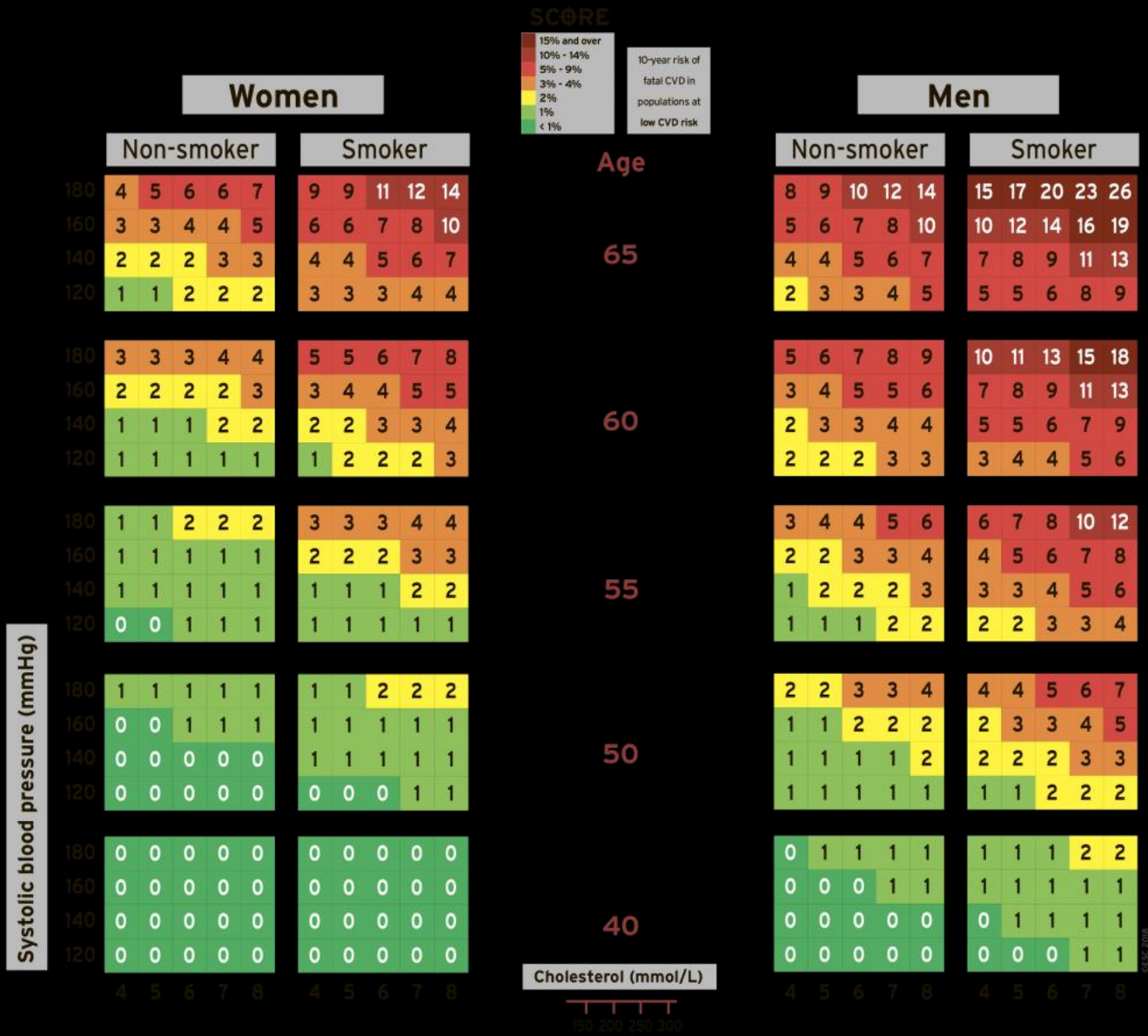
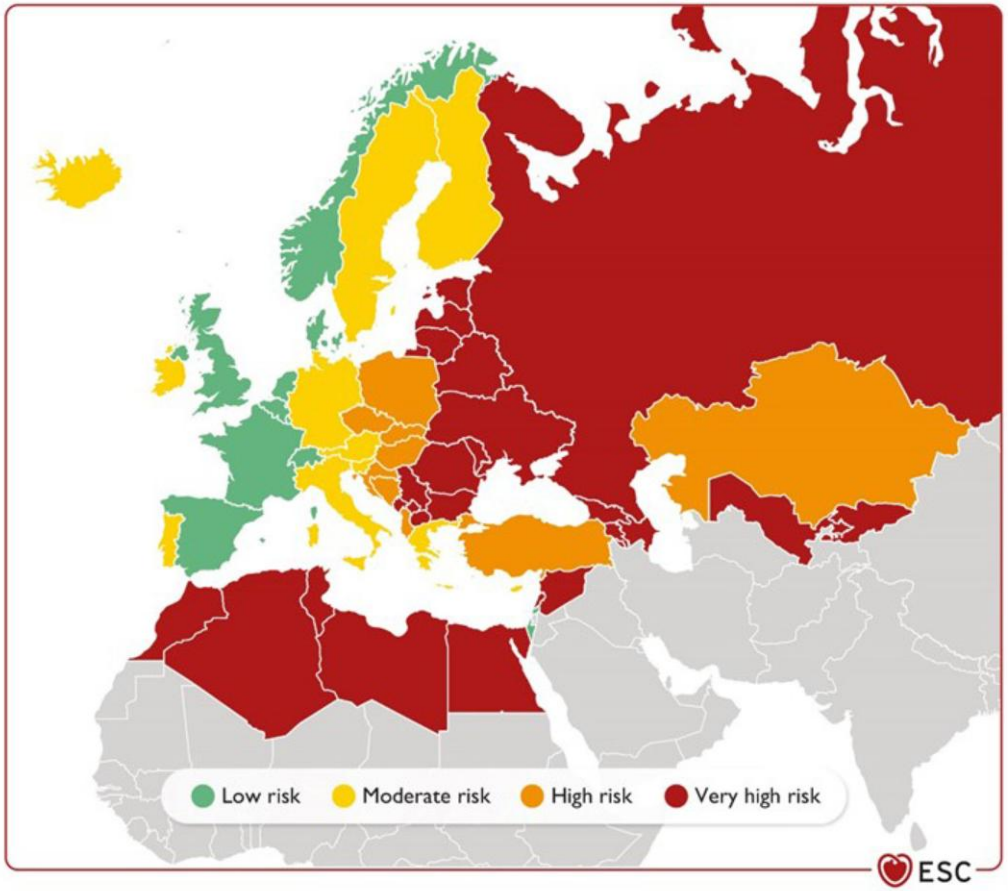
Waar zit de crux..?

SCORE - European Low Risk Chart

10 year risk of fatal CVD in low risk regions of Europe by gender, age, systolic blood pressure, total cholesterol and smoking status




SCORE - European Low Risk Chart
10 year risk of fatal CVD in low risk regions of Europe by gender, age, systolic blood pressure, total cholesterol and smoking status
15% and over
10% - 14%
5% - 9%
3% - 4%
2%
1%
< 1%
10-year risk of fatal CVD in populations at low CVD risk
Women
Men
Non-smoker
Smoker
Non-smoker
Smoker
65
60
55
50
40
Systolic blood pressure (mmHg)
Cholesterol (mmol/L)
"Global risk assessment is particularly useful in young and middle-aged adults for assessing relative risk and absolute long-term risk"
"Risk assessment in these patients will highlight the need for early and prolonged intervention on risk factors"



ESC

Risk regions based on World Health Organization cardiovascular mortality rates

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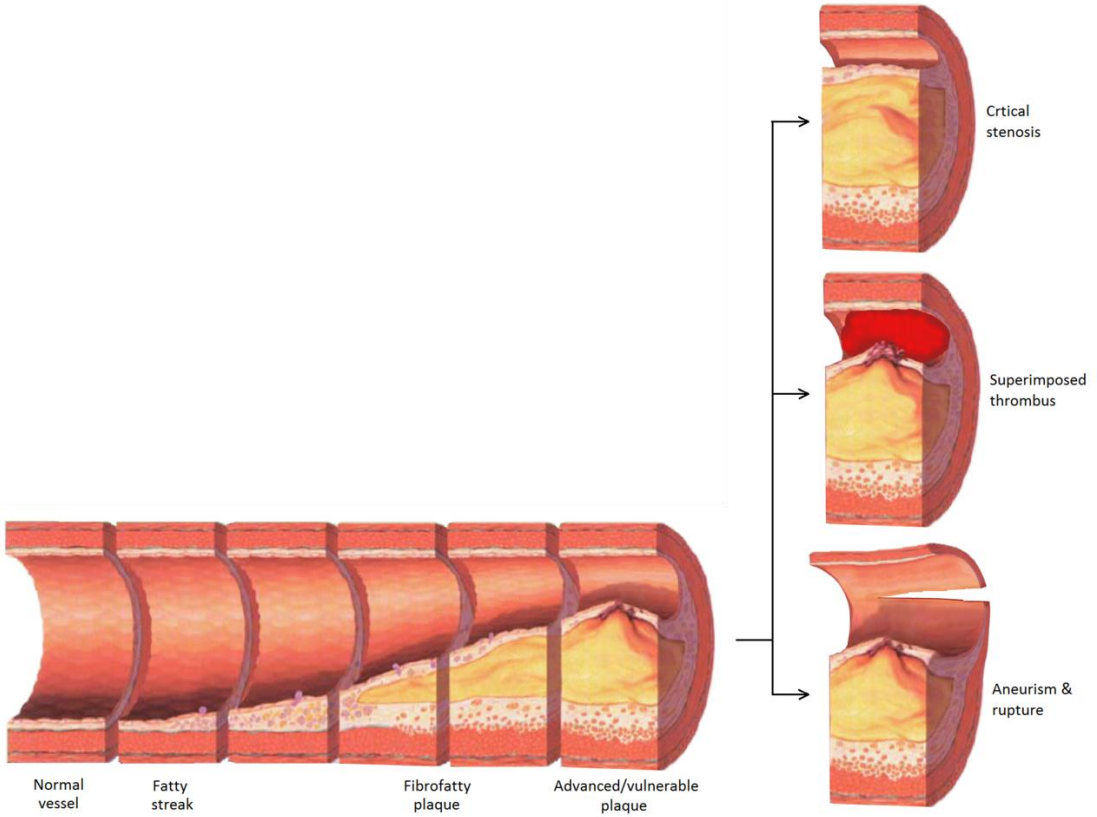
Risk Factors

Non-Modifiable Risk Factors:

- Age
- Sex (M>F)
- Family History
- Ethnic Background



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Risk Factors

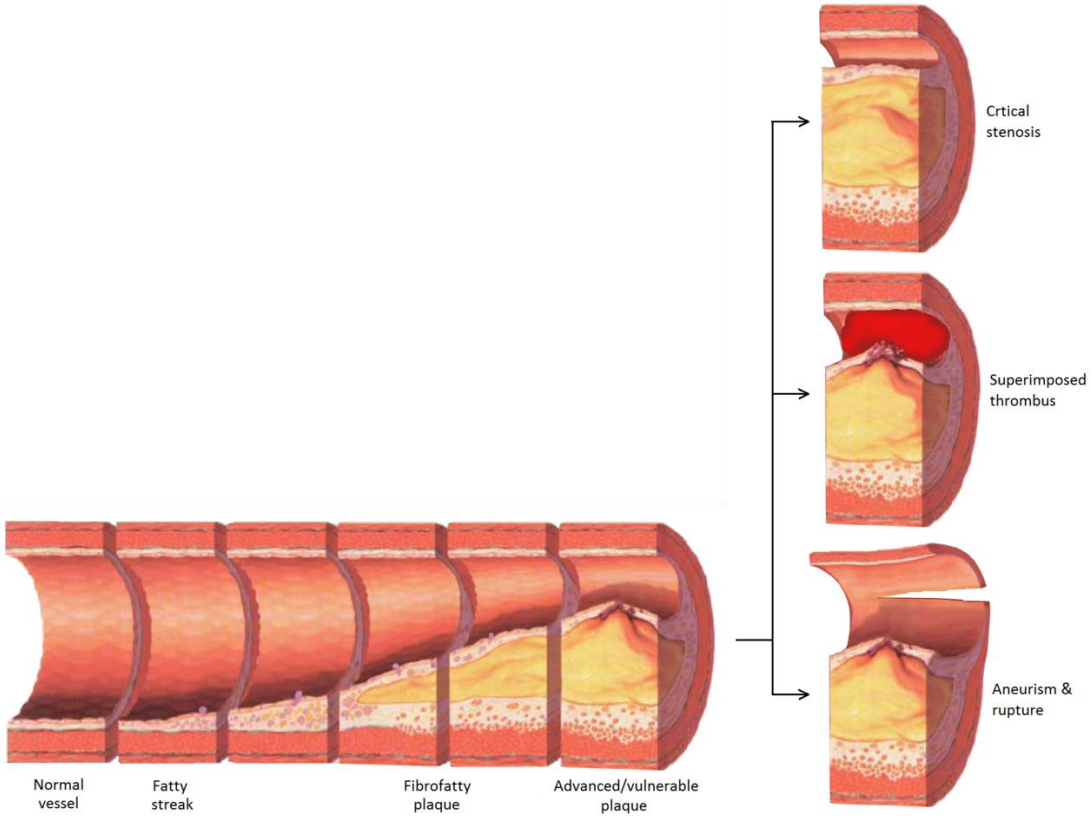
Non-Modifiable Risk Factors:

- Age
- Sex (M>F)
- Family History
- Ethnic Background

Modifiable Risk Factors:

- High Cholesterol
- High Blood Pressure
- Smoking
- Diabetes
- Obesity
- Poor diet
- Physical Inactivity
- Psychosocial (stress)

➔ **OTHER RISKS?**



Risk Factors

VETSTOFWISSELING			
Cholesterol	5.22	2.50-6.50	mmol/l
Triglyceriden	0.66	<2.00	mmol/l
HDL cholesterol	1.57	0.90-3.00	mmol/l
LDL cholesterol	▲ 3.79	<2.50	mmol/l
Chol:HDL-chol ratio	3.32	<5.00	.
non-HDL	▲ 3.6	<3.4	mmol/l

EASA MED.B.010 Cardiovascular System

"For a class 1 medical certificate, estimation of serum lipids, including cholesterol, shall be required at the initial examination, and at the first examination after having reached the age of 40."

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Risk Factors

Table 3. Risk-Enhancing Factors for Clinician–Patient Risk Discussion

Risk-Enhancing Factors
Family history of premature ASCVD (males, age <55 y; females, age <65 y)
Primary hypercholesterolemia (LDL-C, 160–189 mg/dL [4.1–4.8 mmol/L]; non–HDL-C 190–219 mg/dL [4.9–5.6 mmol/L])*
Metabolic syndrome (increased waist circumference [by ethnically appropriate cutpoints], elevated triglycerides [>150 mg/dL, nonfasting], elevated blood pressure, elevated glucose, and low HDL-C [<40 mg/dL in men; <50 mg/dL in women] are factors; a tally of 3 makes the diagnosis)
Chronic kidney disease (eGFR 15–59 mL/min/1.73 m^2 with or without albuminuria; not treated with dialysis or kidney transplantation)
Chronic inflammatory conditions, such as psoriasis, RA, lupus, or HIV/AIDS
History of premature menopause (before age 40 y) and history of pregnancy-associated conditions that increase later ASCVD risk, such as preeclampsia
High-risk race/ethnicity (eg, South Asian ancestry)
Lipids/biomarkers: associated with increased ASCVD risk
Persistently elevated* primary hypertriglyceridemia (≥175 mg/dL, nonfasting)
If measured:
Elevated high-sensitivity C-reactive protein (≥2.0 mg/L)
Elevated Lp(a): A relative indication for its measurement is family history of premature ASCVD. An Lp(a) ≥50 mg/dL or ≥125 nmol/L constitutes a risk-enhancing factor, especially at higher levels of Lp(a).
Elevated apoB (≥130 mg/dL): A relative indication for its measurement would be triglyceride ≥200 mg/dL. A level ≥130 mg/dL corresponds to an LDL-C >160 mg/dL and constitutes a risk-enhancing factor
ABI (<0.9)

*Optimally, 3 determinations.

ABI indicates ankle-brachial index; AIDS, acquired immunodeficiency syndrome; apoB, apolipoprotein B; ASCVD, atherosclerotic cardiovascular disease; eGFR, estimated glomerular filtration rate; HDL-C, high-density lipoprotein cholesterol; HIV, human immunodeficiency virus; LDL-C, low-density lipoprotein cholesterol; Lp(a), lipoprotein (a); and RA, rheumatoid arthritis.

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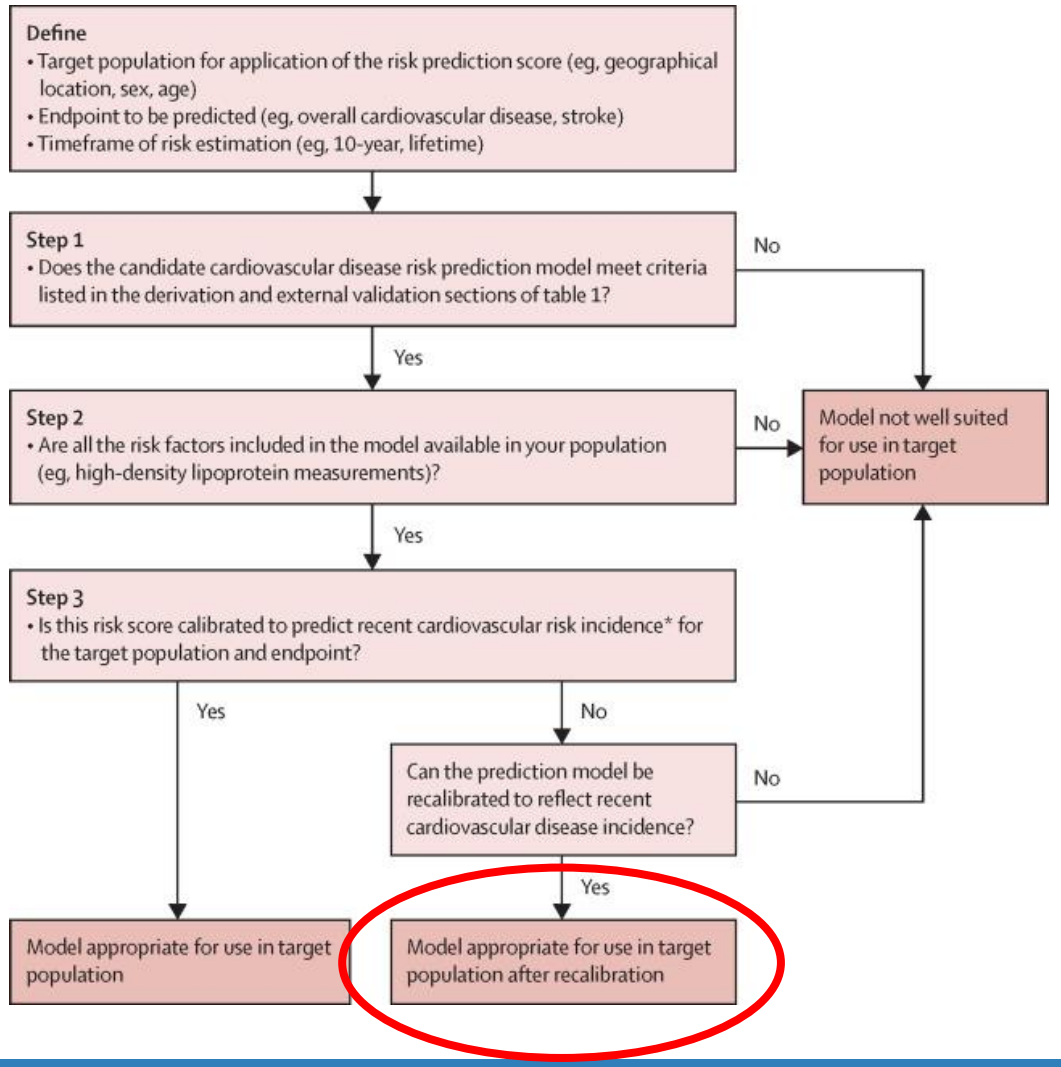
Here's the problem…

Risk Factors



van Daalen KR, Zhang D, Kaptoge S, Paige E, Di Angelantonio E, Pennells L. ***Risk estimation for the primary prevention of cardiovascular disease: considerations for appropriate risk prediction model selection.*** *Lancet Glob Health. 2024 Aug;12(8):e1343-e1358. doi: 10.1016/S2214-109X(24)00210-9. PMID: 39030064; PMCID: PMC11283887.*

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Case report from SUSPECT

- 41-year-old male pilot
- PMH: appendectomy at age 33
- No known risk factors
  - 5 Units alcohol per week
  - Never smoked
  - No medication
  - BMI 24.2
- No family history of premature CAD
- Athletic
  - Running, ice skating

Case report from SUSPECT

- 41-year-old male pilot
- Physical; unremarkable, resting heart rate 36 (ECG), RR 142/89
- Lab:
  - TC 4,4 mmol/L
  - TG 0,7 mmol/L
  - HDL 1,3 mmol/L
  - LDL 2,8 mmol/L
- ECG: normal
- xECG: VO_2 max of 42.5
- CT angiography…
  - ➢ CACS 12.5
  - ➢ LAD 25% stenosis

➔ Referral to hematologist

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Take home message

- Aeromedical exam for preventing incapacitation…
  - Acute incapacitation
    - ➢ Detect illness, anomalies (low prior probability)
  - Long-term prevention
    - ➢ Help prevent early career termination
    - ➢ Life style advice & life style change (yearly)

CURRENT RISK SCORES

➔ ***Prevent the accident before it happens?***

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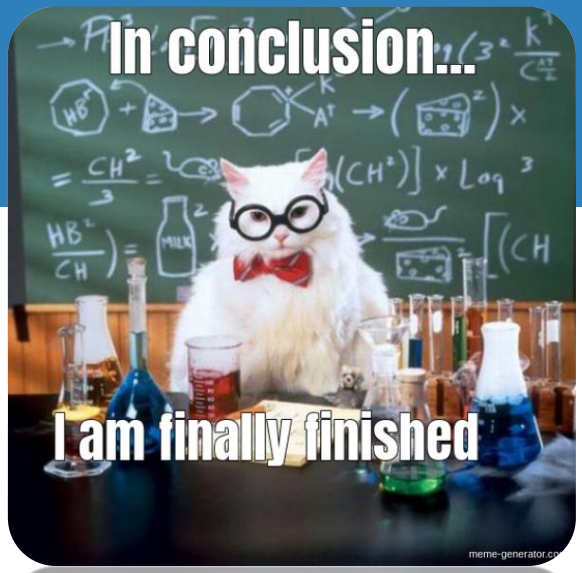
Discussion



- Aeromedical exam as prevention strategy?!
- CT as a screening tool for high-risk occupations?
- However, what about ethical considerations:
  - For treatment of cardiovascular findings?
  - Other findings on CT?
  - Radiation?
  - Refusing scan?
- Results from SUSPECT published

➔ TODO: risk score / decision matrix for enhanced screening of pilots

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Vragen?

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Met dank aan…

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