
# Move Over Lexiscan!

## Updates on Cardiovascular Testing in the EDOU

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# Disclosures

None

# Objectives

- Review coronary computed tomography angiography (CCTA) in context for the evaluation of coronary artery disease (CAD)
- Support for CCTA + FFR in evaluation of chest pain, and influence on decision to proceed to invasive cardiac angiogram (ICA)
- Discuss patient characteristics that influence choice of testing modality
- Evaluate EDOU-specific considerations and implementation strategies

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# Sample Case

58 yo male w hx of tobacco use, HTN, and T2DM

Patient presents with substernal chest pain radiating towards his left shoulder that has been going on for 3 days. Symptoms come and go and are associated with feeling nauseous. Currently pain free.

Vital signs: HR 71 bpm, BP 153/79, O2 97%

ECG demonstrates NSR with nonspecific ST-changes in the lateral leads.

High sensitivity troponin is 12 ng/L

Remainder of workup is reassuring.

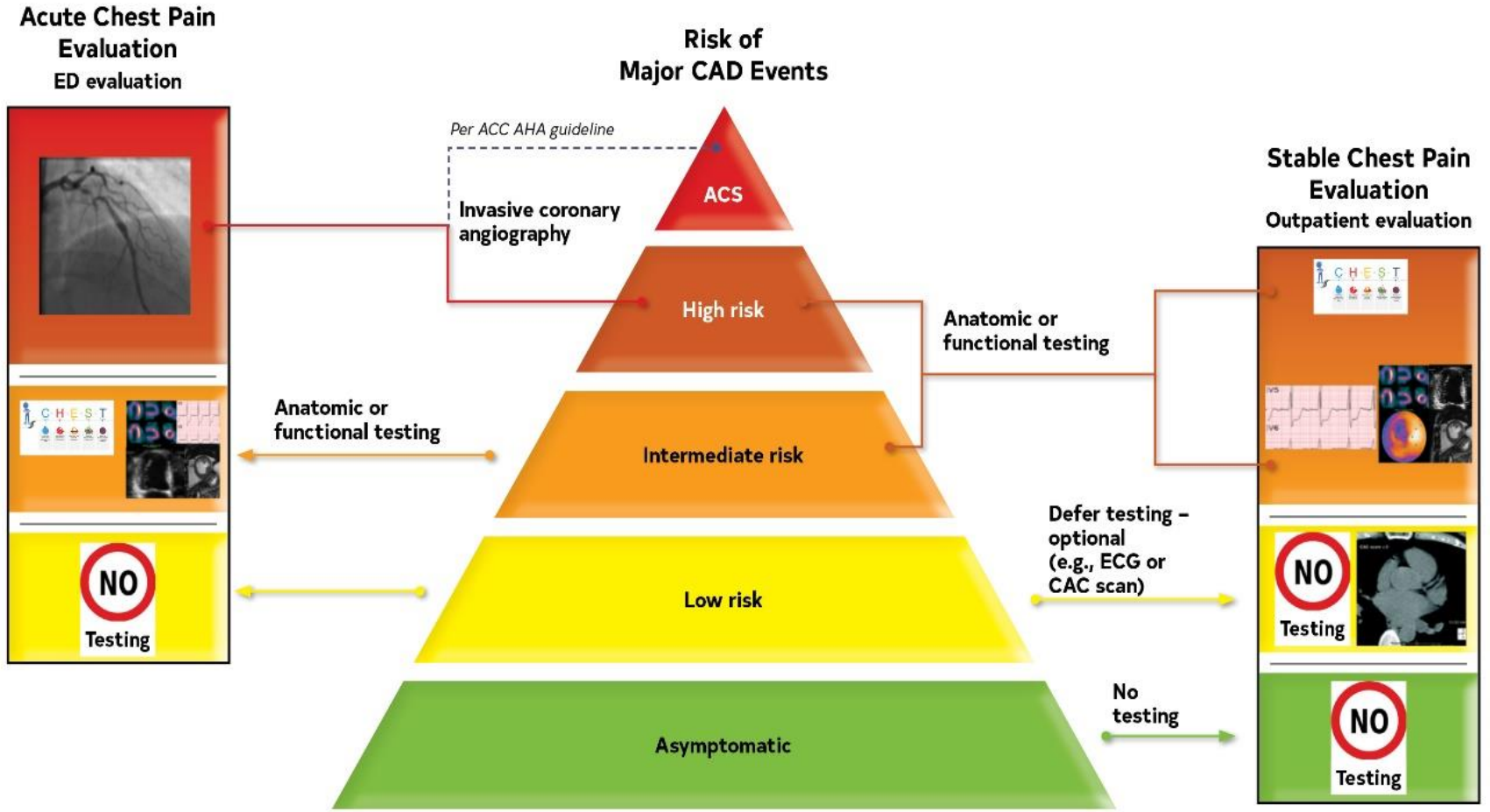
Patient has no history of prior stress testing and is still concerned that his symptoms could be due to heart disease.

So what comes next?

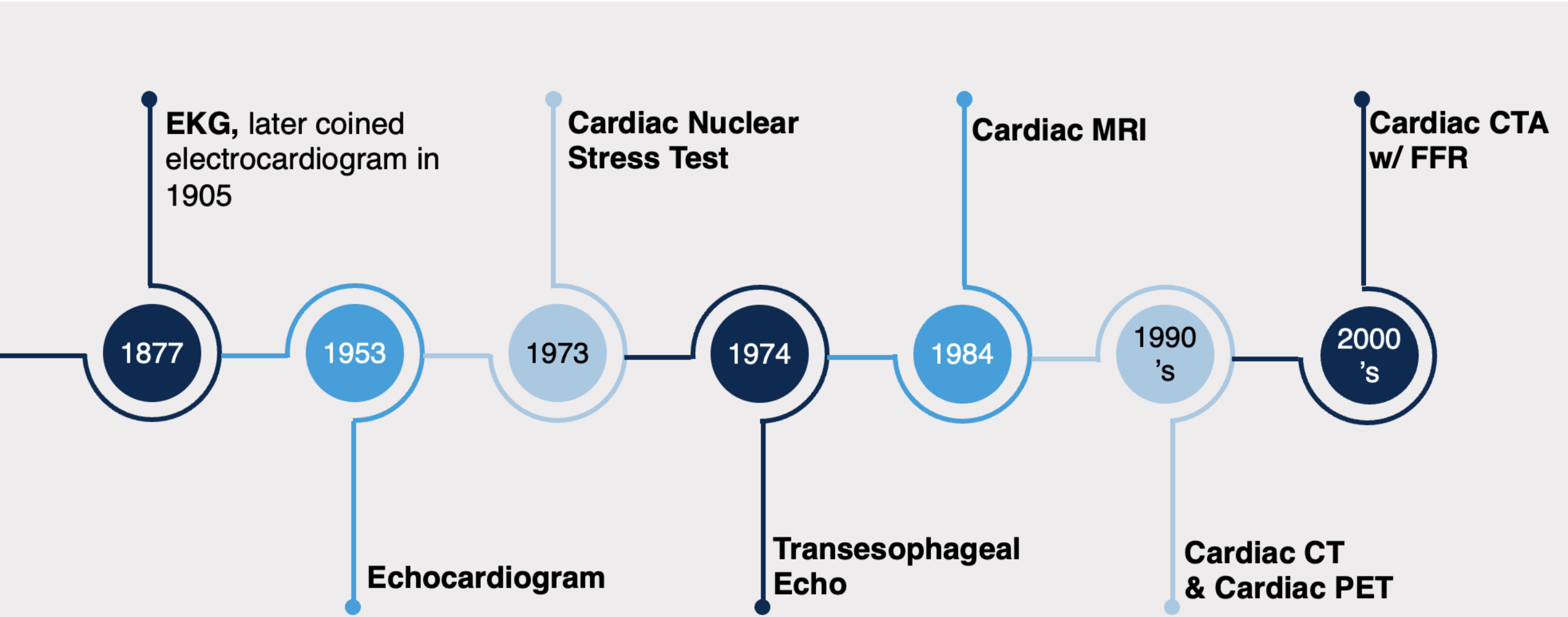
# Evaluation and Diagnosis of Chest Pain

2021 AHA/ACC/ASE/
CHEST/SAEM Guidelines

Chest pain and Cardiac Testing Considerations



# HISTORY OF CV IMAGING

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# The Problem

- Traditional testing pathways sensitivity/specificity
  - Exercise treadmill ECG: 76%, 60%
  - Stress echo: 85%, 77%
  - Stress myocardial perfusion imaging: 83%, 64%
- Focus on ischemia “surrogates”, not disease
- False positives -> unnecessary ICA
  - 33-44% do not have significant CAD
- False negatives
  - More often miss severe disease patterns (triple vessel or left main disease) due to “balanced ischemia”

# The Problem

When caring for a patient with suspected CAD, there are 4 questions that must be considered:

1. Does the patient have atherosclerosis?
2. Is there significant functional impairment in coronary flow?
3. What are the appropriate treatment strategies?
4. What is the prognosis?

Traditional stress testing only really gives us a prognosis

# The Solution?

Coronary computed tomography angiography + $FFR_{CT}$

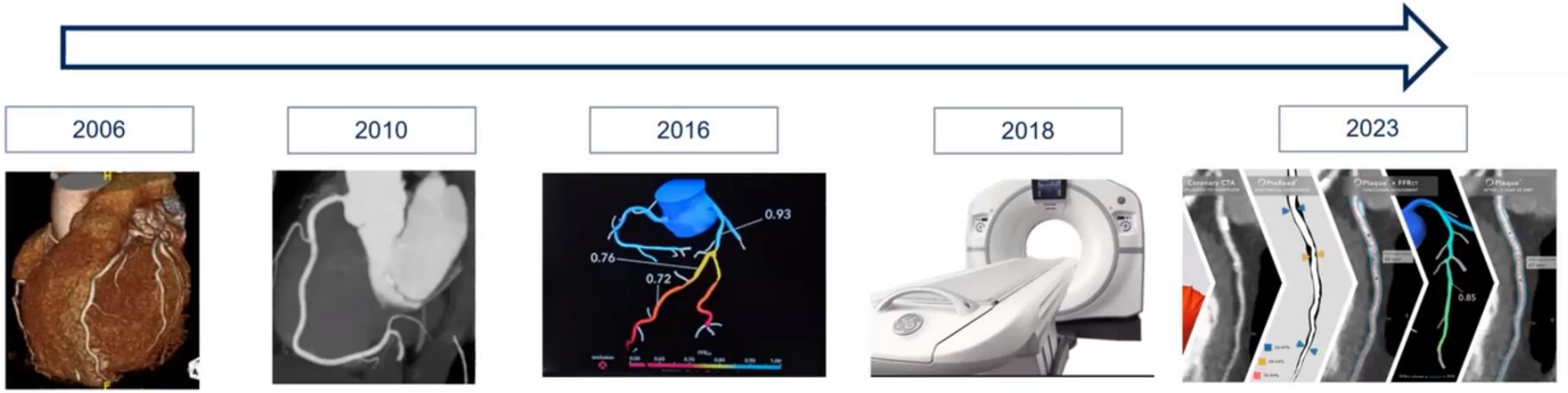
Sensitivity: 94%  Specificity: 76%

NPV: 95%-98%  PPV: 92% - 97%

Answers questions regarding disease, physiology, treatment, and prognosis

Opportunity to refocus attention on slowing disease progression and reducing transitions to acute ischemia

# Evolution of Coronary CTA for the Evaluation of CV disease




**CORONARY ANATOMY**

Accurate Coronary Artery Assessment

Improvement in Resolution

Focus on Radiation

Early Clinical Research / Trials

**CORONARY PHYSIOLOGY**

Cardiac CT - Modest Specificity

Invasive FFR Gold Standard

Goal: Reduce Unnecessary Cath

Evolution of FFR-CT and Trial Data

**CORONARY PLAQUE**

ACC/AHA 2021 Chest Pain Guidelines

AUC and Paradigm Shift

Technology to Assess Plaque

CT Guided Preventive Care

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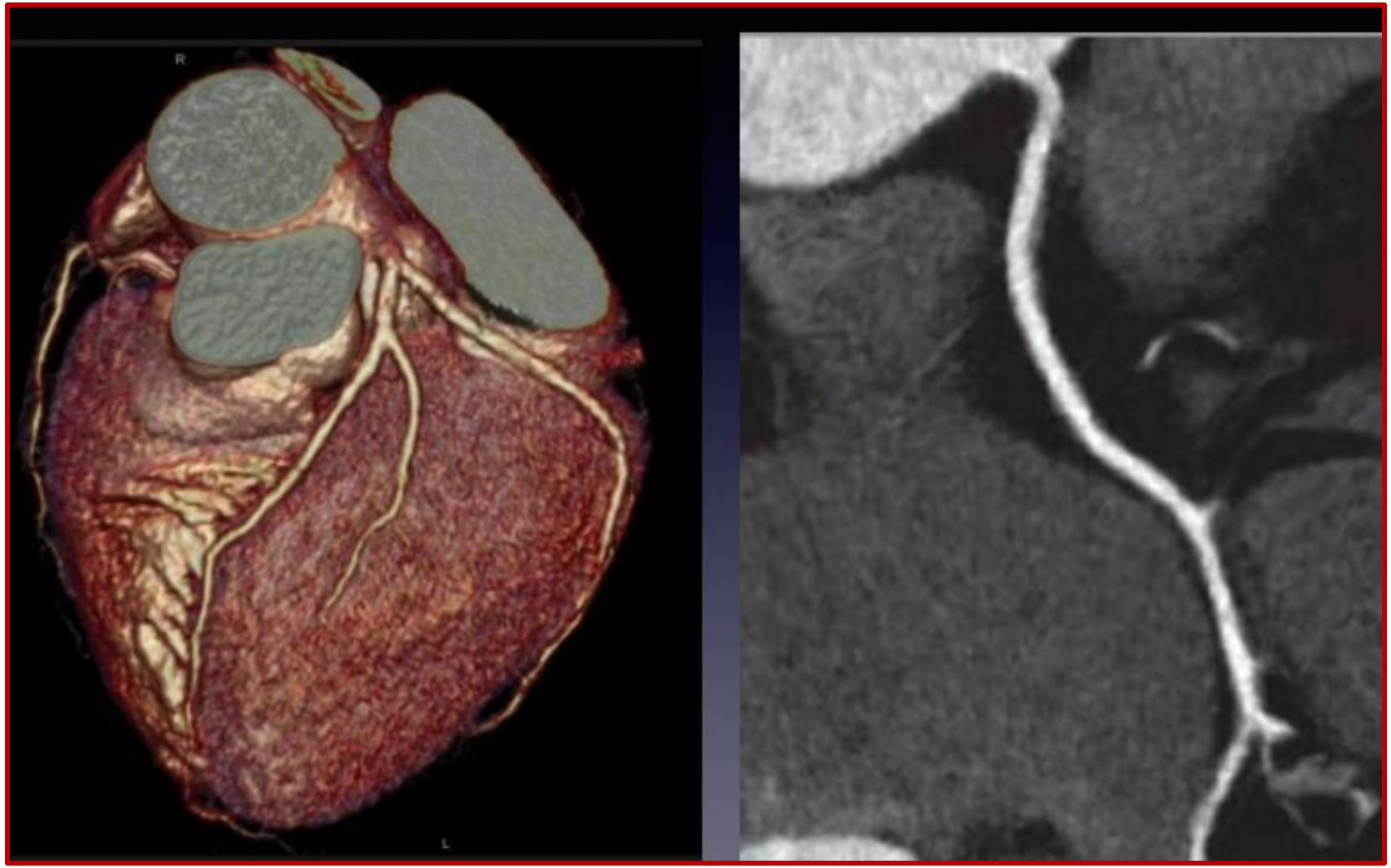
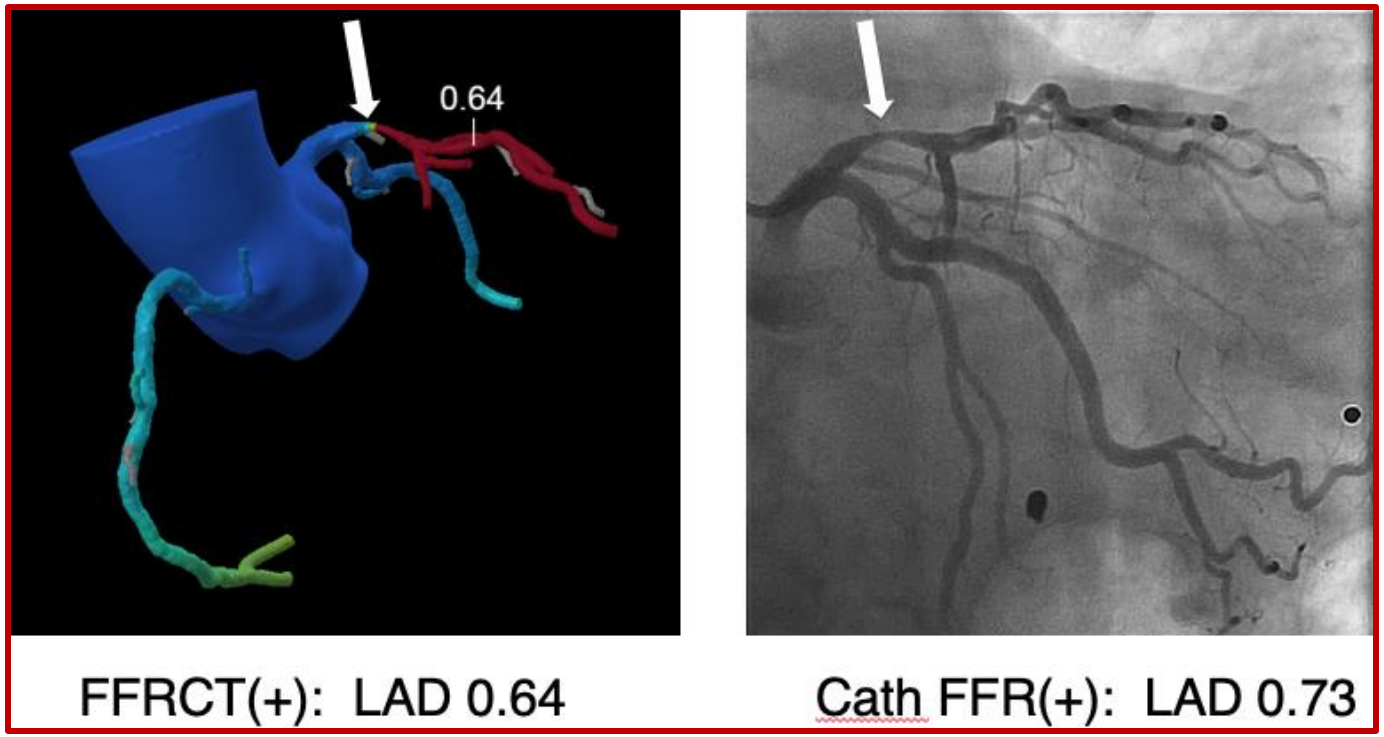
# What is Coronary CTA?



# What is $FFR_{CT}$ ?




$FFR_{CT}$: Computational fluid dynamics (CFD) modeling of coronary blood flow

- Noninvasive assessment of physiologic significance of CCTA plaques
- Utilizes routine but protocol-based CCTA images
- Does not require use of additional medications (no adenosine)
- Performed as a separate and incremental analysis after review of standard CCTA images

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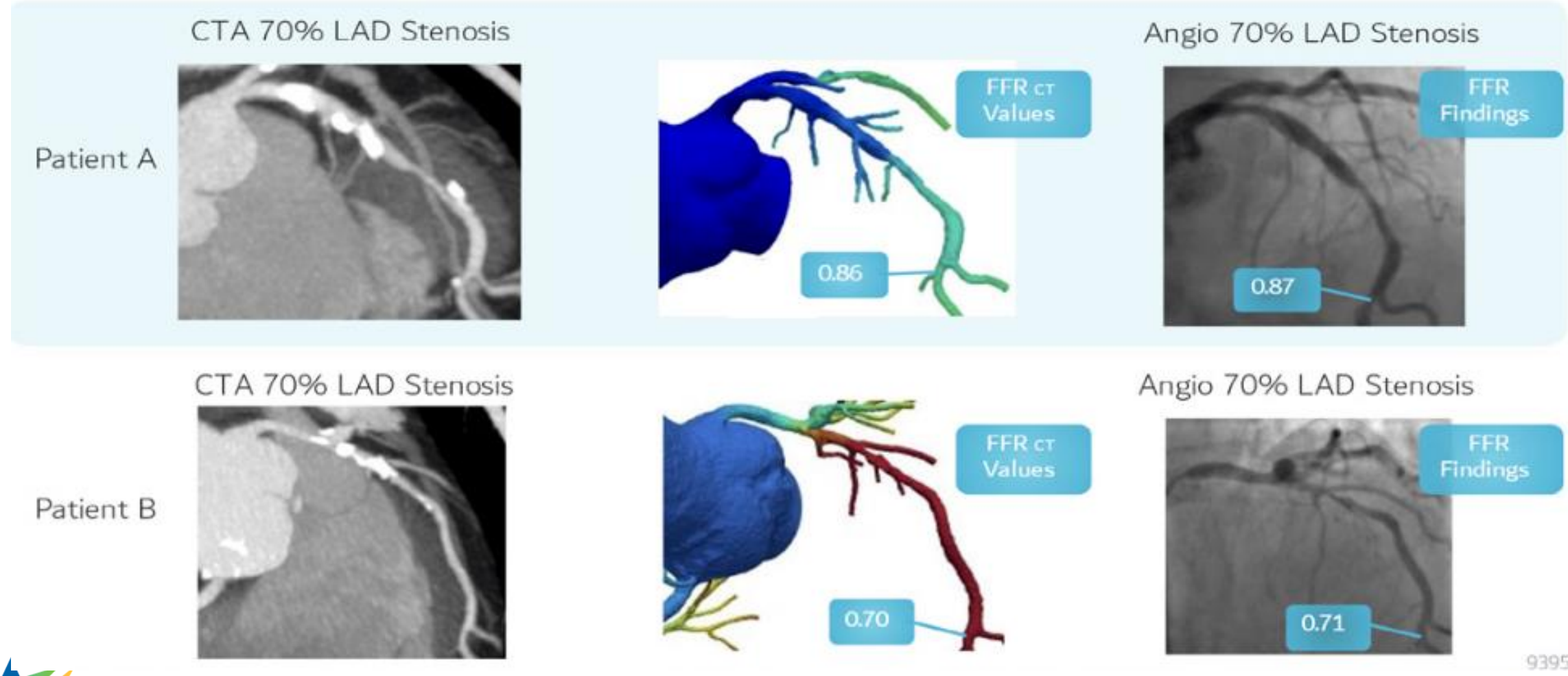
# What is $FFR_{CT}$ ?



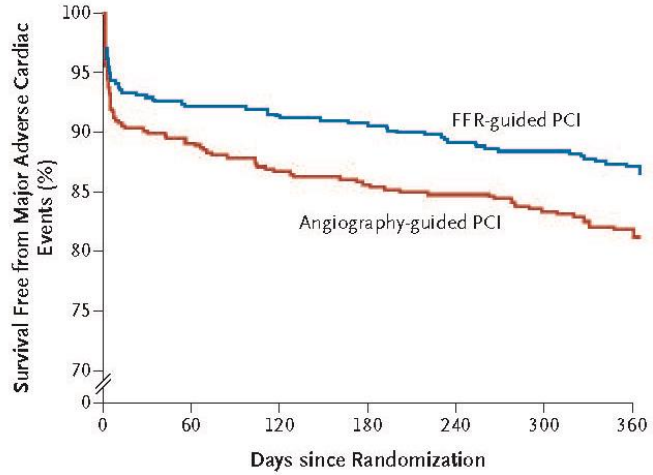
# FFR is the Gold Standard to Identify Vessel-Specific Ischemia

## Robust Clinical Evidence

### FAME

The NEW ENGLAND JOURNAL of MEDICINE

Fractional Flow Reserve versus Angiography for Guiding Percutaneous Coronary Intervention




Conclusion:

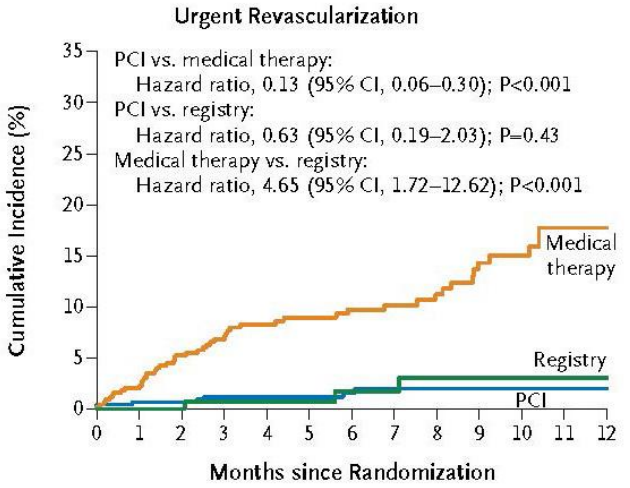
Defer PCI for lesions with FFR > 0.80

Tonino et al., NEJM 2009, 360:213

### FAME II

The NEW ENGLAND JOURNAL of MEDICINE

Fractional Flow Reserve–Guided PCI versus Medical Therapy in Stable Coronary Disease



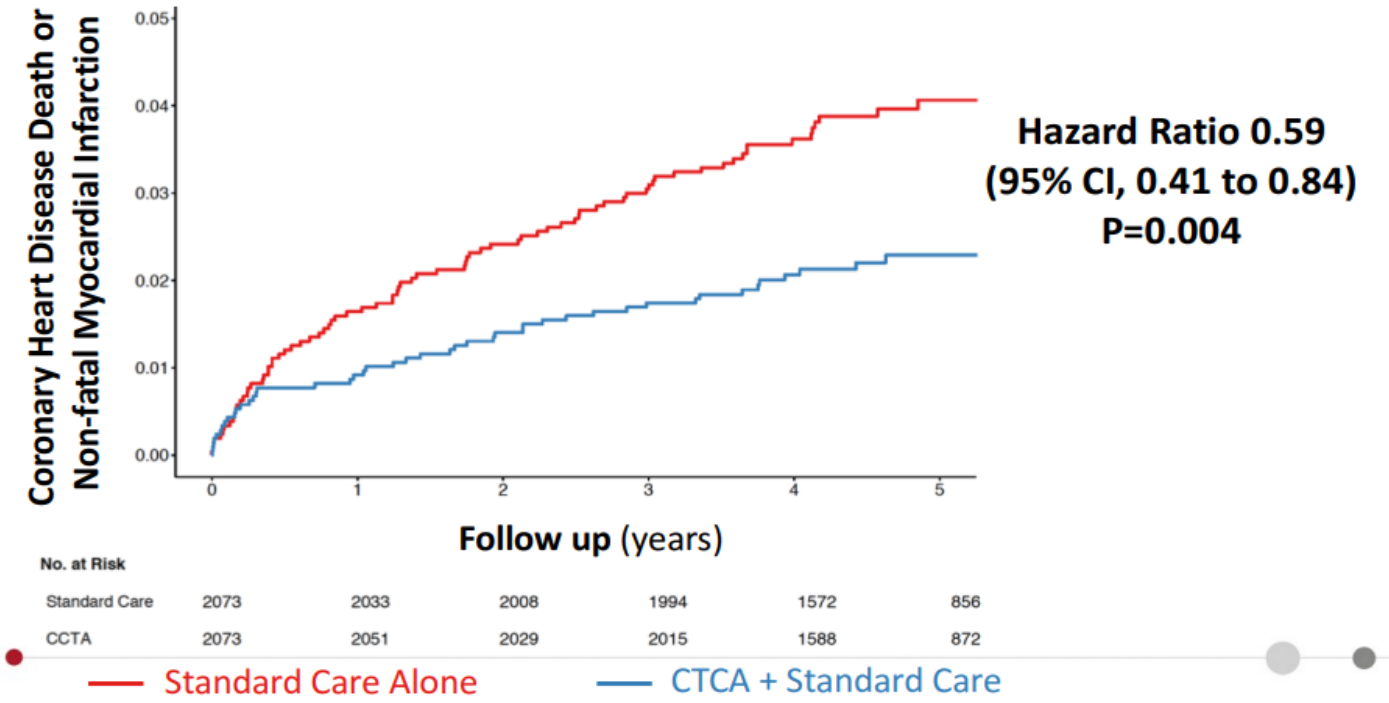

Conclusion:

Perform PCI for lesions with FFR ≤ 0.80

De Bruyne et al., NEJM 2012, 367:991

# SCOT-HEART Trial

## Primary Clinical End Point

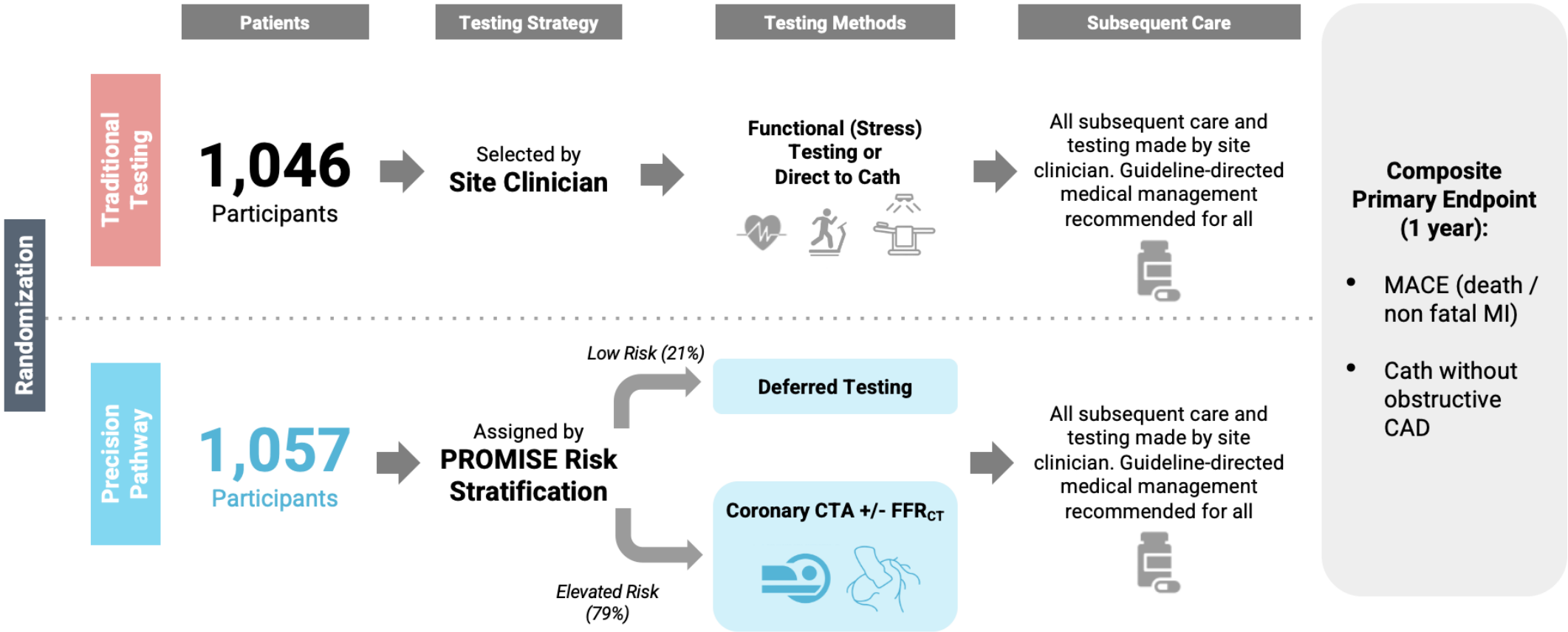



**Hazard Ratio 0.59**
**(95% CI, 0.41 to 0.84)**
**P=0.004**

ESC Congress
Munich 2018

# PRECISE Trial

Global prospective, randomized control trial comparing diagnostic and treatment pathways for stable chest pain




PRECISE trial - Presented at AHA 2022

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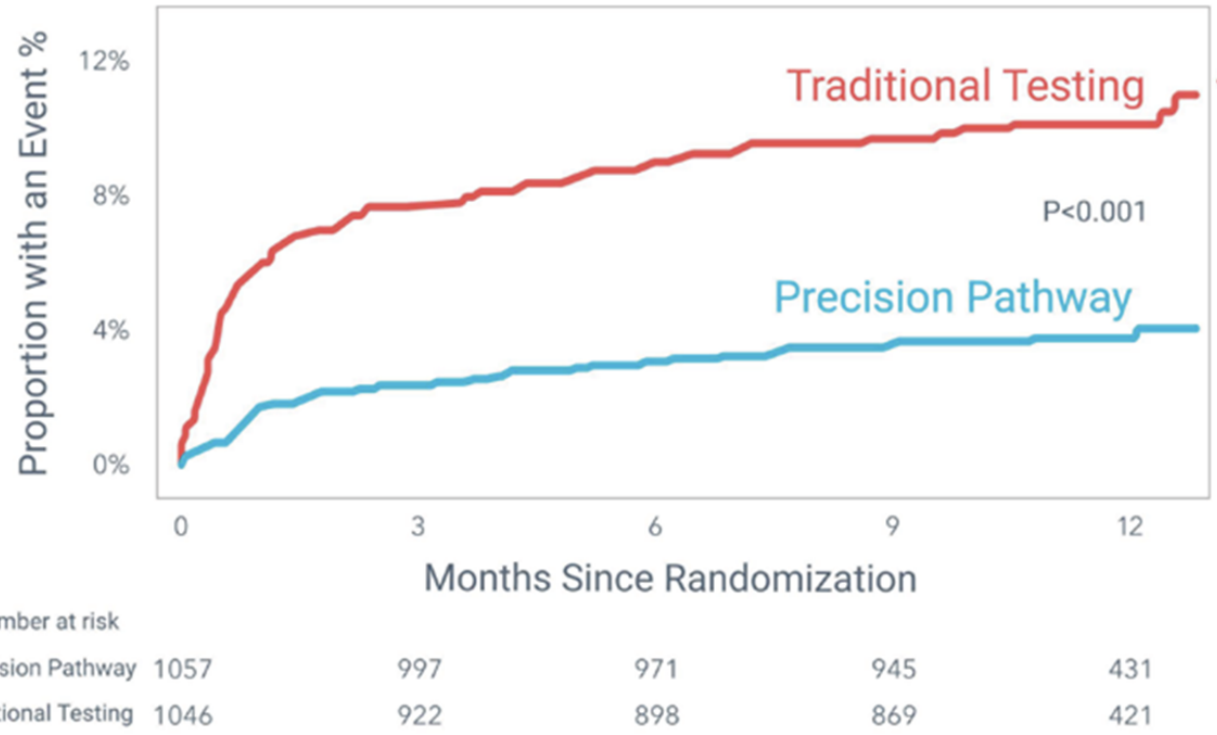
# PRECISE Trial

Superior to traditional testing at 1 year

Precision pathway recommended by AHA/ACC




**70%**

Reduction in the primary endpoint

PRECISE trial - Presented at AHA 2022

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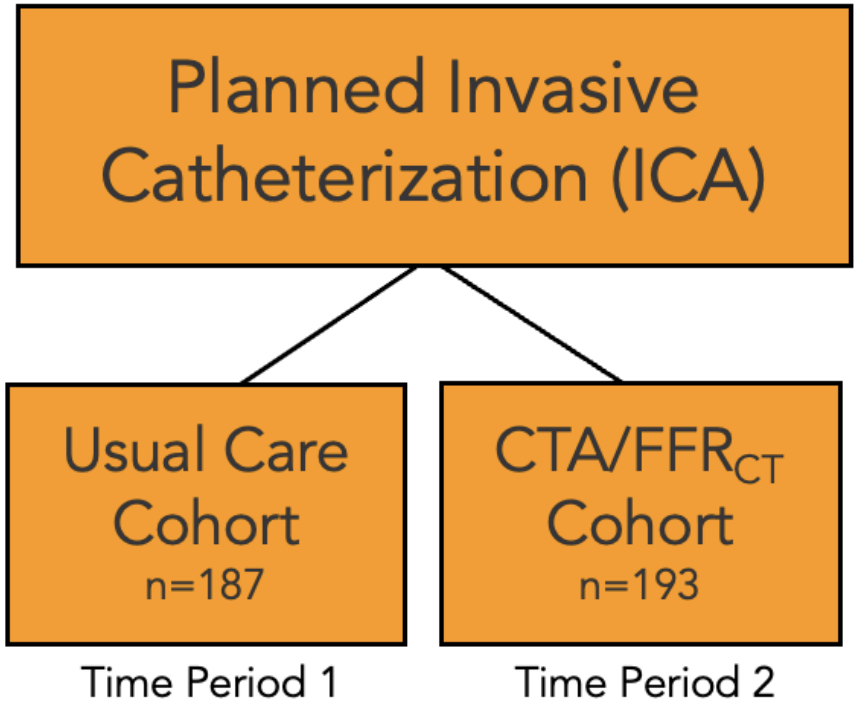
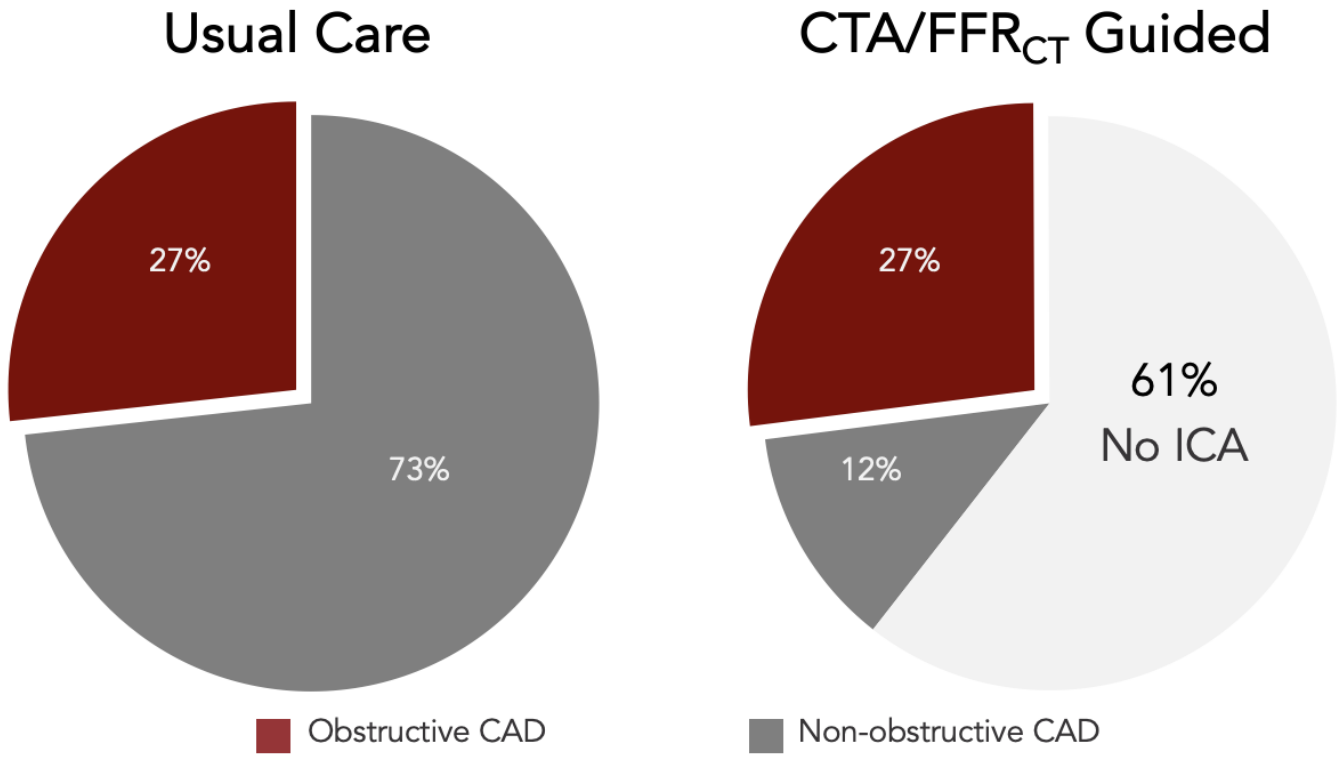
# PLATFORM Trial

- Prospective, controlled, pragmatic comparative effectiveness trial utilizing a comparative cohort design
- Compared the effectiveness of two clinical strategies
- 584 patients with suspected CAD (pre-test likelihood of 20-80%)
- 11 centers; 6 EU countries
- Are patients evaluated using a CCTA + FFR guided strategy less likely to undergo ICA showing no obstructive CAD?



# PLATFORM Trial

Invasive Catheterization (ICA) with No Obstructive Disease




**83% reduction** of ICAs that found no obstructive CAD
**No adverse clinical events** in patients in whom ICA was cancelled.

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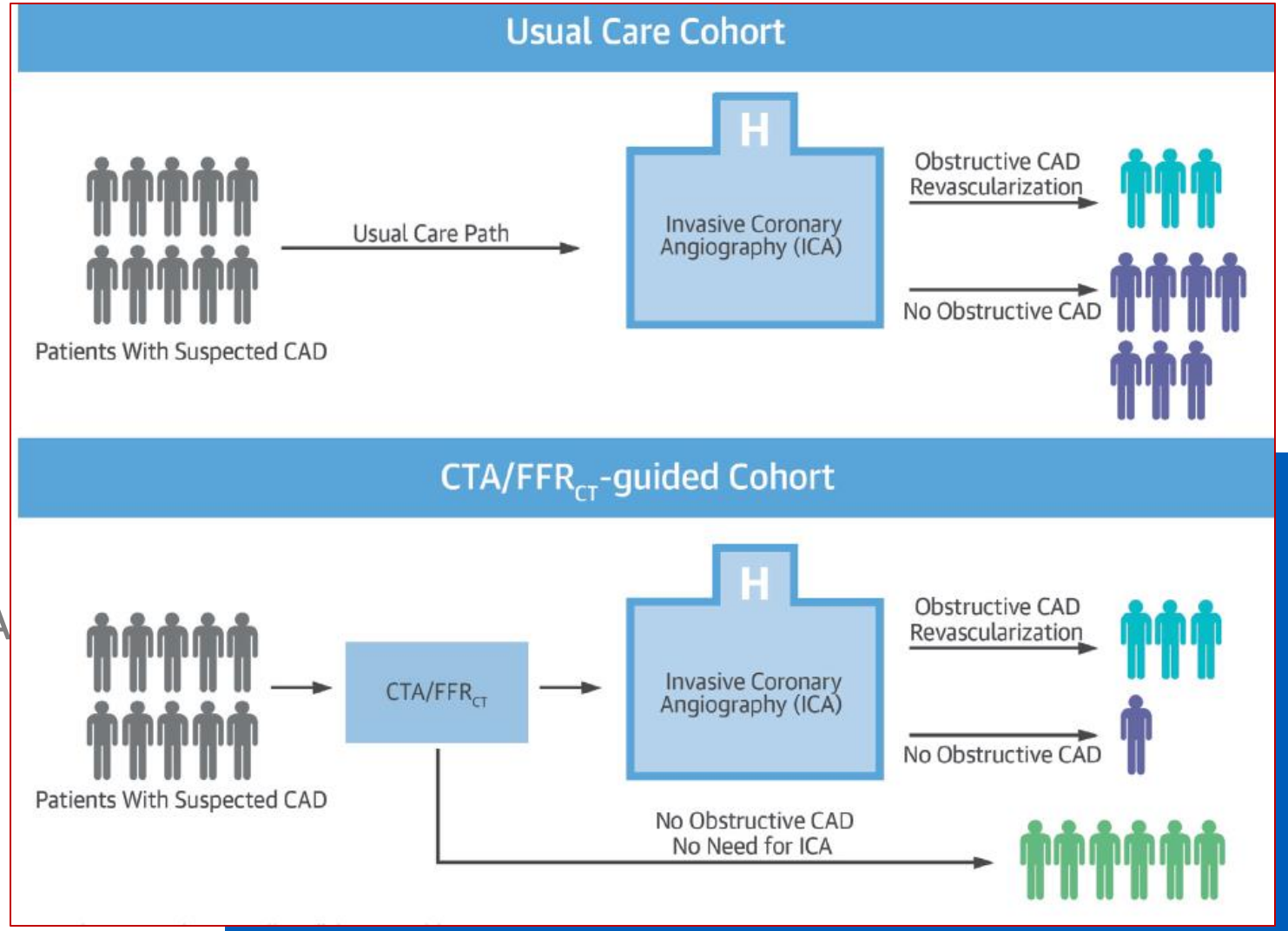
PLATFORM

# PLATFORM Trial

Cath 10 patients to find 3 with CAD

Cath 4 patients to find 3 with CA




Douglas et al. JACC 2016;68:435-45

# Contemporary Testing for Chest Pain in 2025

- CCTA FIRST
  - Class I recommendation by 2021 ACC/AHA/ASE/CHEST/SAEM/SCCT/SCMR Guideline
  - NPV: >95% for CAD in low/indeterminate risk patients

- Appropriate for patients with:
  - Negative functional tests but continued symptoms
  - Equivocal functional tests
  - Contraindications to traditional tests (unable to exercise, etc)
  - Low – moderate pretest probability

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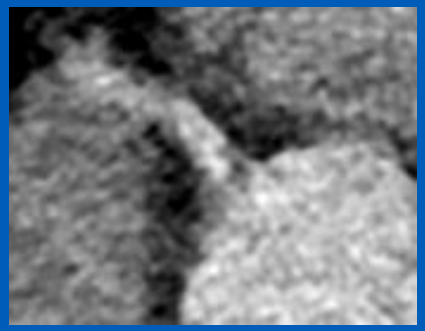
# Secondary Diagnostic Testing: What to Do If Index Test Results Are Positive or Inconclusive

| | | |
|---|---|---|
| **Sequential or Add-on Testing** | | |
| **2a** | **B-NR** | **7. For intermediate-high risk patients with stable chest pain and known coronary stenosis of 40% to 90% in a proximal or middle coronary segment on CCTA, FFR-CT can be useful for diagnosis of vessel-specific ischemia and to guide decision-making regarding the use of coronary revascularization.** |
| **2a** | **B-NR** | **8. For intermediate-high risk patients with stable chest pain after an inconclusive or abnormal exercise ECG or stress imaging study, CCTA is reasonable.** |

# Patient Selection

## Relative Contraindications

- Elevated BMI
- Renal insufficiency
- Age greater than 65 (75?)
- Persistent tachycardia
- Known elevated calcium score



Grainy images from poor penetration

## Significant Contraindications

- **Prior revascularization**
- Active A-fib/flutter
- BMI >55
- Unable to tolerate beta blocker or nitroglycerin

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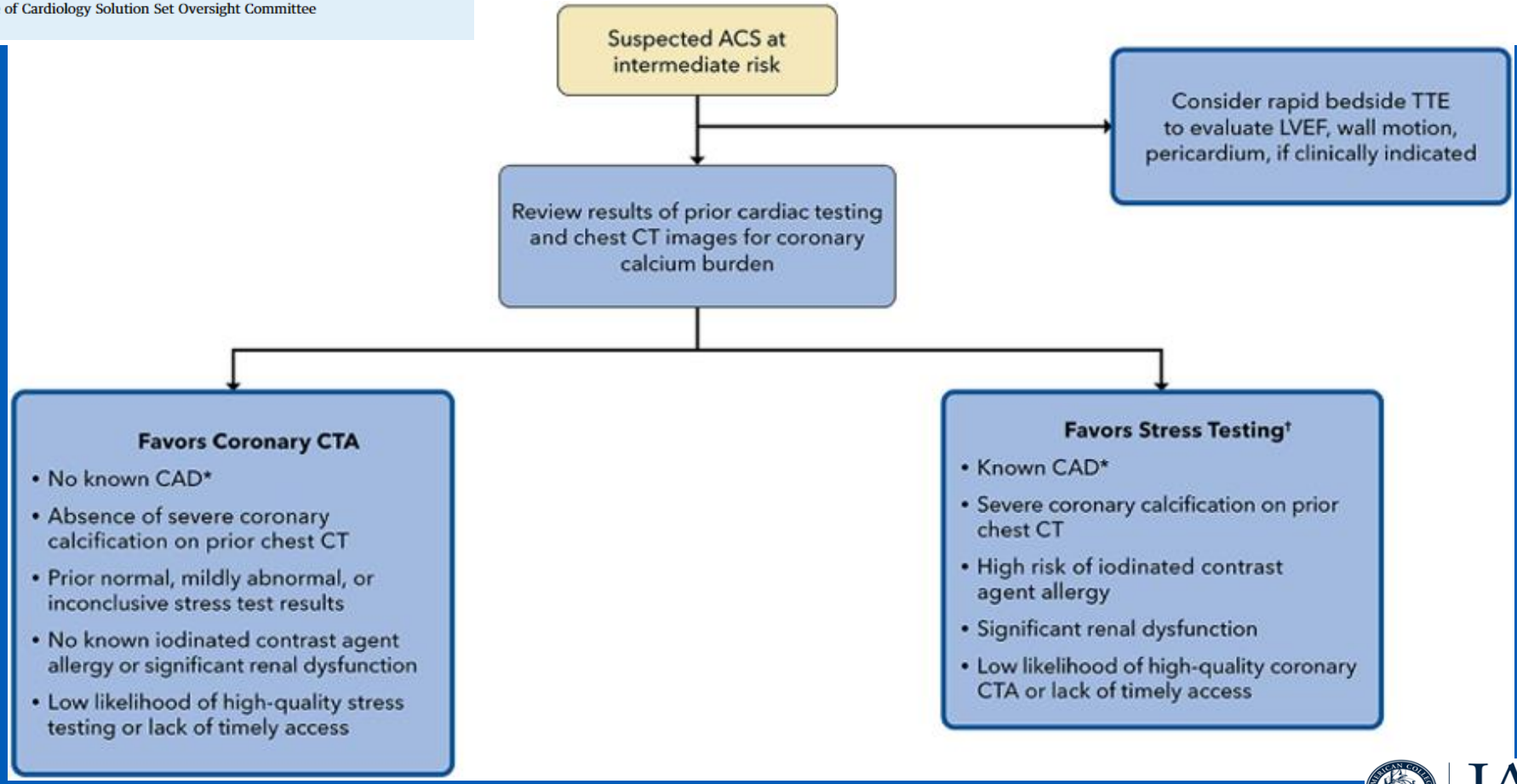
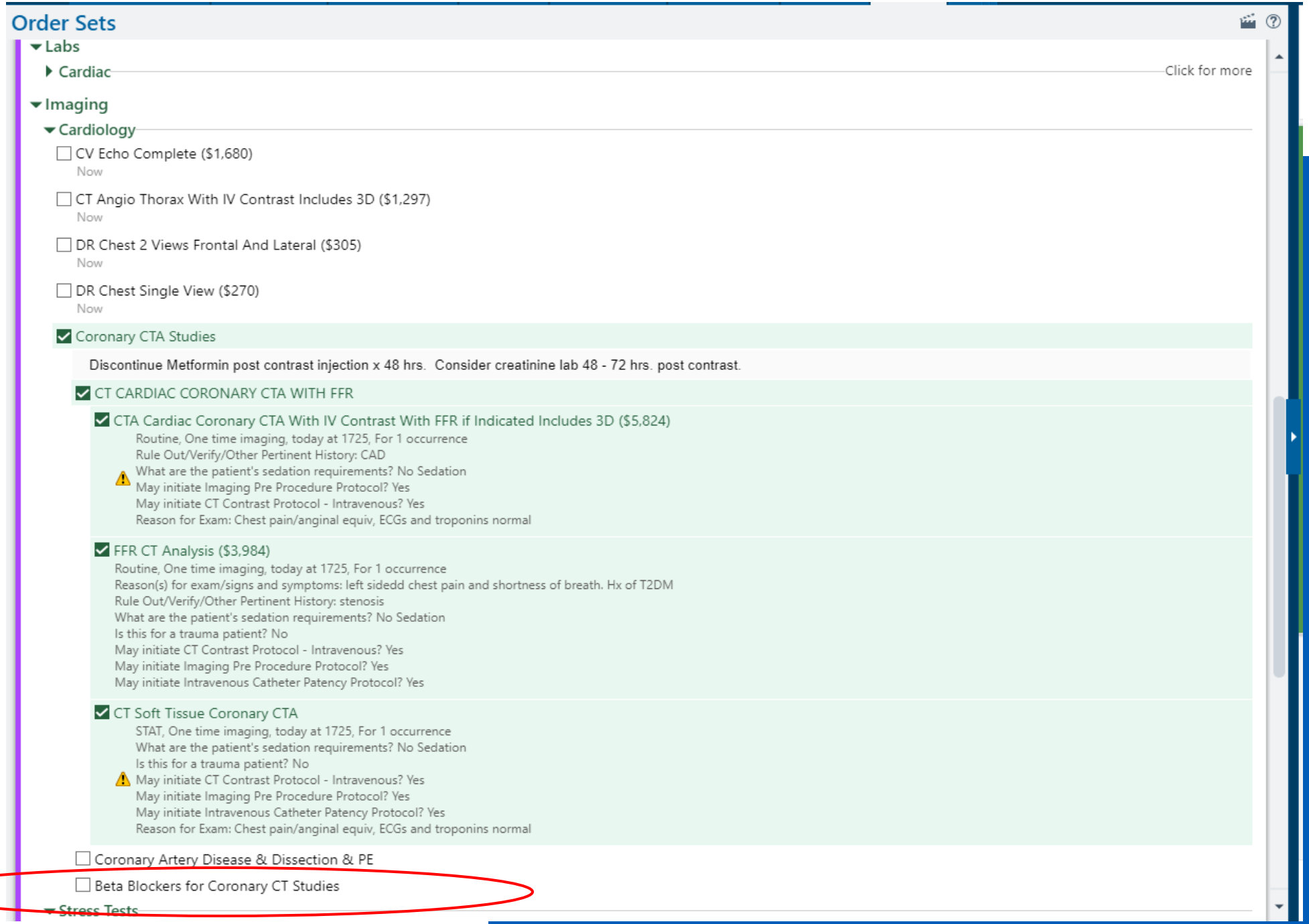
EXPERT CONSENSUS DECISION PATHWAY

# 2022 ACC Expert Consensus Decision Pathway on the Evaluation and Disposition of Acute Chest Pain in the Emergency Department

A Report of the American College of Cardiology Solution Set Oversight Committee




*J Am Coll Cardiol* 2022; 80:1925-1960.


Order Sets
Labs
Cardiac
Click for more
Imaging
Cardiology
CV Echo Complete ($1,680)
Now
CT Angio Thorax With IV Contrast Includes 3D ($1,297)
Now
DR Chest 2 Views Frontal And Lateral ($305)
Now
DR Chest Single View ($270)
Now
Coronary CTA Studies
Discontinue Metformin post contrast injection x 48 hrs. Consider creatinine lab 48 - 72 hrs. post contrast.
CT CARDIAC CORONARY CTA WITH FFR
CTA Cardiac Coronary CTA With IV Contrast With FFR if Indicated Includes 3D ($5,824)
Routine, One time imaging, today at 1725, For 1 occurrence
Rule Out/Verify/Other Pertinent History: CAD
What are the patient's sedation requirements? No Sedation
May initiate Imaging Pre Procedure Protocol? Yes
May initiate CT Contrast Protocol - Intravenous? Yes
Reason for Exam: Chest pain/anginal equiv, ECGs and troponins normal
FFR CT Analysis ($3,984)
Routine, One time imaging, today at 1725, For 1 occurrence
Reason(s) for exam/signs and symptoms: left sidedd chest pain and shortness of breath. Hx of T2DM
Rule Out/Verify/Other Pertinent History: stenosis
What are the patient's sedation requirements? No Sedation
Is this for a trauma patient? No
May initiate CT Contrast Protocol - Intravenous? Yes
May initiate Imaging Pre Procedure Protocol? Yes
May initiate Intravenous Catheter Patency Protocol? Yes
CT Soft Tissue Coronary CTA
STAT, One time imaging, today at 1725, For 1 occurrence
What are the patient's sedation requirements? No Sedation
Is this for a trauma patient? No
May initiate CT Contrast Protocol - Intravenous? Yes
May initiate Imaging Pre Procedure Protocol? Yes
May initiate Intravenous Catheter Patency Protocol? Yes
Reason for Exam: Chest pain/anginal equiv, ECGs and troponins normal
Coronary Artery Disease & Dissection & PE
Beta Blockers for Coronary CT Studies
Stress Tests

# Medications

## Beta Blockers

- Slows heart rate in order to obtain clear images
- CCBs generally considered 2nd line

## Nitrates

- Direct coronary smooth muscle vasodilation
- Optimizes imaging quality
- 400-800 µg of sublingual nitroglycerin (commonly 1-2 tablets) administered prior to CCTA.
- Higher dose increasingly preferred in clinical practice
    - Modest evidence showing better optimization

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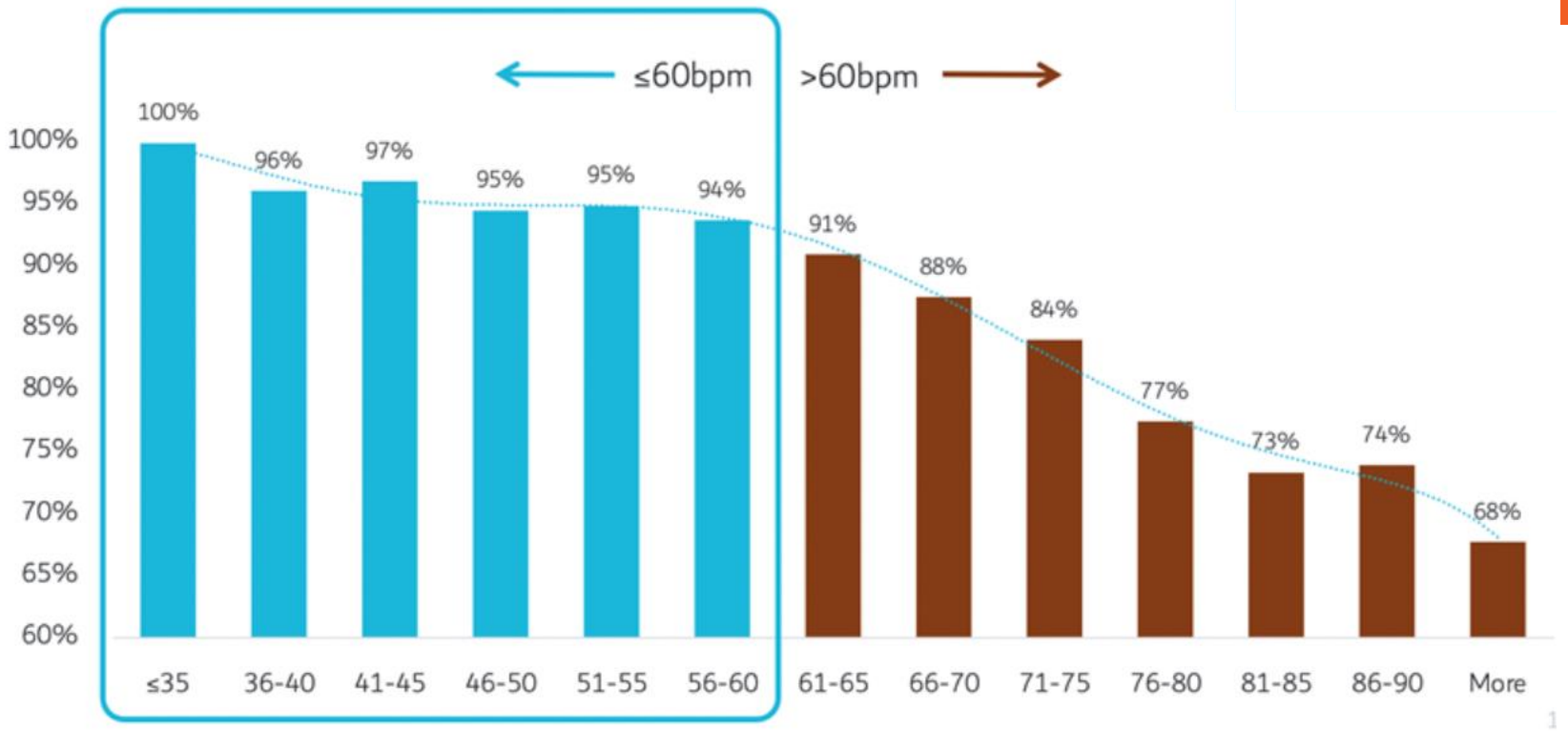
# Acceptance for FFR by heart rate




*Reference: Weir-McCall and Fairbairn, 2020*

# Medications

Alternate Rate Control Options for Intolerance/Non-Response to Beta Blockers

Individually select each medication below if the patient is intolerant/non-responsive to beta-blockers, or if patient already taking diltiazem or verapamil. For patients already taking immediate-release verapamil, give their existing home dose. Otherwise give 40 mg.

- [ ] verapamil (CALAN) tablet - If the patient is on immediate release verapamil at home, give the patient an additional dose of their home strength instead of the 40mg default ($0.04/day)
  40 mg, Oral, Once, Give 90 minutes before CCTA. Hold if Heart Rate 60 or lower.
- [ ] dilTIAZem (CARDIZEM) IV push - To be given 30 minutes prior to CCTA ($0.77/day)
  10 mg, Intravenous, Every 10 min PRN (inactive), 30 minutes prior to CCTA if HR greater than 90 bpm, Starting H+1 Hours, for 4 doses, Hold if SBP less than 100 mmHg
- [ ] nitroGLYCERIN (NITROSTAT) tablet - To be given at time of CCTA ($0.35/day)
  0.4 mg, Sublingual, Once, Starting H+90 Minutes, Give at time of CCTA. Hold if SBP less than 100 mmHg.

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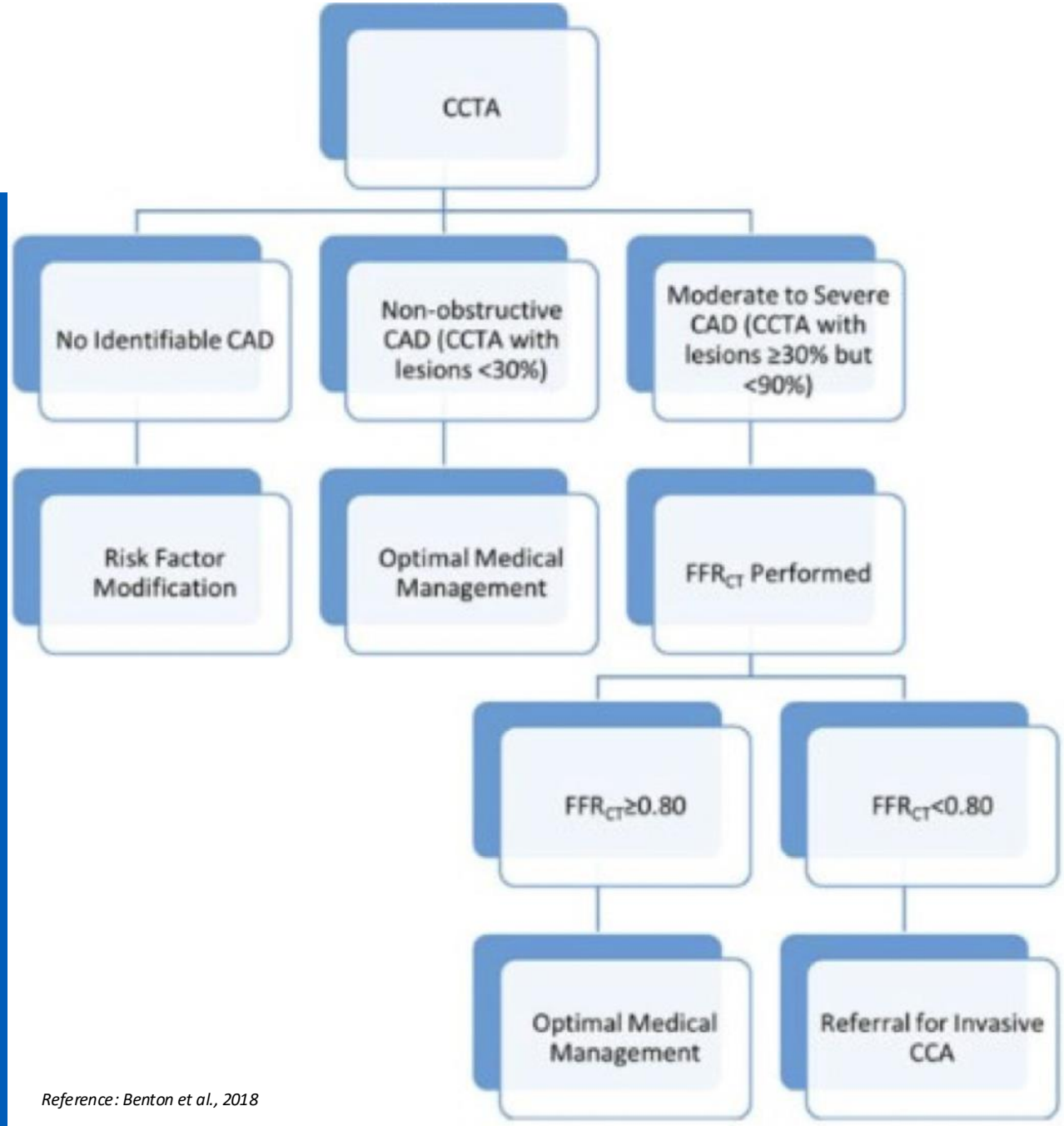
# CCTA Treatment Pathway




*Reference: Benton et al., 2018*

# Reasoning for CCTA in the EDOU

- Performance exceeds that of traditional stress tests.
- Reduced LOS average of 7.6 hours.
- Safe, cost-effective method of screening patients with low-to-intermediate-risk chest pain
  - Similar rates of adverse events,
  - Reduced short-term costs by ~ 21%

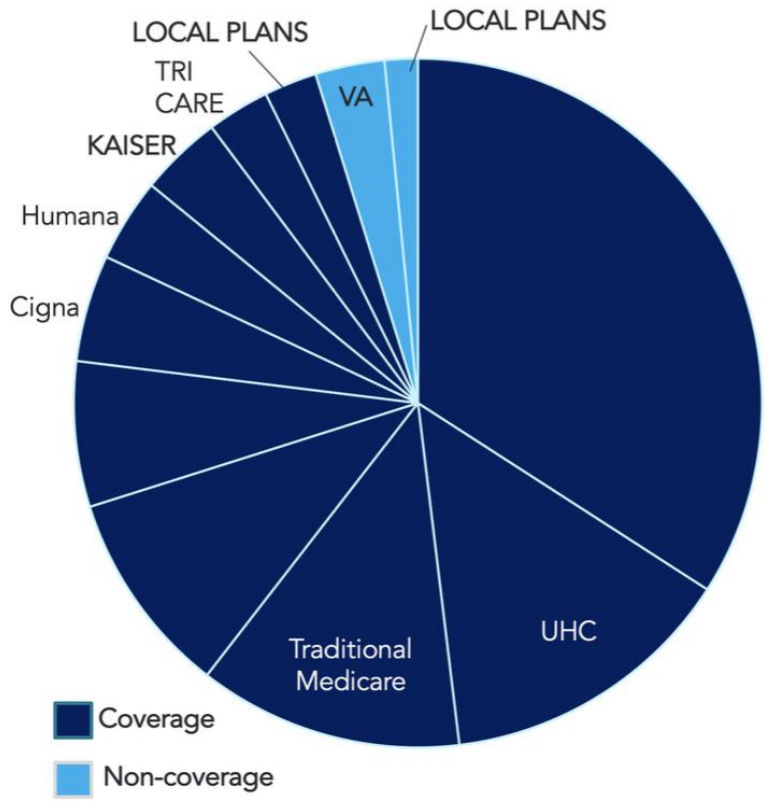
# Costs

## Commercial Coverage

>95% of commercial payers cover $FFR_{CT}$

- UnitedHealthcare data – "CT-first" strategy reduces costs for patients with stable chest pain compared to stress imaging

- PLATFORM study – 23% reduction in costs at 90 days (driven by avoidance of invasive catheterizations)



# Barriers to Adoption

- Available physician pool for reading studies
- Nursing education
- Provider ordering patterns
- Scanner standards and technologist competencies
- Patient education on what constitutes a “stress test”

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| **Radiology reads all** CCTA and $FFR_{CT}$ and **provides information to Cardiology** | **Radiology reads all CCTA**<br>**Cardiology reads all $FFR_{CT}$** | **Radiology and Cardiology both have readers sharing a schedule for CCTA and $FFR_{CT}$ interpretation** | **Cardiology reads all CCTA and $FFR_{CT}$**<br>**Radiology performs non-cardiac overreads** |
|---|---|---|---|
| Radiology provides summary of all information to Cardiology. | Aligns specialty expertise to CT imaging and coronary physiology. | Enables both groups to fully understand and integrate anatomy and physiology. Allows for shared learning. | Cardiology will need CT reading expertise, and can leverage experience with coronary anatomy and patient care. |
| Radiology will need to expand knowledge of physiology and $FFR_{CT}$. | Requires very careful coordination to integrate information since neither team is looking at all information. | Larger reader pool to handle higher volumes. | Radiology overreads allow optimal patient care and liability obligations. |
| Cardiology will need to understand Coronary CT, limitations and all aspects of $FFR_{CT}$. | May work locally but more difficult in a larger system. | Radiology overreads allow optimal patient care and liability obligations. | |

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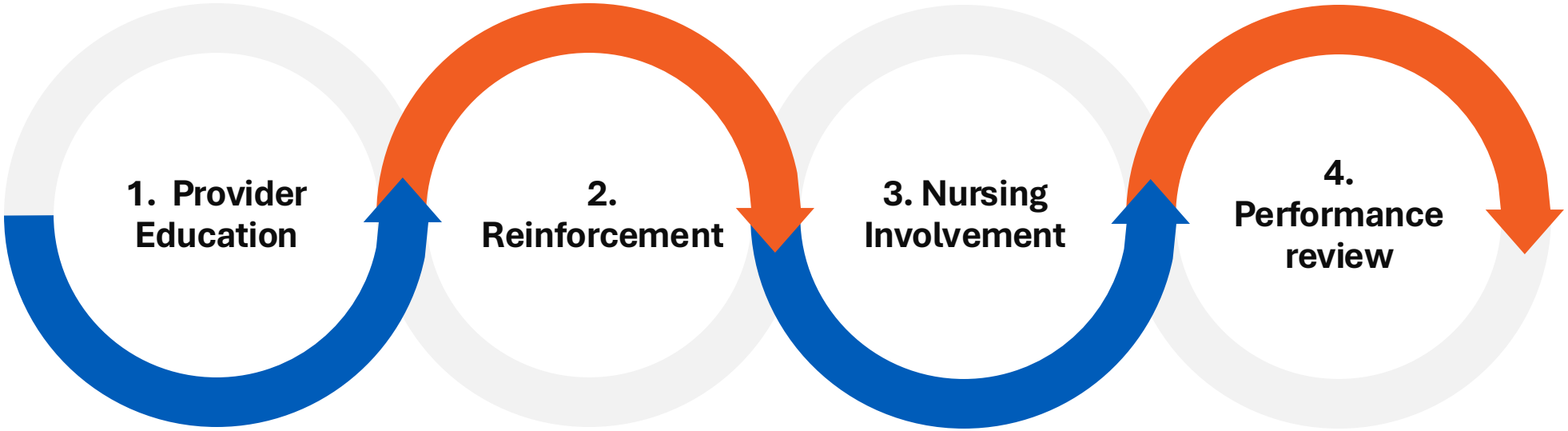
# Interventions



# Patient Experience

- CCTA can generally be performed faster than traditional stress noninvasive imaging modalities.
- The addition of FFRCT requires no additional patient time, effort or exposure to radiation.
- Providing patients with reports that include both anatomic and physiologic data – in layman's terms – may improve patient engagement with prevention strategies and treatment compliance.

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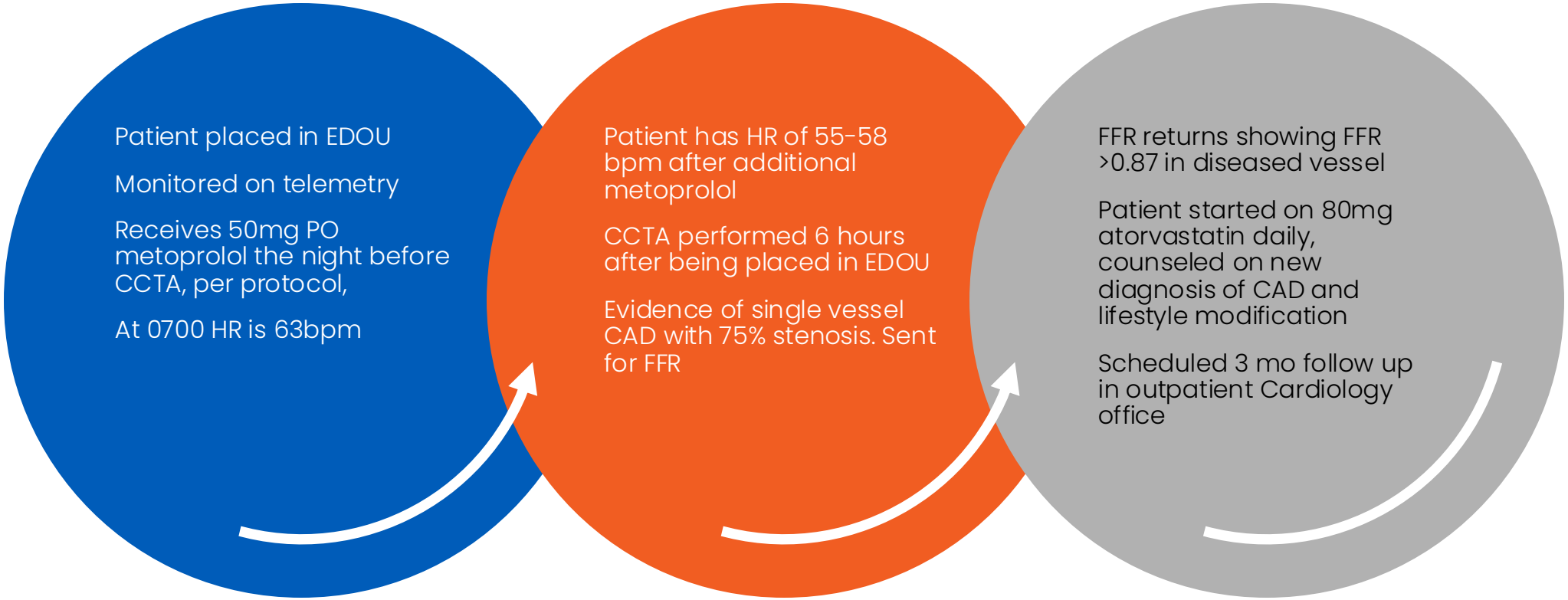
# Case Resolution

58 yo male w hx of tobacco use, HTN, and T2DM

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# Summary

CCTA is recommended as 1st line test for patients with possible ACS

CCTA answers the 4 major questions being asked when a patient presents with concern for ACS, including long term prognosis

$FFR_{CT}$ < 0.8 indicates significant flow reductions and should be referred for ICA

CCTA in the EDOU allows safe disposition of patients with rapid turnaround and lower cost

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Thank You

# Questions