2023 MID-ATLANTIC CONFERENCE

11th ANNUAL CURRENT CONCEPTS IN

VASCULAR THERAPIES

2023

Hilton Virginia Beach Oceanfront
Virginia Beach, Virginia

APRIL 20-22

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VASCULAR THERAPIES

2023

Advances in CT cardiac Imaging:

Innovation in Care

Innovation Health Services

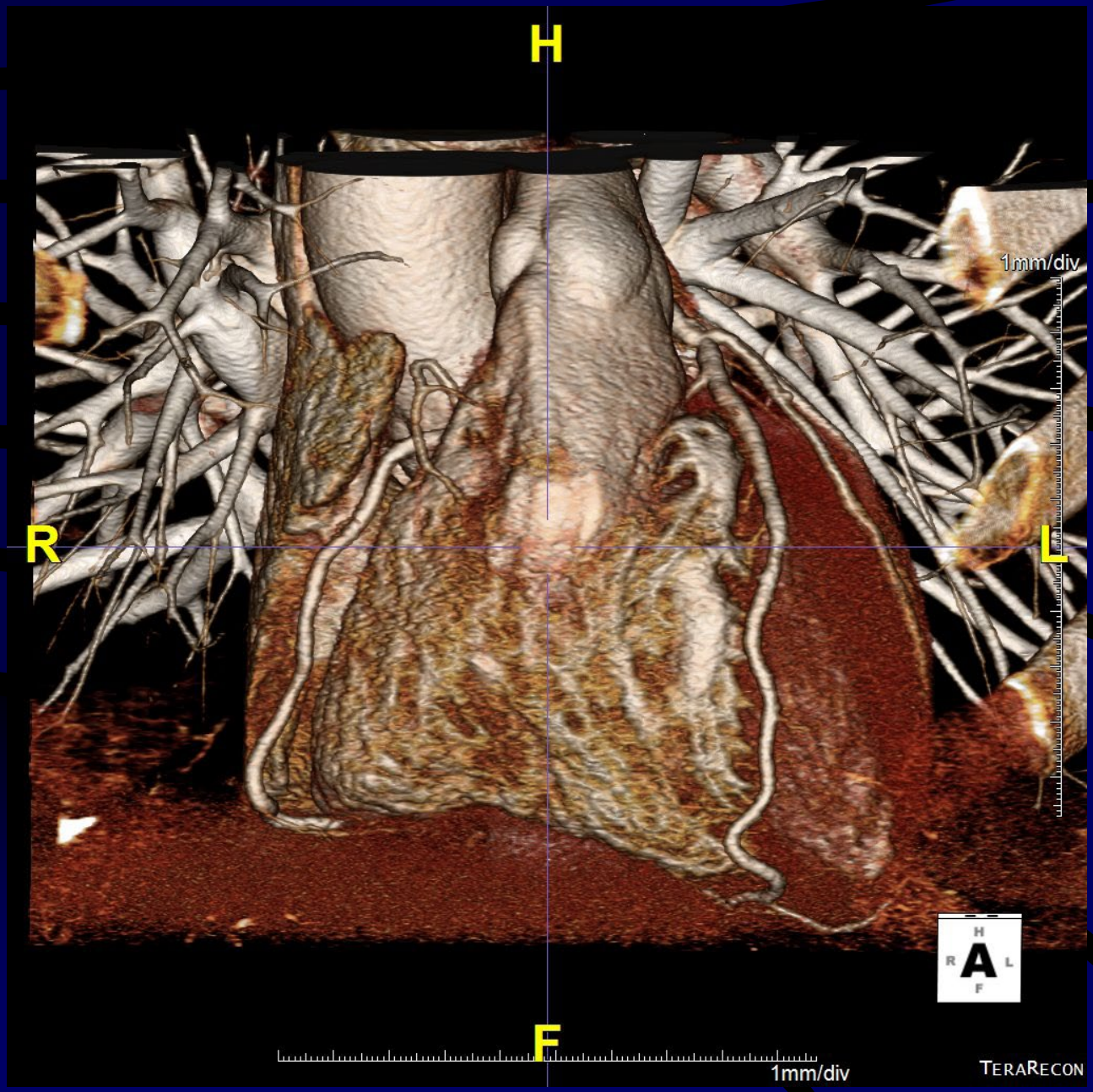
ihsmd.org

Mohit Bhasin MD, FACC, FSCCT

President, Innovation Health Service

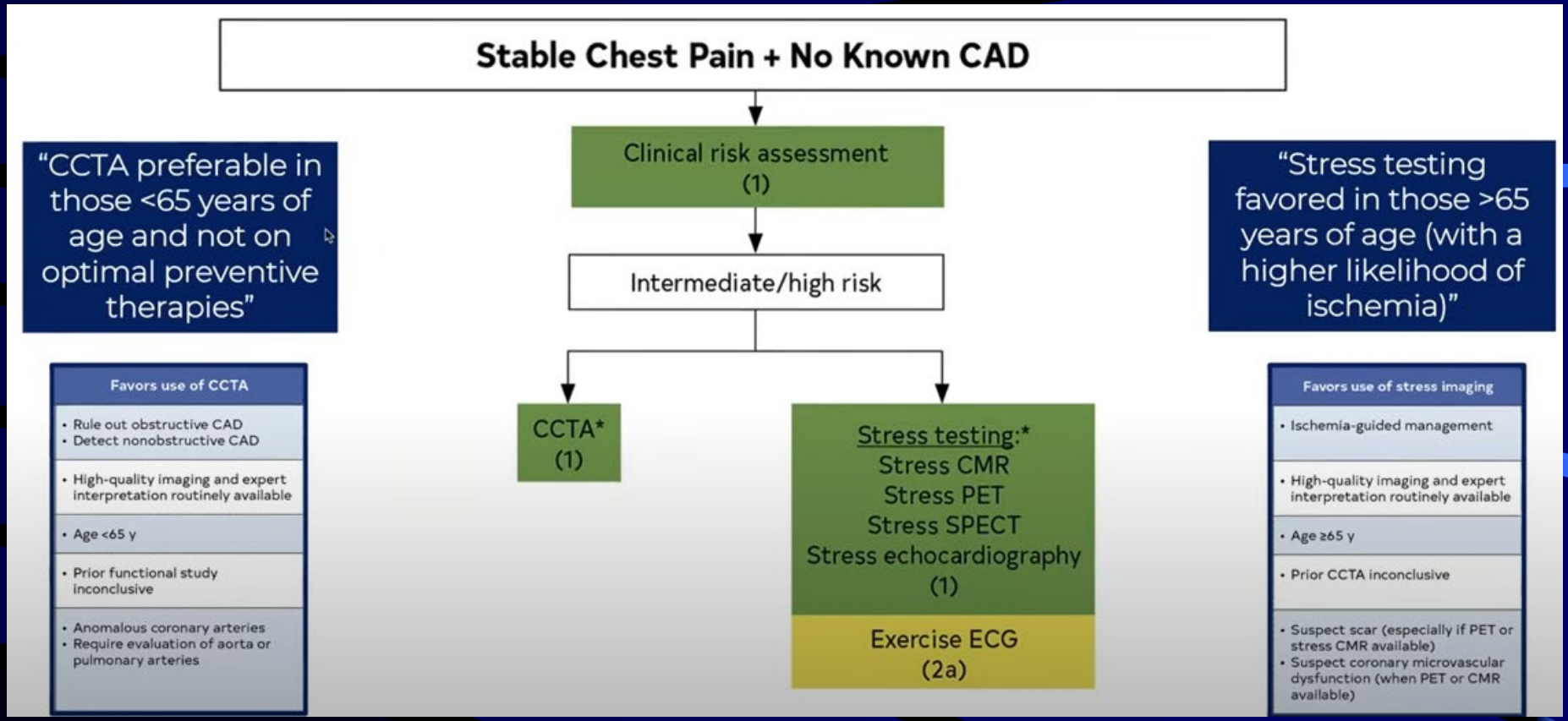
Medical Director, Cardiac Imaging Sentara Heart

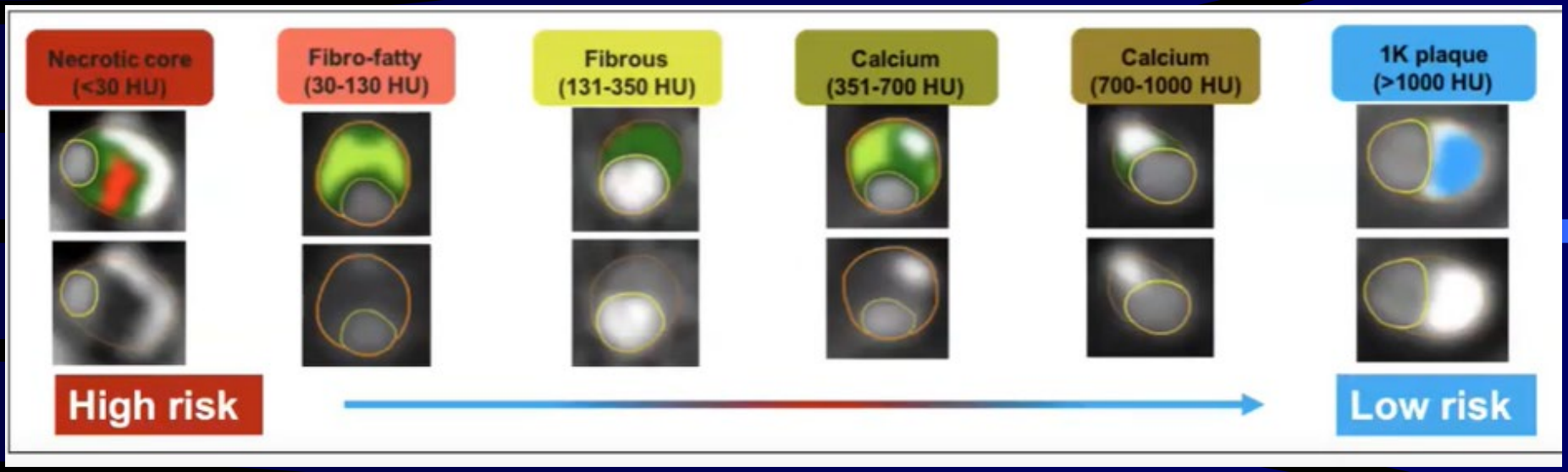
CT Heart and great vessels with contrast



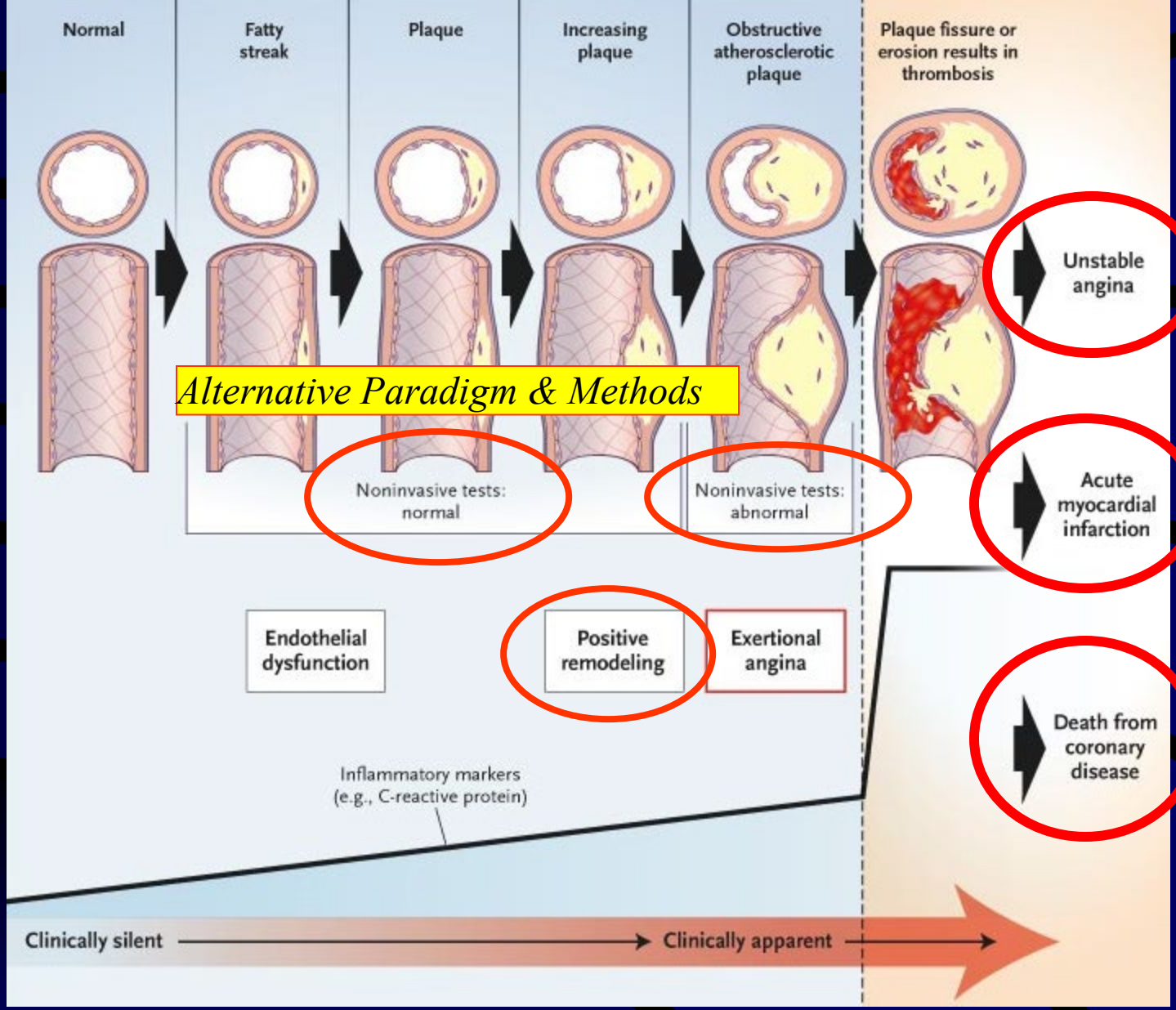
Normal Cardiac CT has 100 % NPV

ACC Chest Pain Guidelines 2021

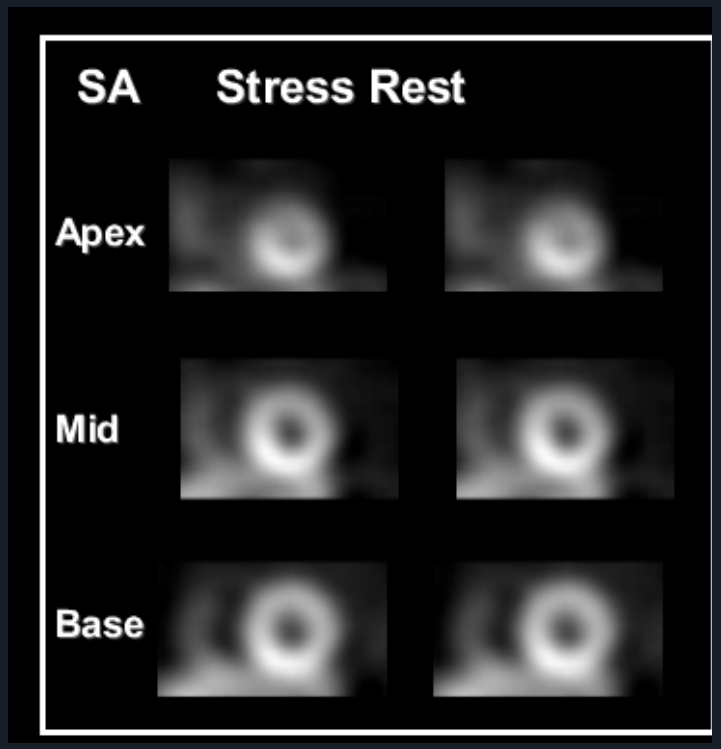


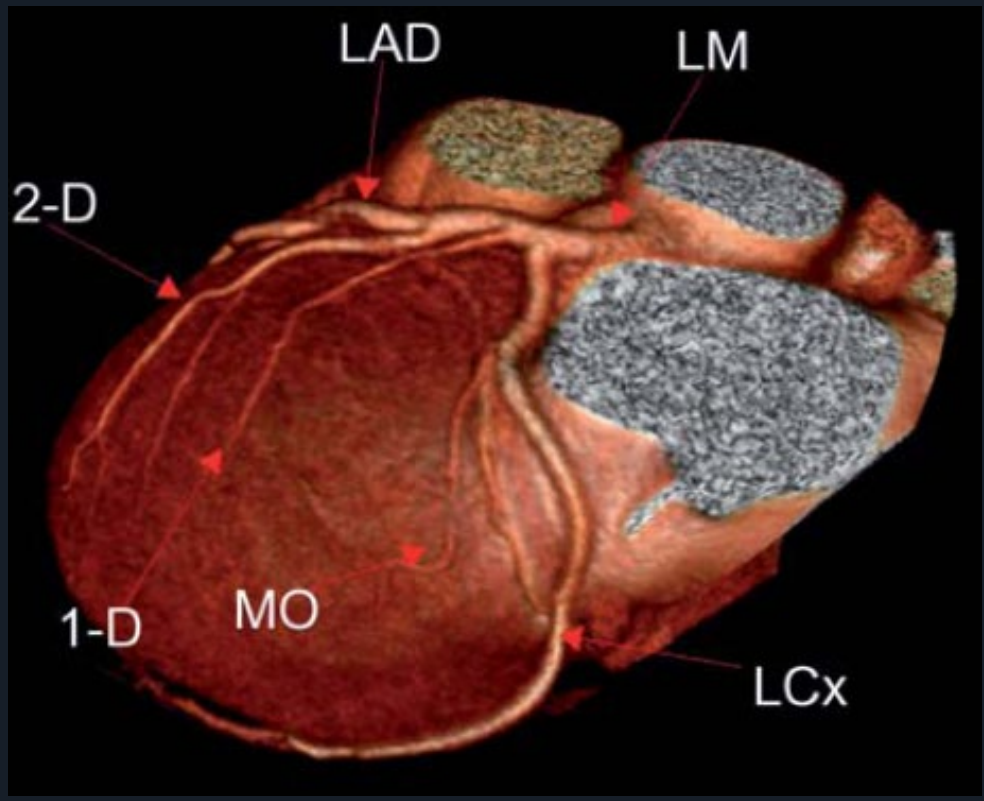

Necrotic core
(<30 HU)
Fibro-fatty
(30-130 HU)
Fibrous
(131-350 HU)
Calcium
(351-700 HU)
Calcium
(700-1000 HU)
1K plaque
(>1000 HU)
High risk
Low risk


zSen16 Str Cardiac CTA,Uni Erlangen 1
CorCTA 1.0 70% 2
R MED 2/ Uni Erlangen
Sensation Cardiac
10-Oct-2003 12:04:10
CT
P
RES/SHADE/SURF
B 100 W 439
O 52 C 185
L
A



Stress imaging has been insensitive for early atherosclerosis, relying on hemodynamic obstruction (>70% stenosis)





What happens when we move from insensitive stress tests to Cardiac CT?

Increase in *appropriate* cath & PCI/CABG

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Coronary CT Angiography and 5-Year Risk of Myocardial Infarction

The SCOT-HEART Investigators*

ABSTRACT

BACKGROUND

Although coronary computed tomographic angiography (CTA) improves diagnostic certainty in the assessment of patients with stable chest pain, its effect on 5-year clinical outcomes is unknown.

METHODS

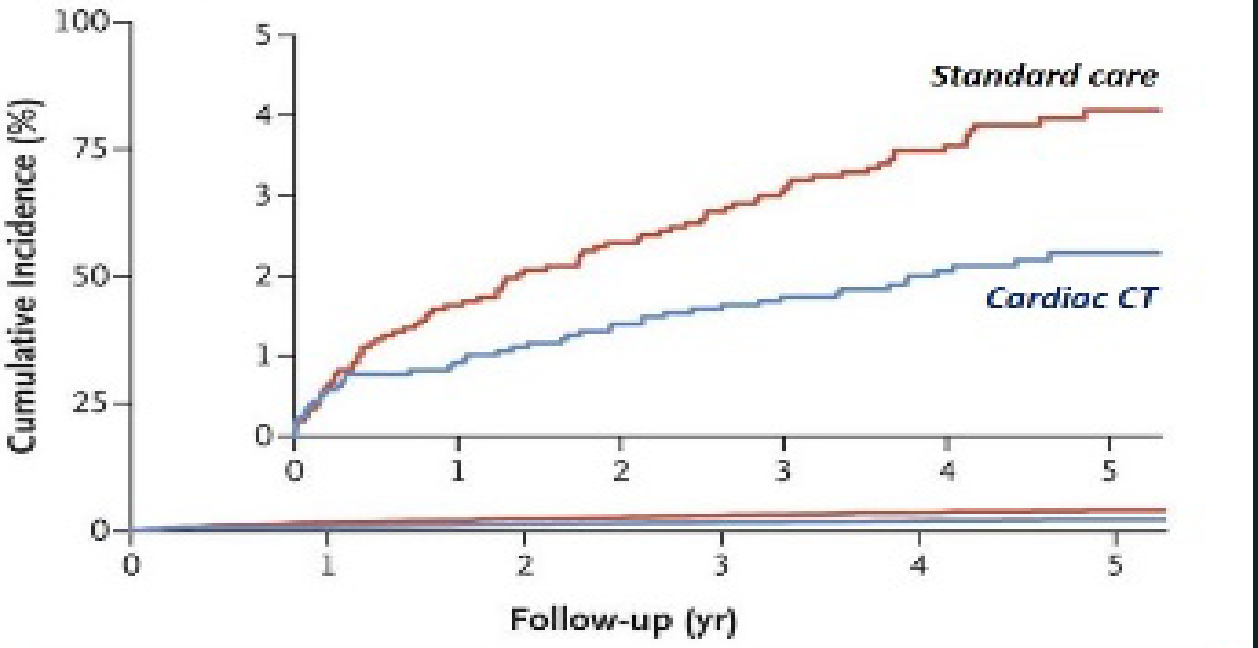
In an open-label, multicenter, parallel-group trial, we randomly assigned 4146 patients with stable chest pain who had been referred to a cardiology clinic for evaluation to standard care plus CTA (2073 patients) or to standard care alone (2073 patients). Investigations, treatments, and clinical outcomes were assessed over 3 to 7 years of follow-up. The primary end point was death from coronary heart disease or nonfatal myocardial infarction at 5 years.

RESULTS

The median duration of follow-up was 4.8 years, which yielded 20,254 patient-years of follow-up. The 5-year rate of the primary end point was lower in the CTA group than in the standard-care group (2.3% [48 patients] vs. 3.9% [81 patients]; hazard ratio, 0.59; 95% confidence interval [CI], 0.41 to 0.84; P=0.004). Although the rates of invasive coronary angiography and coronary revascularization were higher in the CTA group than in the standard-care group in the first few months of follow-up, overall rates were similar at 5 years: invasive coronary angiography was performed in 491 patients in the CTA group and in 502 patients in the standard-care group (hazard ratio, 1.00; 95% CI, 0.88 to 1.13), and coronary revascularization was performed in 279 patients in the CTA group and in 267 in the standard-care group (hazard ratio, 1.07; 95% CI, 0.91 to 1.27). However, more preventive therapies were initiated in patients in the CTA group (odds ratio, 1.40; 95% CI, 1.19 to 1.65), as were more antianginal therapies (odds ratio, 1.27; 95% CI, 1.05 to 1.54). There were no significant between-group differences in the rates of cardiovascular or noncardiovascular deaths or deaths from any cause.

NEJM Aug 2018

Death or MI after Coronary CT vs Stress Testing



SCOT-HEART trial: long-term impact in stable chest pain
1° outcome: death from coronary heart disease or nonfatal MI

During the first year after randomization, more patients in the CCTA group underwent coronary revascularization (246 versus 208)

NEJM
Aug 2018

Increased coronary revascularizations

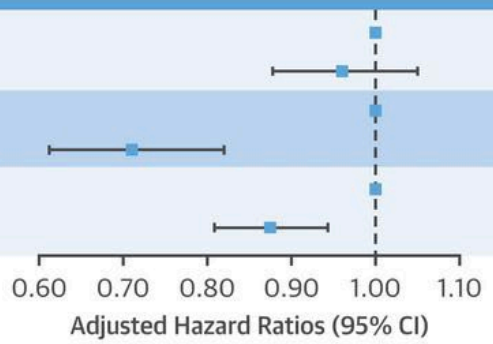
Danish Registry

Total of 86,705 patients underwent either older stress testing (n = 53,744, mean age 57, 49% males) or coronary CTA (n = 32,961, mean age 57 years, 45% males) followed for a median of 3.6 years.

interval: 0.61 to 0.82).

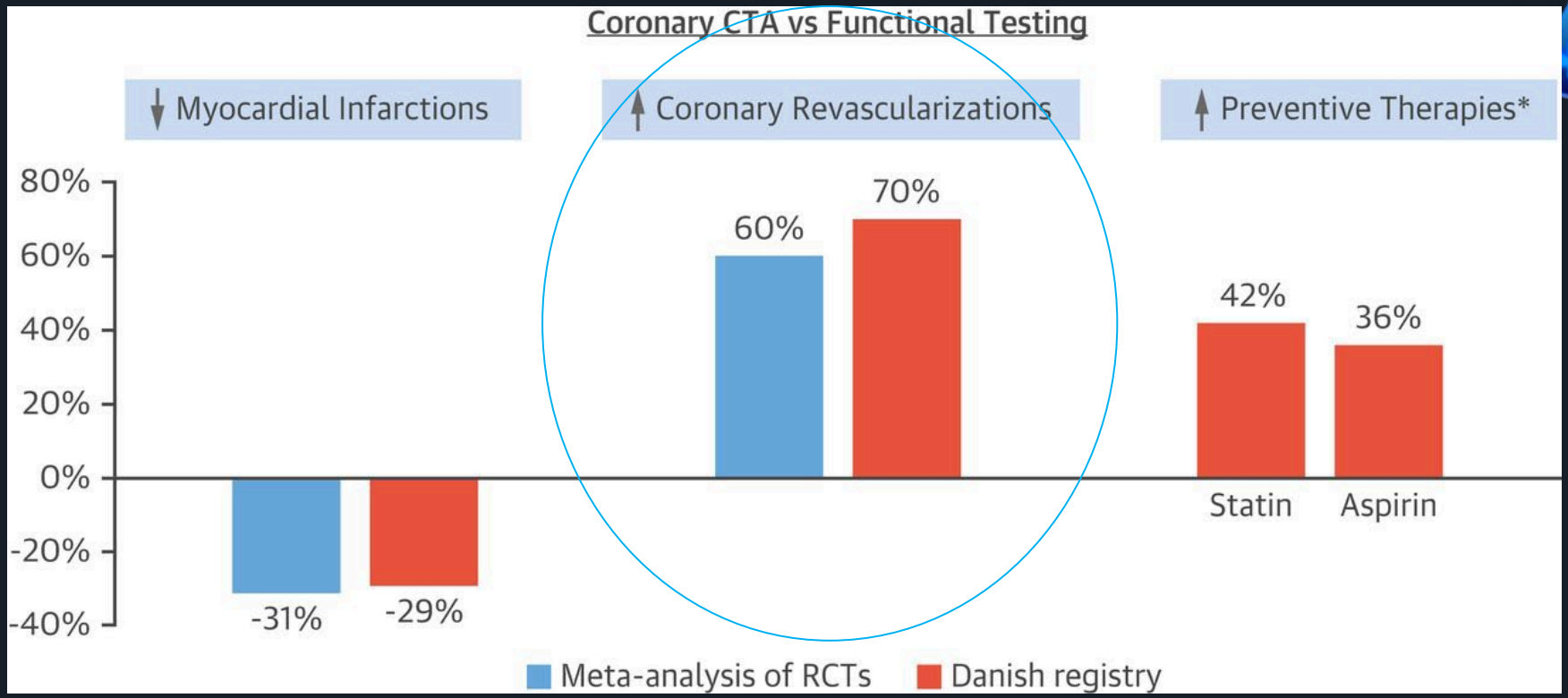
CENTRAL ILLUSTRATION: Long-Term Risks of All-Cause Mortality and MI

		Events (n)	Absolute risk (%)	Adjusted Hazard ratios
All-Cause Mortality	Functional testing	2,131	3.97	Ref.
	Coronary CTA	699	2.12	0.96 (0.88-1.05)
Myocardial Infarction	Functional testing	830	1.54	Ref.
	Coronary CTA	259	0.79	0.71 (0.61-0.82)
Combined Endpoint	Functional testing	2,847	5.30	Ref.
	Coronary CTA	929	2.82	0.87 (0.81-0.94)



Jørgensen, M.E. et al. J Am Coll Cardiol. 2017;69(14):1761-70.

Mads E. Jørgensen et al. JACC 2017;69:1761-1770


Coronary CTA vs Functional Testing
Myocardial Infarctions
Coronary Revascularizations
Preventive Therapies*
80%
60%
40%
20%
0%
-20%
-40%
-31%
-29%
60%
70%
42%
36%
Statin
Aspirin
Meta-analysis of RCTs
Danish registry

Annals of Internal Medicine

ORIGINAL RESEARCH

Subclinical Coronary Atherosclerosis and Risk for Myocardial Infarction in a Danish Cohort

A Prospective Observational Cohort Study

**Andreas Fuchs, MD, PhD; Jørgen Tobias Kühl, MD, PhD, DMSc; Per Ejlstrup Sigvard
Andreas Dehlbæk Knudsen, MD, PhD; Mathias Bech Møller, MD, PhD; Martina Cha
Mathias Holm Sørgaard, MD, PhD; Børge Grønne Nordestgaard, MD, DMSc; Lars V
Klaus Fuglsang Kofoed, MD, PhD, DMSc**

Background: Coronary atherosclerosis may develop at an early age and remain latent for many years.

Objective: To define characteristics of subclinical coronary atherosclerosis associated with the development of myocardial infarction.

Design: Prospective observational cohort study.

Setting: Copenhagen General Population Study, Denmark.

Participants: 9533 asymptomatic persons aged 40 years or older without known ischemic heart disease.

Measurements: Subclinical coronary atherosclerosis was assessed with coronary computed tomography angiography conducted blinded to treatment and outcomes. Coronary atherosclerosis was characterized according to luminal obstruction (nonobstructive or obstructive [≥50% luminal stenosis]) and extent (nonextensive or extensive [one third or more of the coronary tree]). The primary outcome was myocardial infarction, and the secondary outcome was a composite of death or myocardial infarction.

Results: A total of 5114 (54%) persons had no subclinical coronary atherosclerosis, 3483 (36%) had nonobstructive disease, and 936 (10%) had obstructive disease. Within a median follow-up of 3.5
died and 71 had
infarction was in
relative risk, 9.1
[CI, 3.53 to 16.5
farction was note
ical coronary ath
5.50 to 28.12])
risk, 8.28 [CI, 3.
point of death or
with extensive di
example, nonob
[CI, 1.72 to 4.25
risk, 3.15 [CI, 2.0

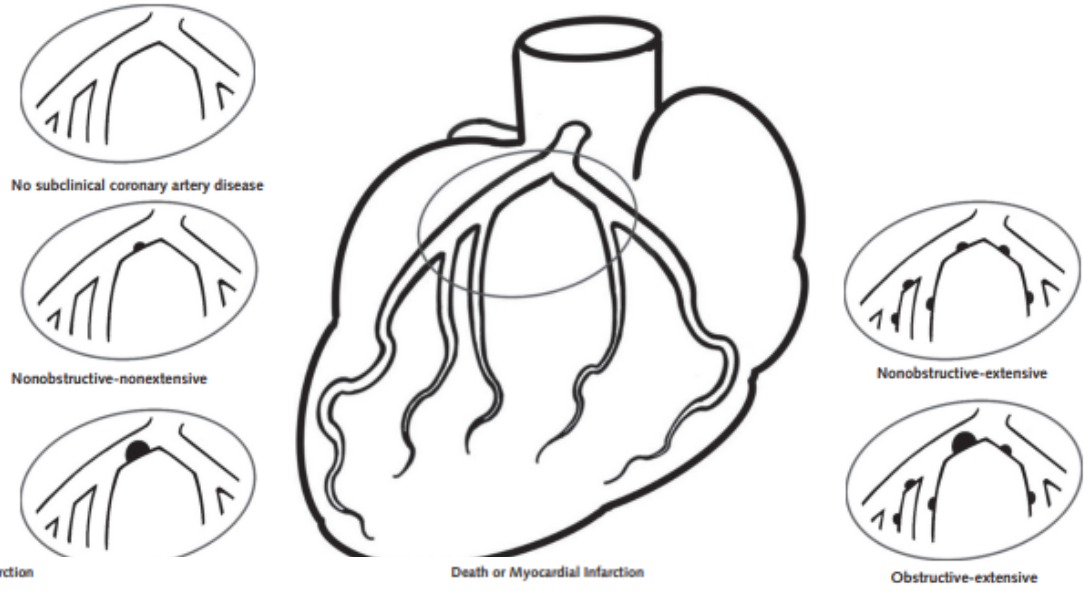
Limitation: Mos

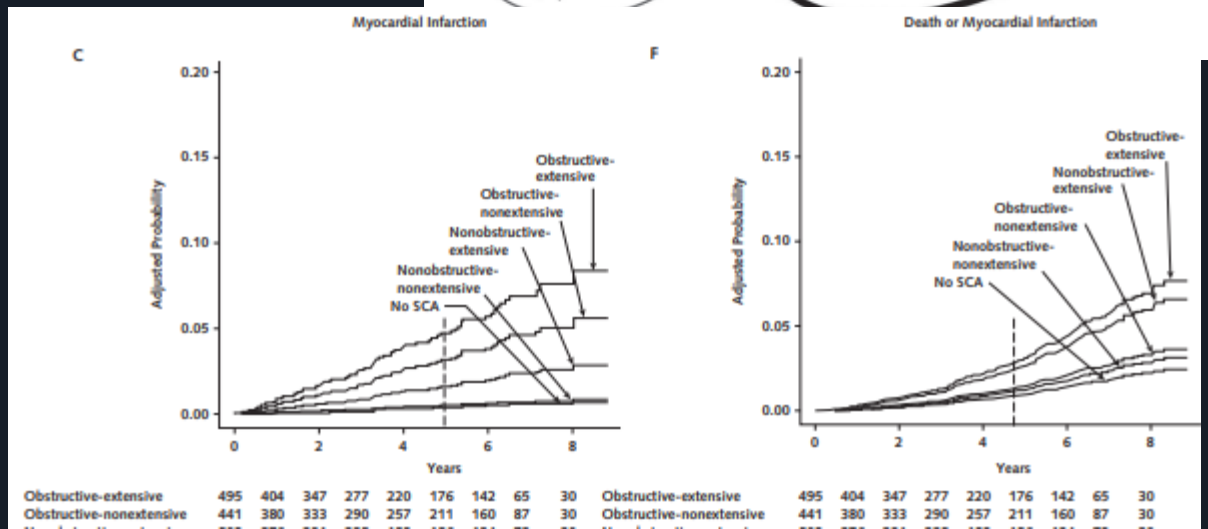
Conclusion: In
tive coronary at
8-fold elevated

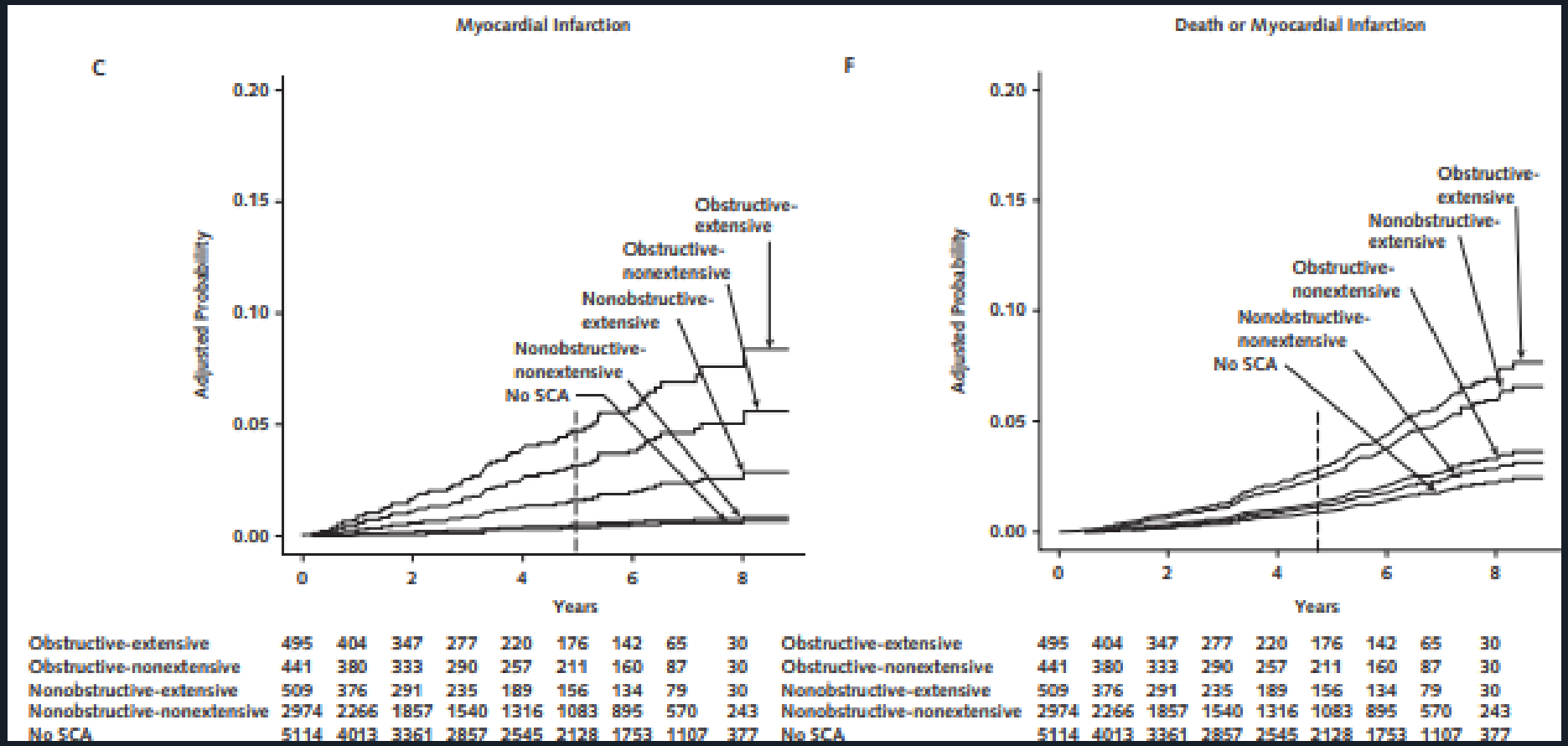
Primary Fundi
Mc-Kinney Mølle

Ann Intern Med. do
For author, article,
This article was pub

Figure 1. Illustration of combined subclinical coronary atherosclerosis groups by coronary computed tomography angiography.



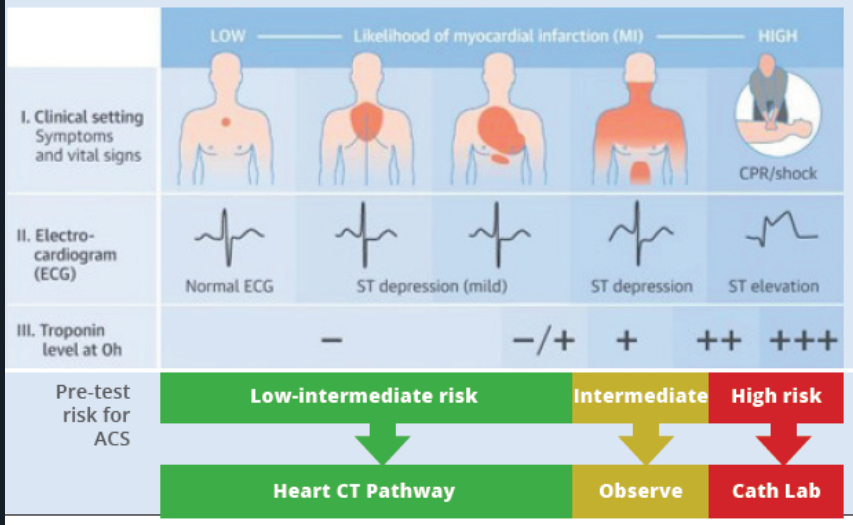




Scholars predict coronary CTA will become the routine colonscopy of the heart for those over 40, or 30-40 with high risk

Innovation Health Services
Care for the Vulnerable

Early Rapid Assessment by CT Heart



Likelihood for PF or AAS is not low

Coronary CTA

Multiple Rule-Out CTA

- History of DVT
- History of malignancy
- Immobility
- Age >65 & tachycardia
- History of Marfan's syndrome, aortic valve disease or thoracic aneurysm
- Abrupt onset of ripping / stabbing / tearing pain
- Physical exam findings of pulse or blood pressure deficit
- New murmur of aortic insufficiency

Pre-mediacte: HR target <60 bpm

Acquire CT Heart

2nd Troponin & ECG at 3 hours

Disposition Recommendations

CATCH Study

JACC: CARDIOVASCULAR IMAGING
VOL. 8, NO. 12, 2015

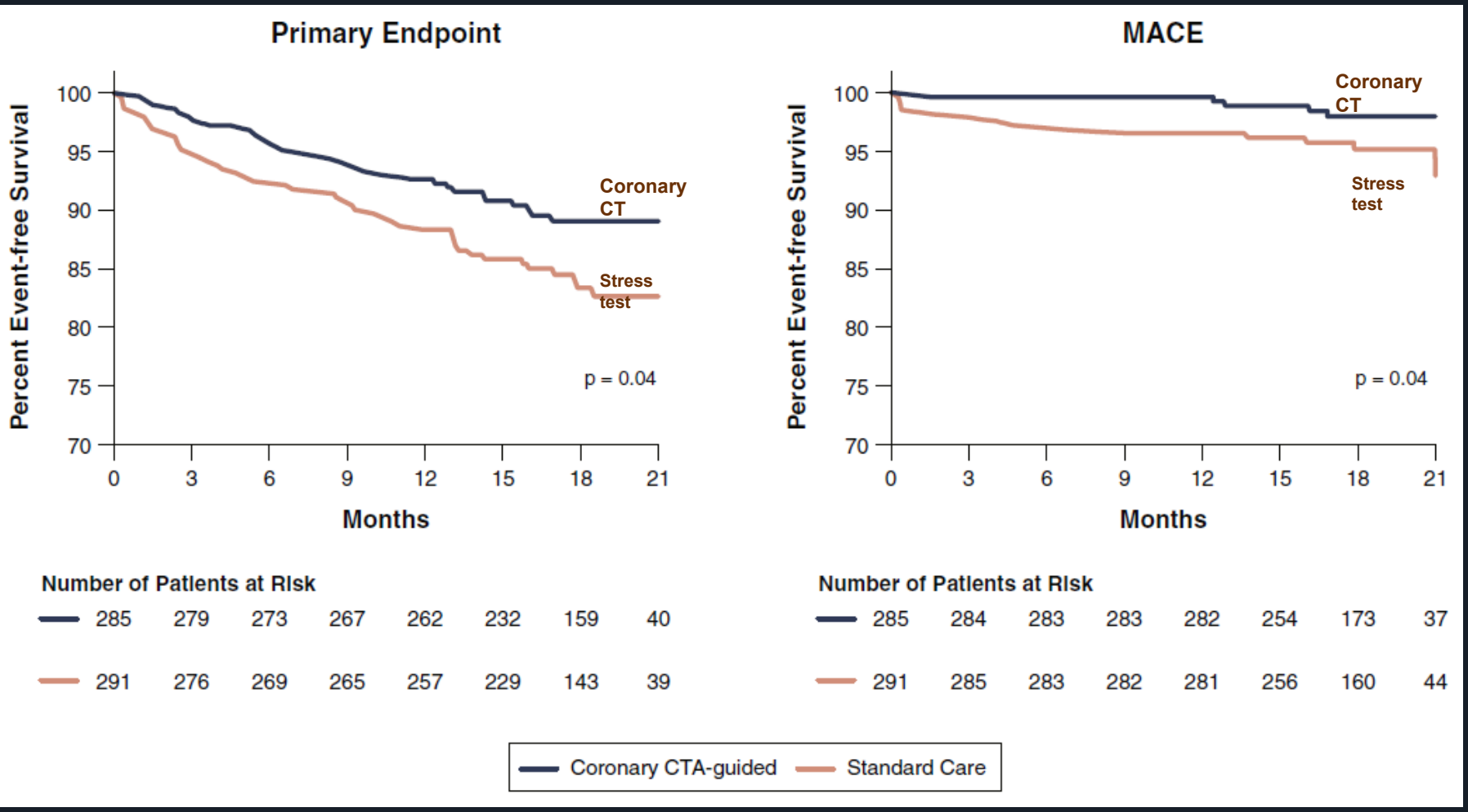
ISSN 1936-878X/$36.00
PUBLISHED BY ELSEVIER INC.
http://dx.doi.org/10.1016/j.jcmg.2015.07.015

Long-Term Clinical Impact of Coronary CT Angiography in Patients With Recent Acute-Onset Chest Pain

The Randomized Controlled CATCH Trial

Jesper J. Linde, MD, PhD,*† Jens D. Hove, MD, PhD,*‡ Mathias Sørgaard, MD,† Henning Kelbæk, MD, DMSc,§ Gorm B. Jensen, MD, DMSc,* Jørgen T. Kühl, MD, PhD,† Louise Hindsø, MB,† Lars Køber, MD, DMSc,† Walter B. Nielsen, MD, PhD,* Klaus F. Kofoed, MD, PhD, DMSc†‖

CATCH Study



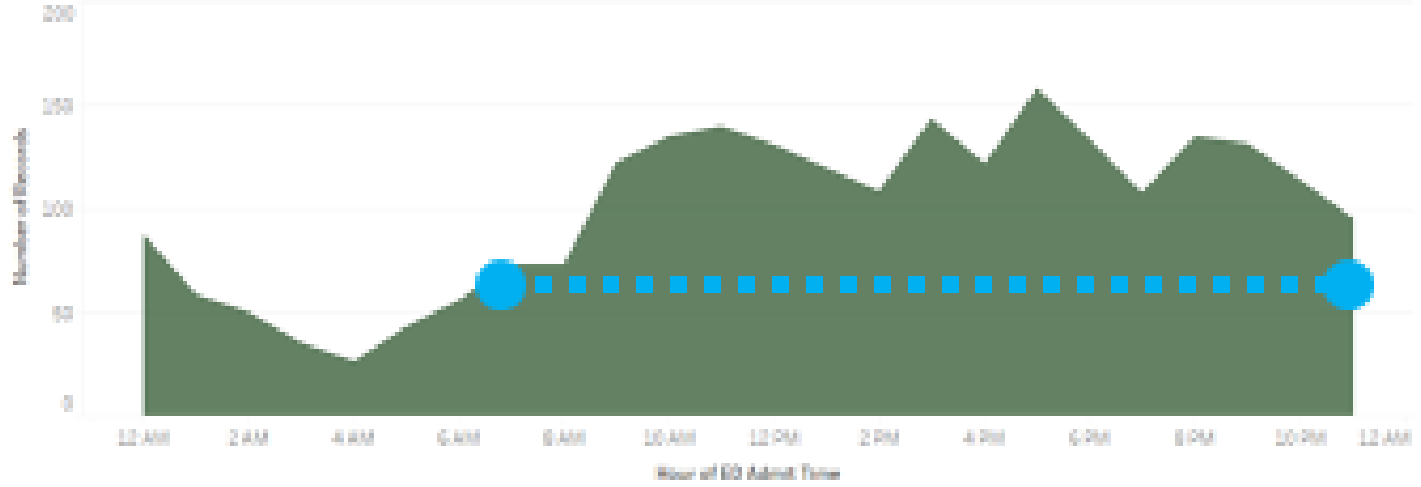
Endpoint: cardiac death, MI, hospitalization for unstable angina, late symptom-driven revascularization, & readmission for chest pain

Economic Value of Cardiac CT in ED

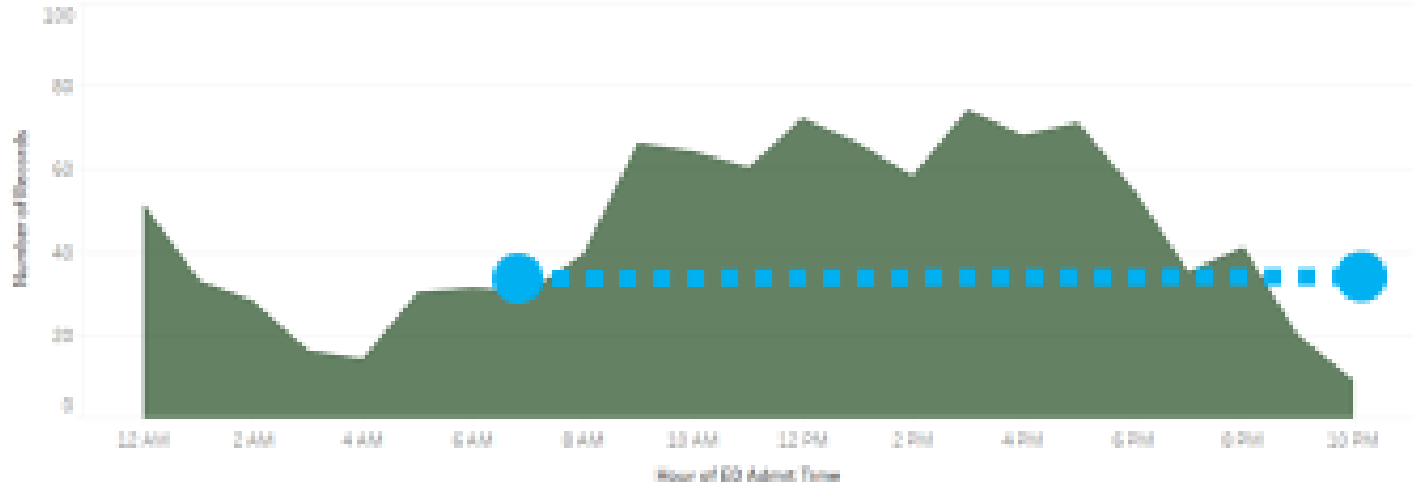
	CT-STAT	ROMICAT2	ACRIN-PA	BEACON	CT-compare
	699	985	1370	500	562
Comparator	SPECT MPI	Usual care	Usual care	Usual care (hs-TnT)	XECG
ACS rate	1.8%	2.5%	1%	8%	4.2%
Cath rate	≈	≈	≈	≈	↑2x
Revascularization	≈	≈	≈	≈	≈
Hospital admission		↓40%	↓35%	≈	
Length of stay		↓25%	↓27%	≈	↓34%
Downstream testing				↓62%	
Costs	↓38% (ED)	≈ (hospital)		↓34%	↓19%
Adverse events	≈	≈	≈	≈	≈

Time distribution of SNGH chest pain presentations
IHS service 0700-2300 serves >90%, minimizing costs

Missing ED Times replaced by "Admit Time"



ED Times Only



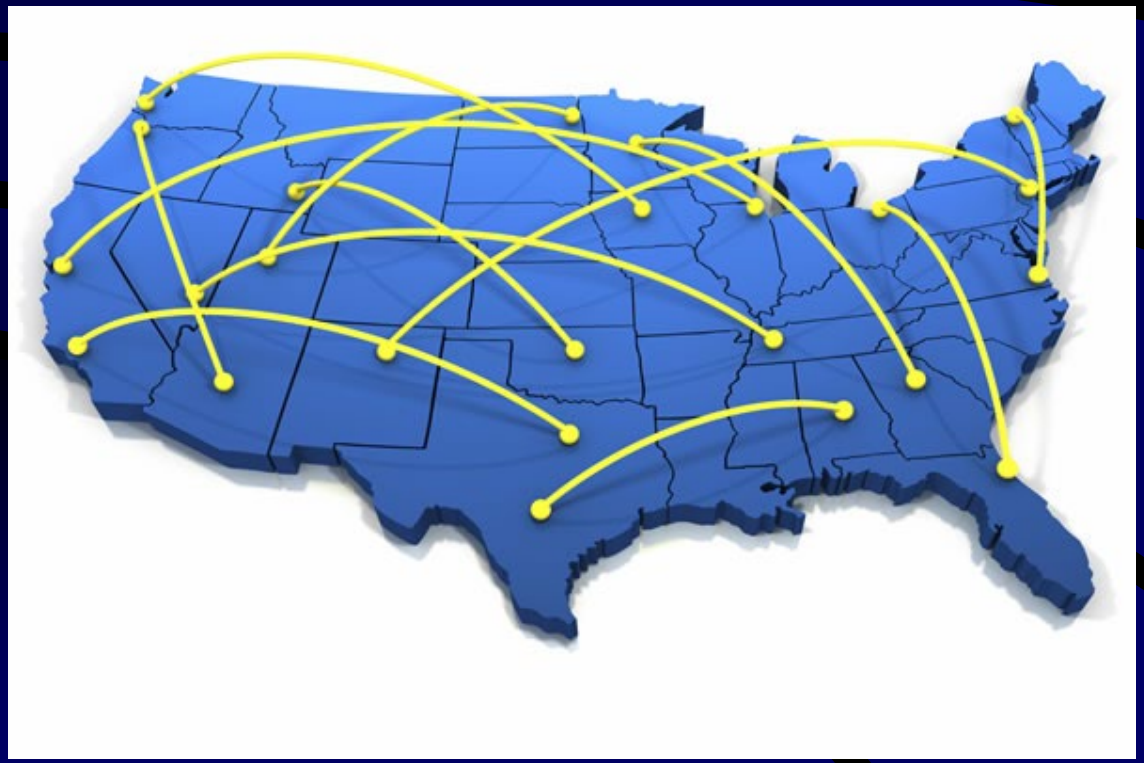
NIH
PROMISE trial Economic Substudy:
Estimation of Initial Chest Pain Testing Costs

Dx Test	*Mean Cost**	*MD Fees***	*Total*
Coronary CTA	*$285*	*$119*	*$404*
Echo w/ exercise stress	*$428*	*$86*	*$ 514*
Echo w/ pharmacologic stress	*$415*	*$86*	*$ 501*
ECG-only nonimaging stress	*$137*	*$37*	*$174*
Nuclear w/ exercise stress	*$829*	*$117*	*$ 946*
Nuclear w/ pharmacologic stress	*$1015*	*$117*	*$ 1132*

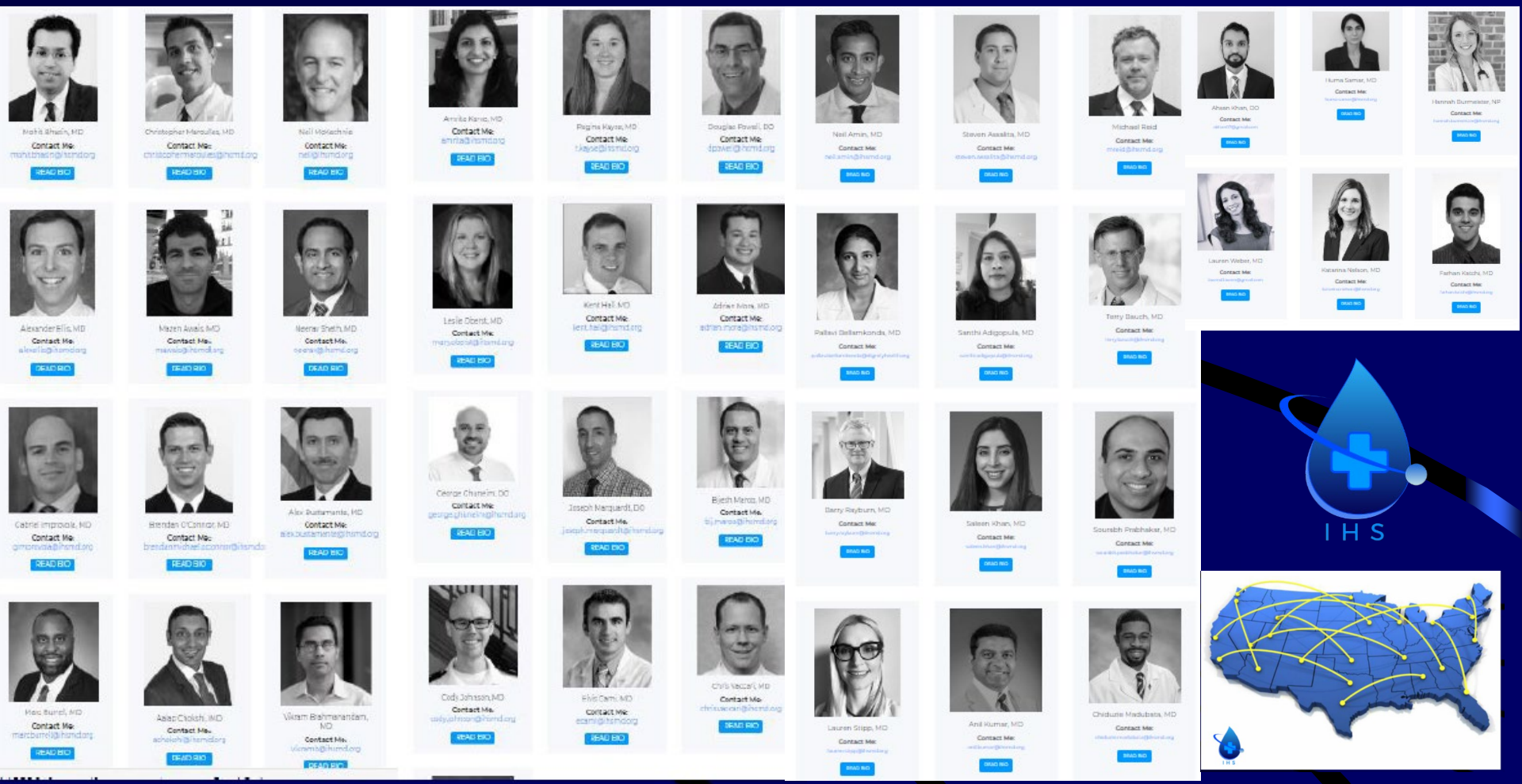
**based on costs in Premier database*
***based on Medicare Fee Schedule*

How to Provide cardiac CT 24/7 with few local imagers?

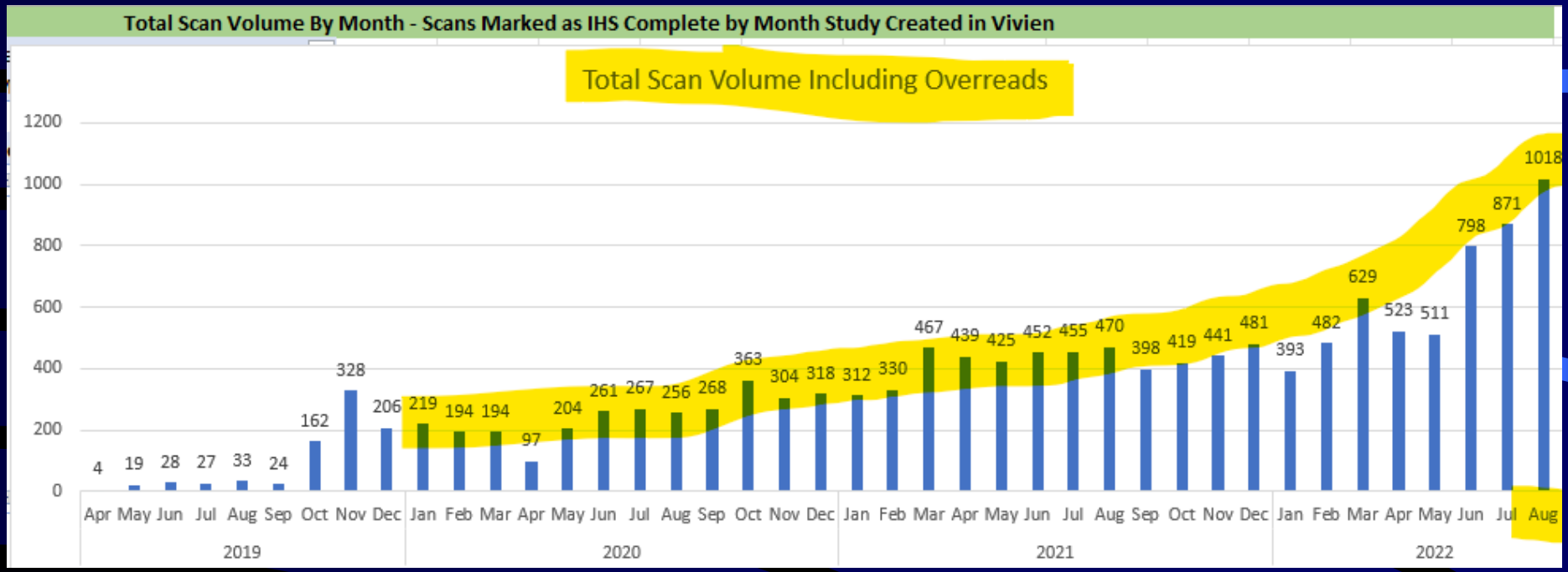
Unlock efficiencies by interstate telecardiology



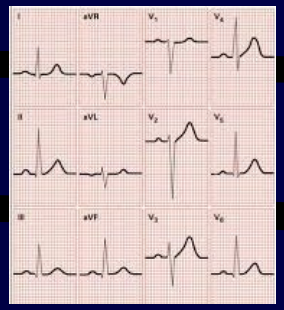
IHS National Physician Digital Practice



IHS metrics:
Growth (300%), Speed 35 min to ED, High Accuracy



How we implemented…



Cardiologists, Cardiac Radiologists, and Systems Engineers **across North America** collaborated to design a complex national system of care for the vulnerable

Patient (Hospital) Experience

ED Doctors & PA Experience

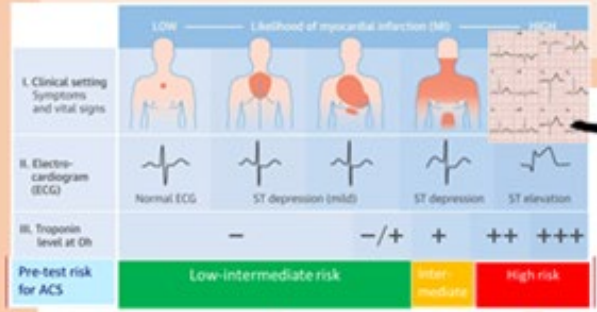
ED Nurses

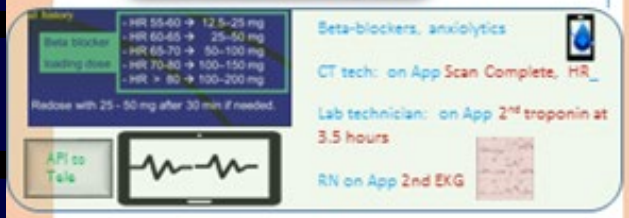
CT Technologists & lab technician

Imager Experience

IHS Orchestrators Experience

Blueprint for rapid coordination, delightful user experiences, cost innovation, evolvable, modular & maintainable. Today's design choices have irreversible evolutionary consequences in the short term, medium and long term journey. Data analytics builds a moat of optimized service.





Beta-blockers, anxiolytics

CT tech: on App Scan Complete, HR_

Lab technician: on App 2nd troponin at 3.5 hours

RN on App 2nd EKG

Likelihood for AAS or PE is low

Likelihood for AAS or PE is not low

CT Multiple rule out

History of DVT, PE, or cancer
Immobility
Age>65 & tachycardia
Abrupt ripping/stabbing/tearing pain
BP difference between arms
New murmur of aortic regurgitation
History of Aortic valve disease, aneurysms, or Marfan's

Two Color reports printed for PCPs with clear recommendation, MD picture & bio

Patient-level reports with hyperlinks to multimedia and color images (emailed)

DICOM HL7 part 20 CDA / MRRT-> can auto-generates worklist items

API to EPIC: FHIR, Redox, Mulesoft

Mobile App

Web Interface

ED triage secure texts EKG for QA:
Imager responds "OK to Scan", "Scan reported"

CT Visualization Vessel-walk Cardiac CT (with low latency) to structured reporst (DICOM->HL7): Terrarecon links for remote desktop, backed up by Terra cloud and Nuance DICOM transfers

CMR Visualization Heart IT cloud server hyperlink backed up by Terra cloud and Nuance DICOM transfers

Hyperlinks to EMRs /PACS for old studies & labs office 365

EKGs for QA (on App and Web interface)

Swipe to display instant availability
0700-1700 Available to read locally
0700-1700 Available to read for network
0700-1700 Not Available for diagnostic backup
0700-1700 Not Available for surge scans

Diagnostic Backup request /respond (AAS, ACHD, LVAD, EP):

Call to EDs direct from App & Web interface
-embedded voice dialing (masked phone numbers)
Shared worklog excel ; teaching scans Onedrive
Shift scheduling Outlook calendar office 365
Two-factor authentication Duo, multiple
Secure-text HIPPA compliant QliqSoft, Ring Central, OhMD, Twillo
Telemedicine license & credentialing management

Receipt of global upload and electronic payments Web-based uploader Port 443 encrypted

Tag teaching cases for anonymization and transfer for machine-learning curated dataset licensing to AI algorithm developers

Transfer to CT-FFR for intermediate lesions

Second look using AI-assisted algorithm for AAS, PE & lung over-read (Envoy, Nuance)

Dashboards / Analytics

Milestone Clocks
Door to EKG
Pathway orderset to HR<70, to CT scan, to 2nd trop/EKG
TAT Turn-around-time for reports
Door to Discharge

Number of Available imagers 0700-1700: 12-35

Daytime minutes covered 0700-1700

Minutes of imager Availability without a scan (logged by app swipes)

On Call coverage 1700-2300 Time zone dispersion (West coast & Hawaii imagers for EST hospitals

Progress Bars per imager for Diagnostic backup (mentor points) and surge reads

Surges outstripping capacity –> surge payments to doctors

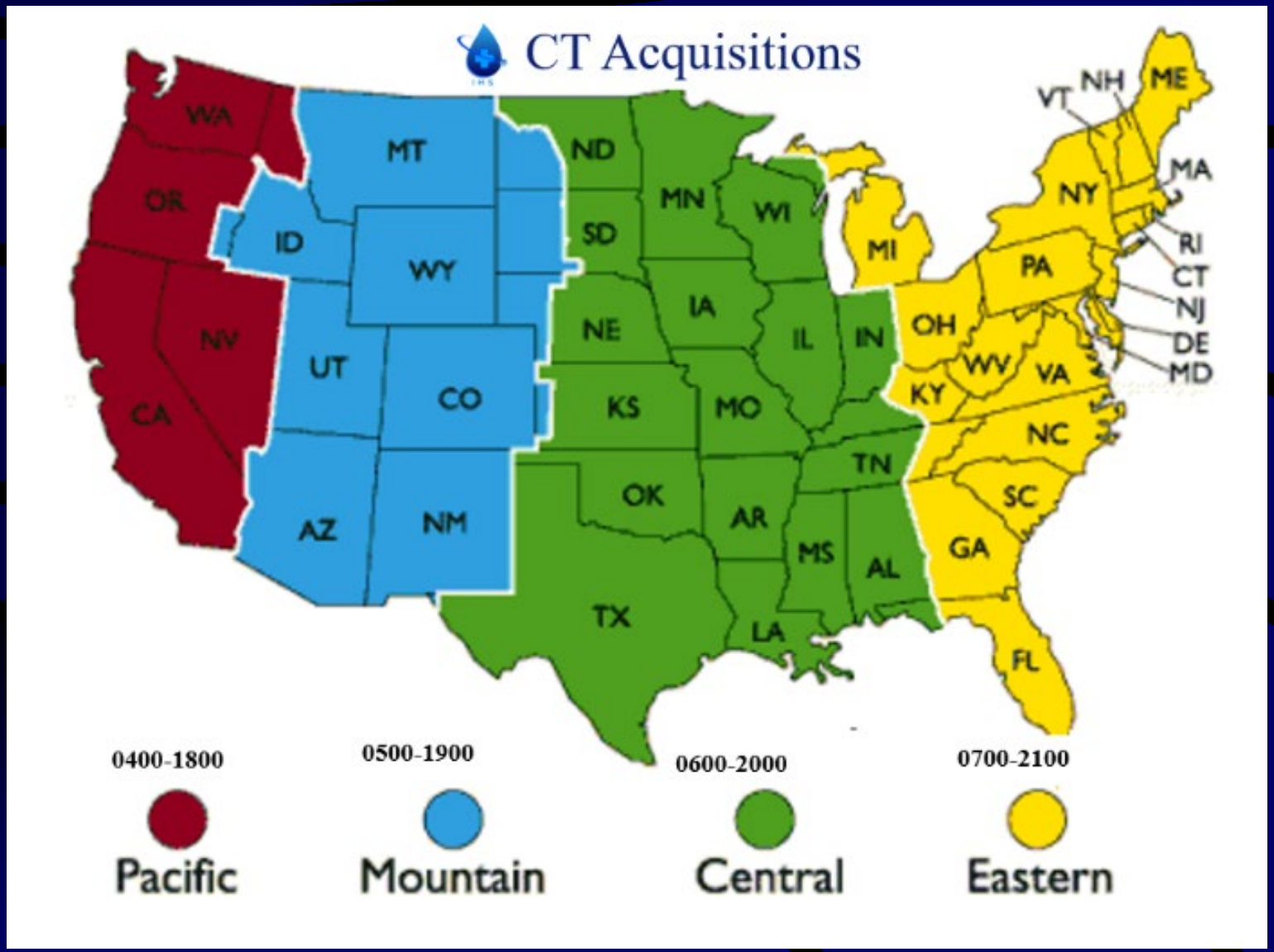
IHS Push/ text notifications
1700-2200 On Call primary for network
1700-2300 On Call backup for network
1700-2300 Diagnostic Backup requested
1700-2200 Surge reading needed

- Number of CT heart acquisitions/ Number of scan sites
- Scan complexity
  - CT heart vs CT triple-rule out
  - EP vs TAVR/AHF/ACHD/Aortic
- Evening scans per time zone
- Scan quality (improves speed of interpretation and cognitive load – based on HR and scanner model)
- Minutes from scan to report
- Minutes with no imager available Number of Uploads for elective reads

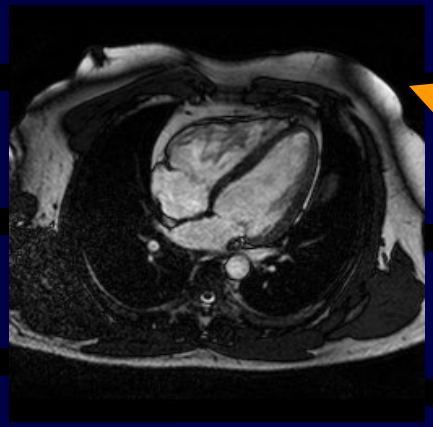
How we implemented

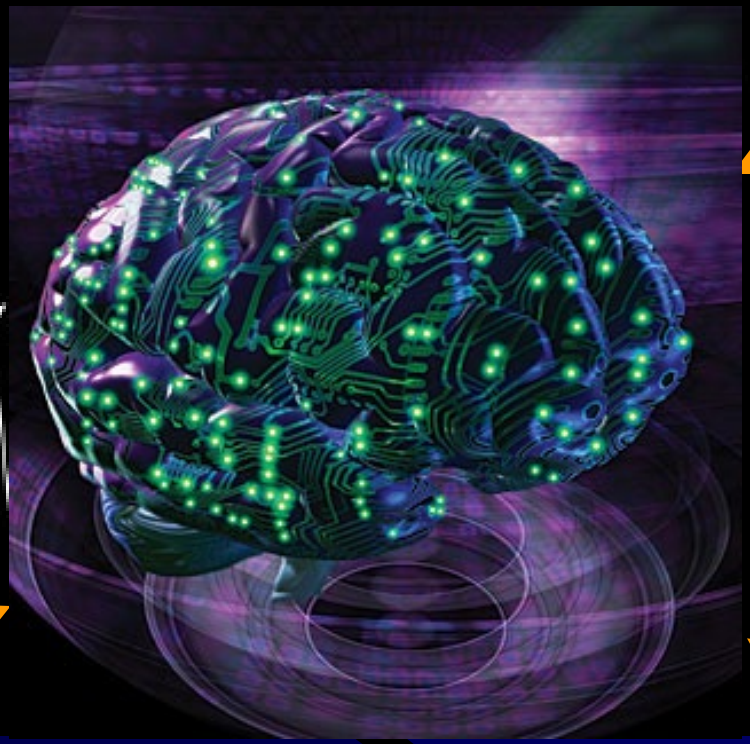
- recruit cardiologists and radiologists from both coasts, allowing for time-zone based balancing of workloads, founded with a physician-based culture of service, care for the vulnerable, and co-ownership
- collaboration between radiologists and cardiologists by instant videoconferences for life-threatening cases, and weekly scheduled case videoconferences
- transfer CT and MRI datasets to cloud servers with GPUs enabled for 3D visualization software for instant collaborative review
- custom smartphone applications to ping available doctors with specific expertise, like acute aortic syndromes and adult congenital heart disease
- browser-based to increase portability and flexibility of the work to maximize providers
- real-time database coordinates end-to-end workflow including triage by life-threatening priority, contacts, worktype, technologist feedback, imager scheduling, report generation, and electronic filing of final results

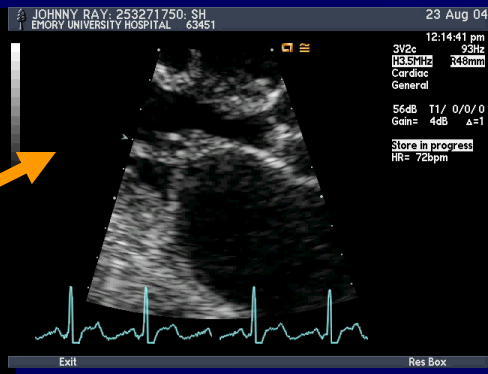
Mon-Fri 0700-2300, sat/sun 0800-1700

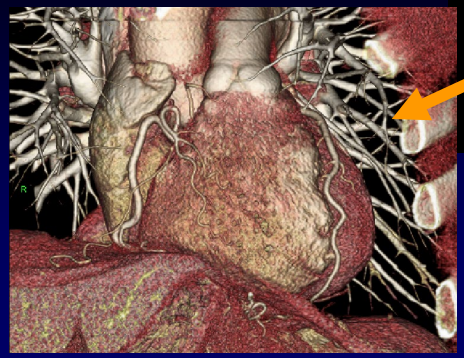


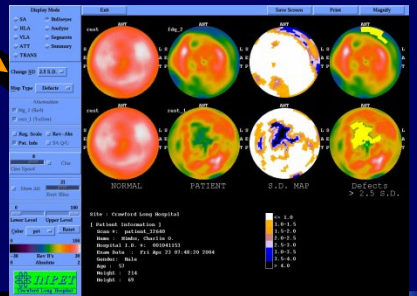
Artificial Intelligence as “second pair of eyes” scanning for errors, increasing efficiencies, and capturing physicians group knowledge







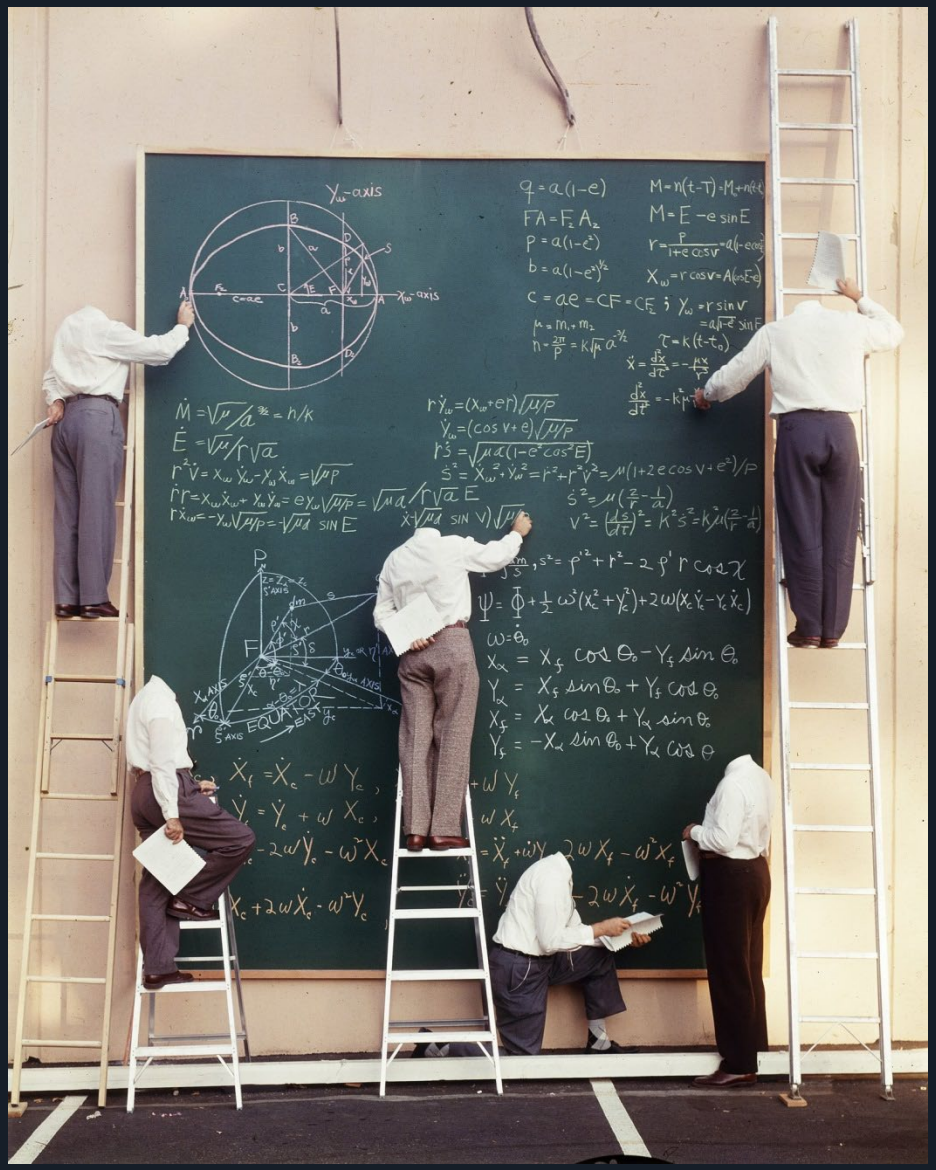




Can A.I. Be Taught to Explain Itself?

Explainable AI = "XAI"

- As machine learning becomes more powerful, researchers find themselves unable to account for what their algorithms know — or how they know it.
- For wide adoption in medicine, XAI finds approaches to explain why a decision was made – rather than a black box.
- "Show your work!"



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VASCULAR THERAPIES

2023

Advances in CT cardiac Imaging:

Innovation in Care

Innovation Health Services

ihsmd.org

Mohit Bhasin MD, FACC, FSCCT

President, Innovation Health Service

Medical Director, Cardiac Imaging Sentara Heart

The End