



**CORONARY MICROVASCULAR
DYSFUNCTION OVERVIEW**

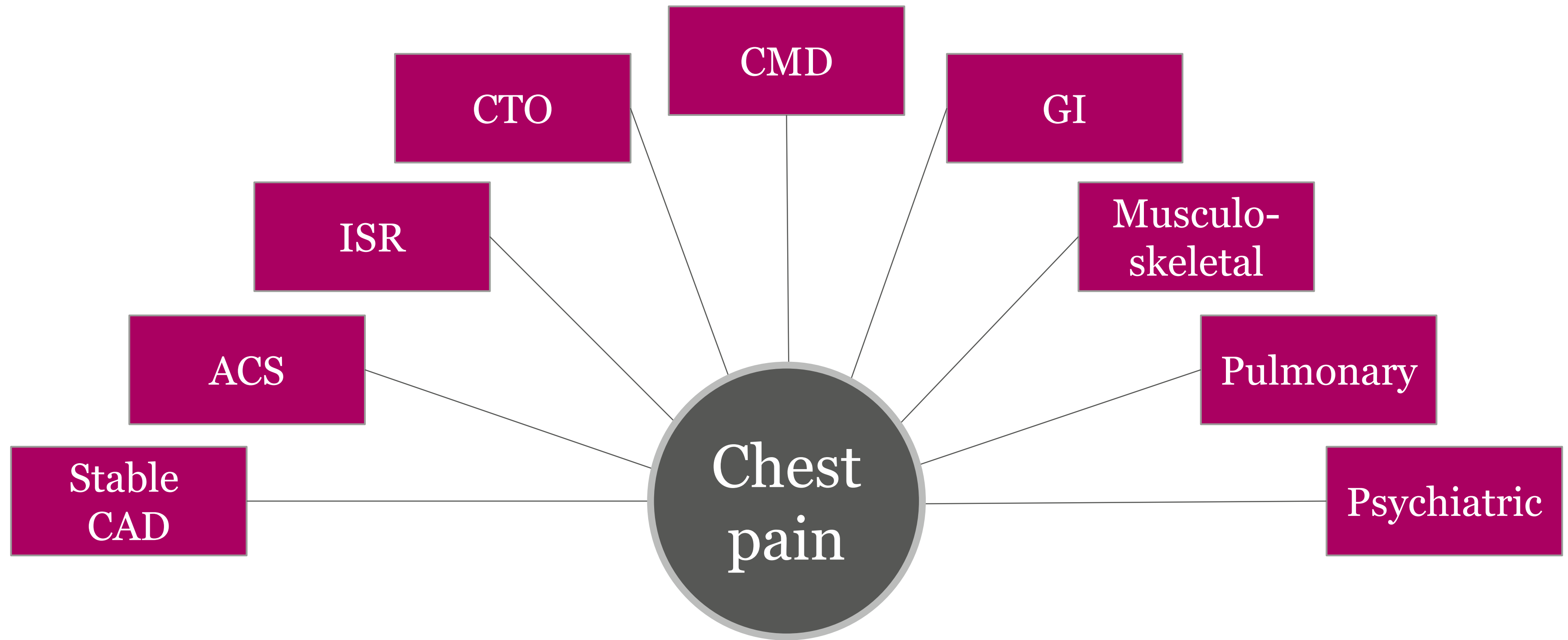
Assessing the Microcirculation

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Chest Pain Diagnosis Can Be Challenging



Chew et al. *Heart, Lung, and Circ.* 2016; Marinescu et al. *JACC CI* 2015.

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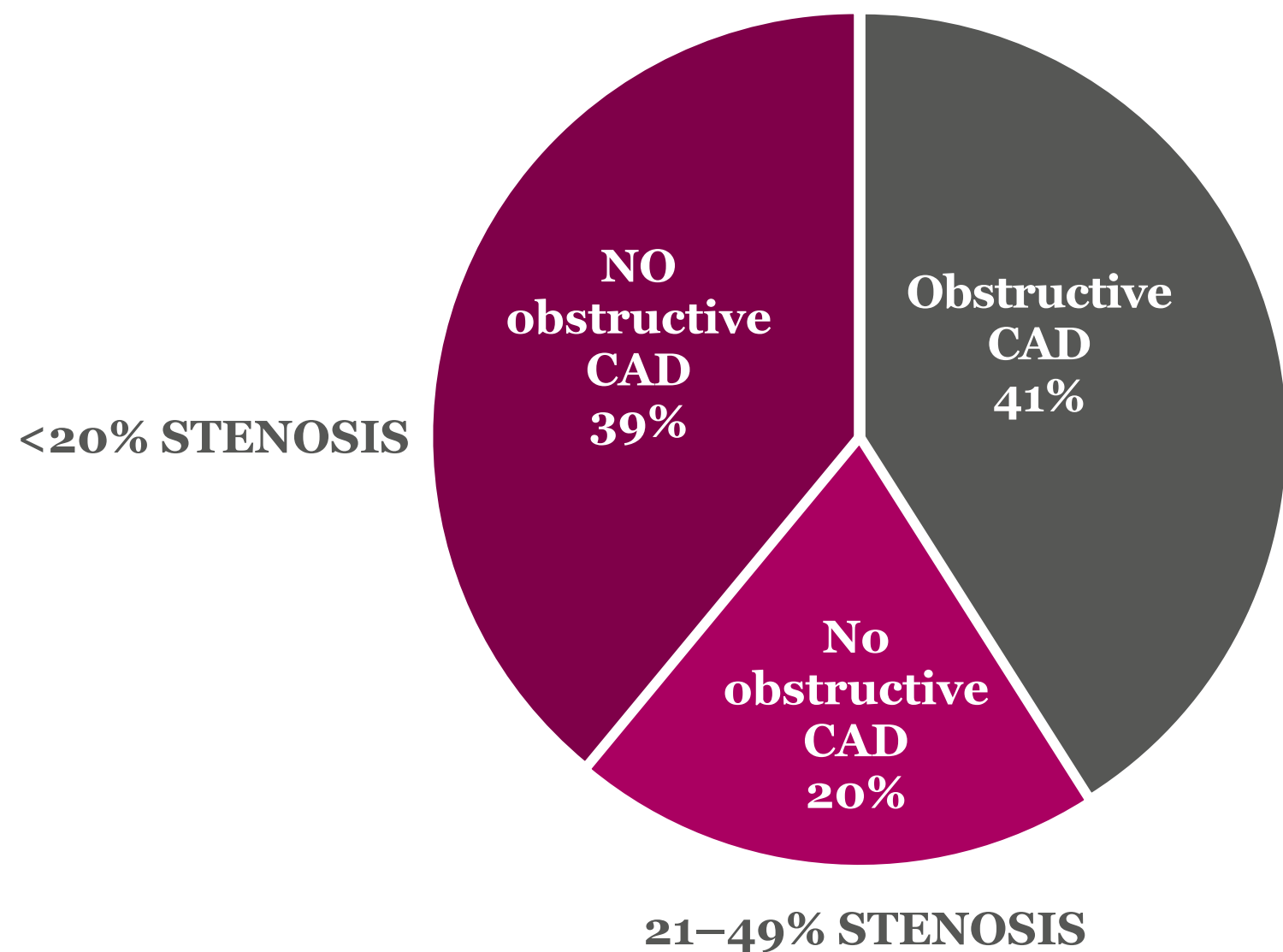
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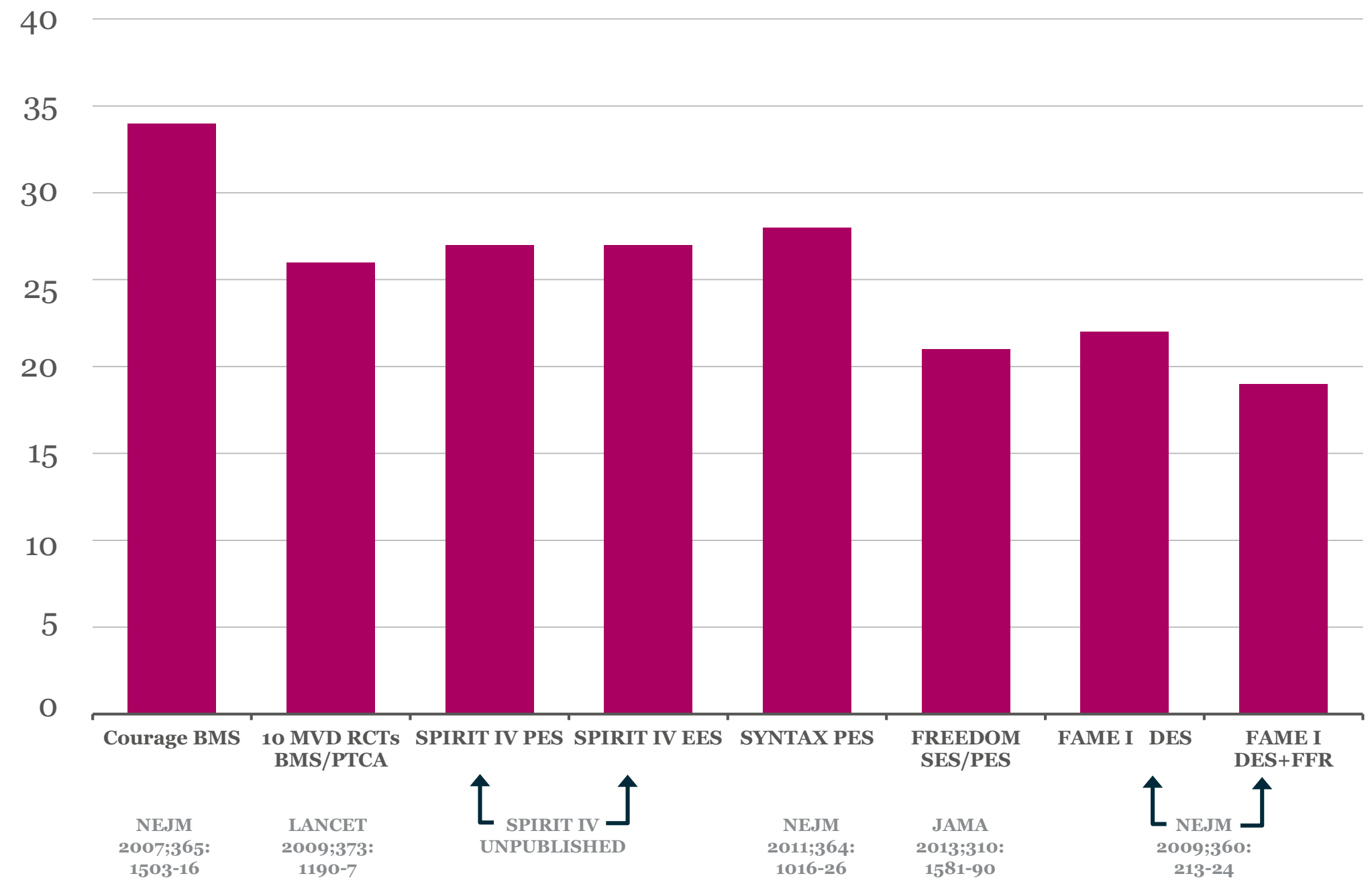
Unresolved Angina is Surprisingly Common

Obstructive CAD is found in only 41% of elective patients coming to the cath lab

CAD Classification in the NCDR Registry (n=398,978 patients)



Angina post-PCI occurs in 20-30% of patients at 1 year



Patel et al. Low diagnostic yield of elective coronary angiography. *NEJM* 2010.

Jeremias et al. DEFINE PCI. *ACC* 2019.

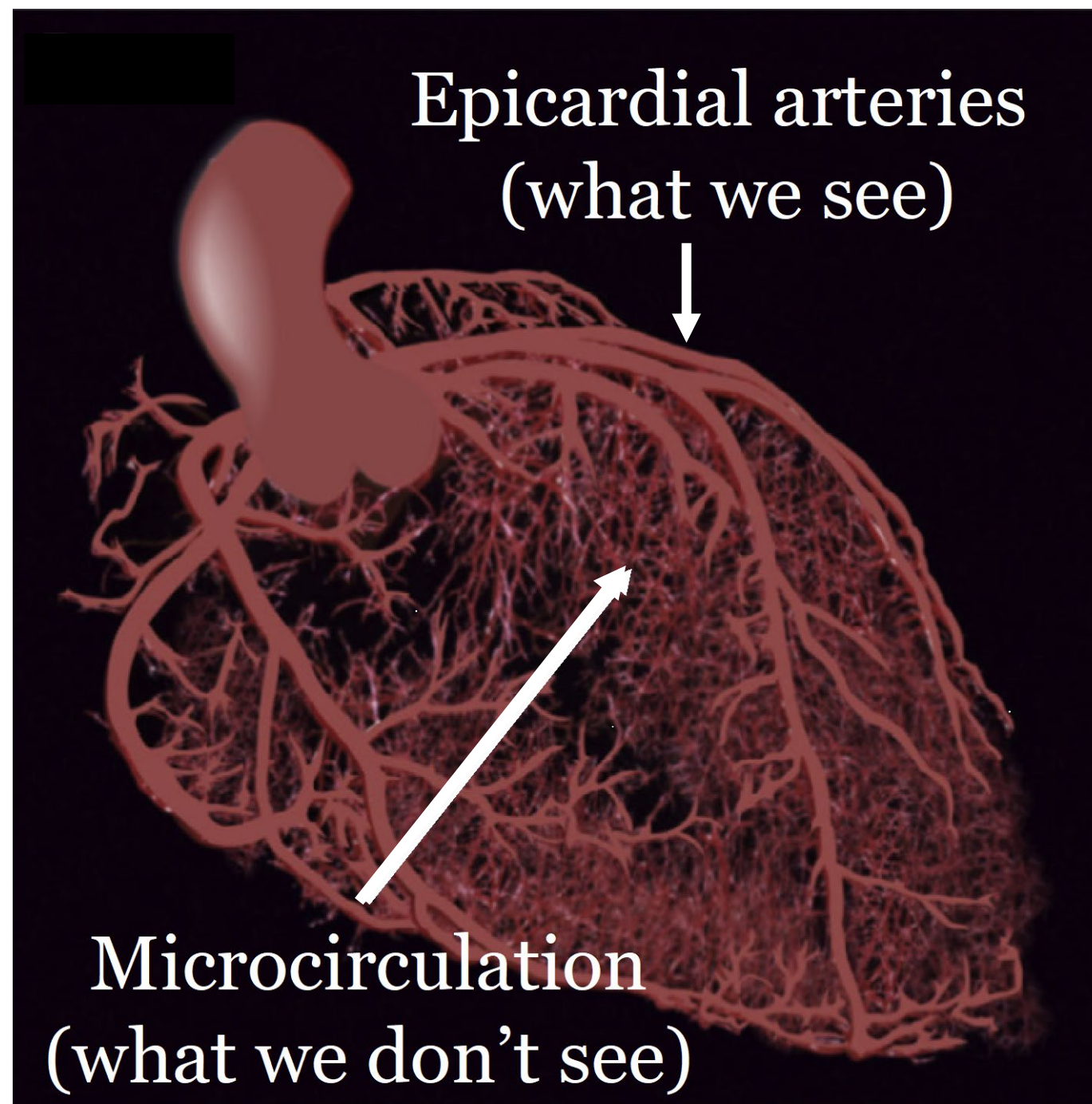
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Coronary Microvascular Dysfunction (CMD) is a Common Cause of Unresolved Angina¹

Anatomy of the coronary circulation²



- The microcirculation is responsible for the regulation and distribution of blood flow to the myocardium
- CMD can be a key mediator of patient symptoms such as angina

1. Taqueti et al. Coronary Microvascular Disease Pathogenic Mechanisms and Therapeutic Options. *JACC* 2018. 2. Figure adapted from Taqueti et al. *JACC* 2018.

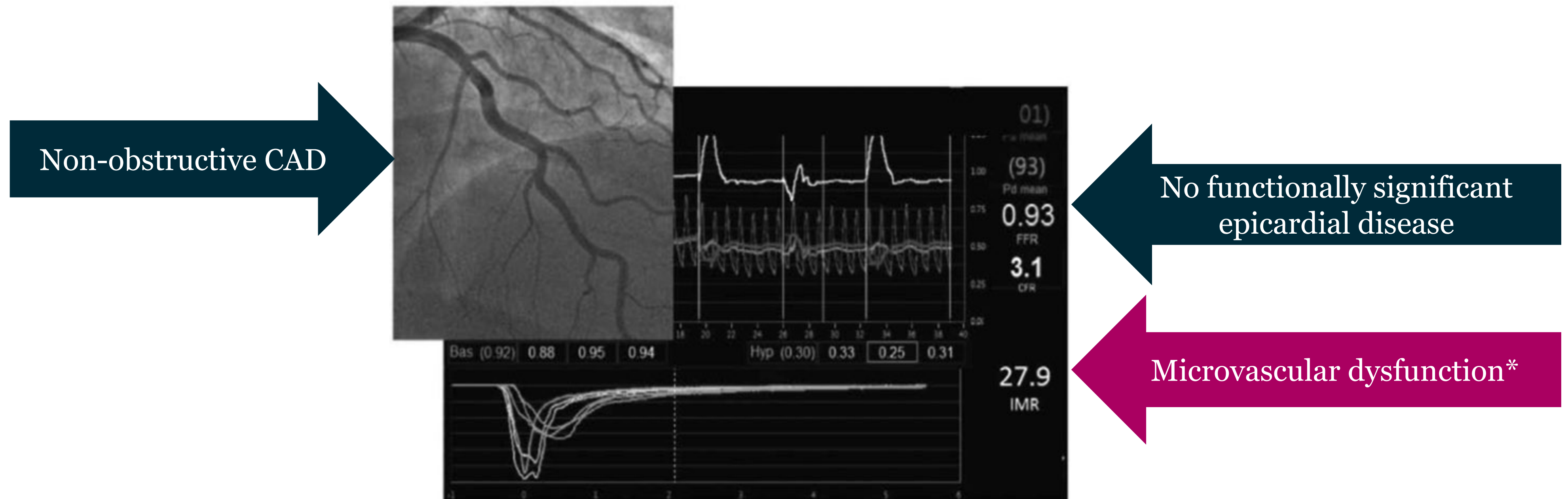
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A Negative Angio Doesn't Confirm Angina is of Non-cardiac Origin

Ischemia and non-obstructive coronary arteries (INOCA) presentation is difficult to diagnose without the right tools



Lee et al. *Circ.* 2015. * Based on a threshold of IMR > 25 used in Ford, T.J. et al *J Am Coll Cardiol Interv.* 2020;13(1):33-45.

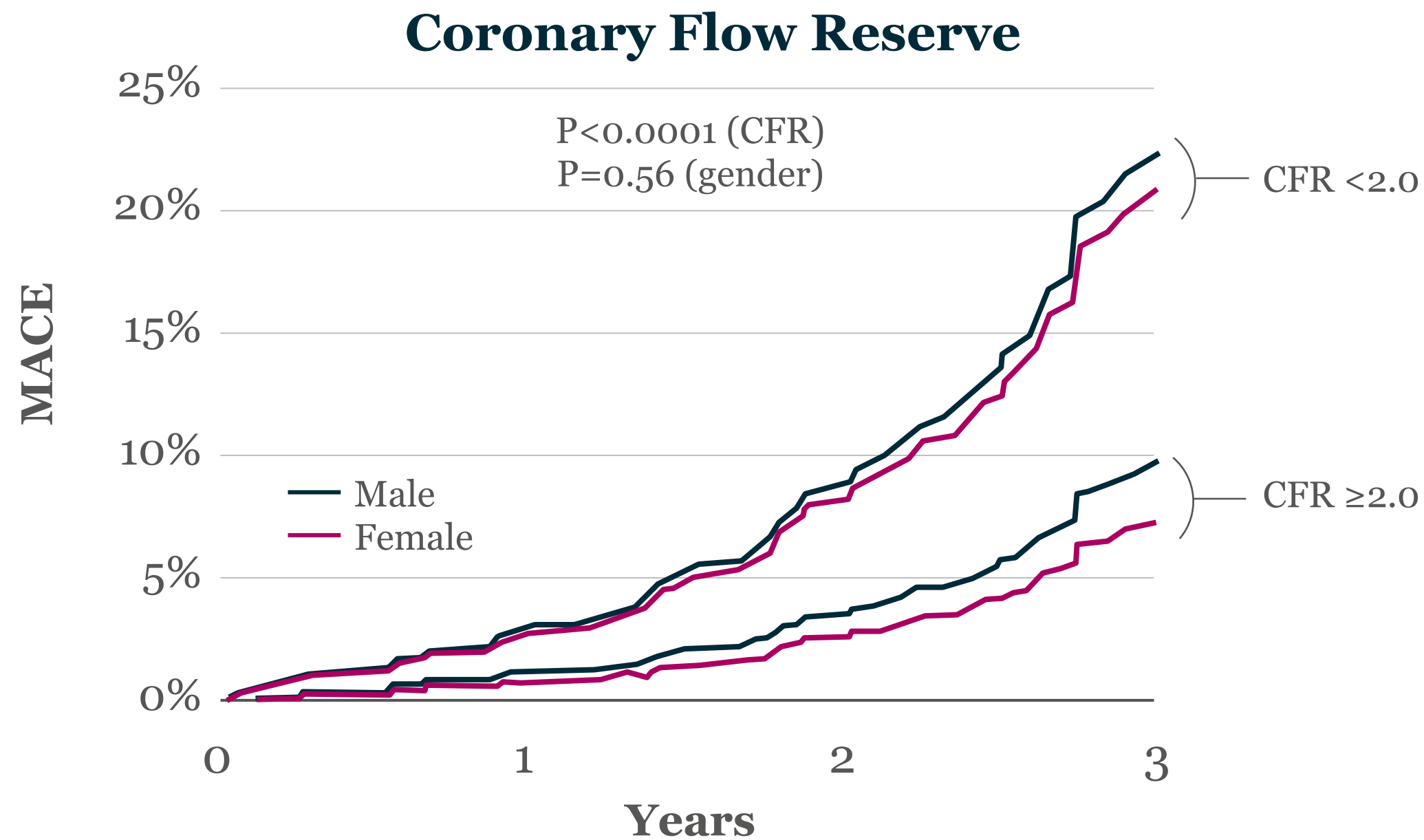
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INOCA is Not Benign

INOCA with a low coronary flow reserve (CFR) is associated with higher MACE¹



CMD is associated with²:

4X increase in mortality

5X increase in MACE

1. Taqueti et al. Coronary Microvascular Disease Pathogenic Mechanisms and Therapeutic Options. *JACC* 2018. 2. Gdowski M, et al. *JAHA*. 2020; 9:e014954. DOI: 10.1161/JAHA.119.014954.

Persistent Angina After PCI May Also be Caused by CMD

STRUCTURAL CAUSES

- In-stent restenosis
- Stent thrombosis
- Progression of atherosclerotic disease in other segments
- Incomplete revascularization
- Diffuse atherosclerotic disease without focal stenosis
- Presence of myocardial bridges

FUNCTIONAL CAUSES

- Epicardial vasospasm
- Coronary microvascular dysfunction
- Stent-related mechanical stretch of the arterial wall

Recurrent or persistent angina

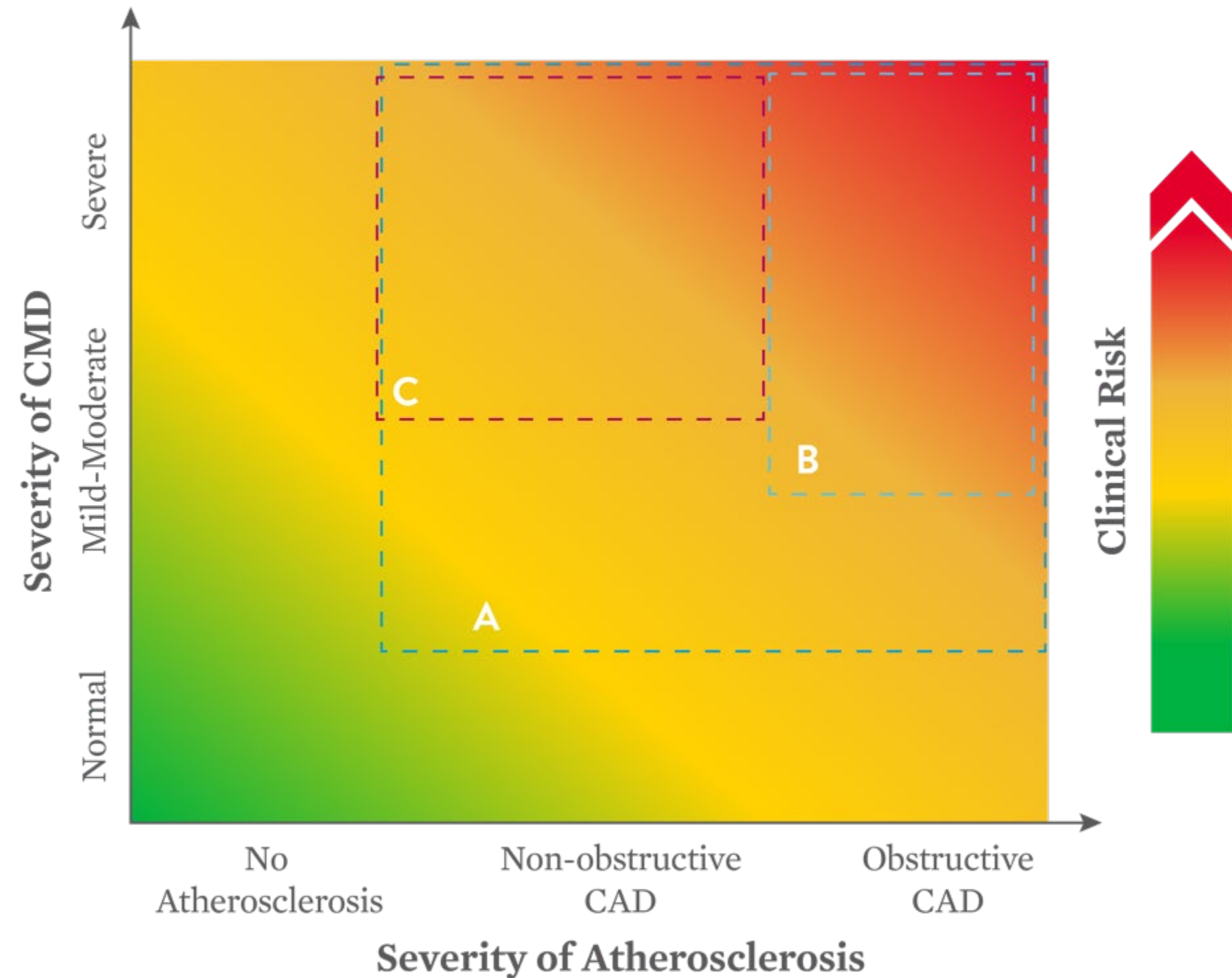
Adapted from Niccoli et al. Angina after percutaneous coronary intervention: The need for precision medicine. *IJC* 2017.

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Severity of Atherosclerosis and CMD Together Determine Clinical Risk



Boxes represent different CMD phenotypes of particular therapeutic interest. (A) CMD with CAD; (B) moderate-severe CMD with obstructive CAD; (C) moderate-severe CMD with nonobstructive CAD. CAD $\frac{1}{4}$ coronary artery disease; CMD $\frac{1}{4}$ coronary microvascular disease.

1. Taqueti et al. Coronary Microvascular Disease Pathogenic Mechanisms and Therapeutic Options. *JACC* 2018. 2. Figure adapted from Taqueti et al. *JACC* 2018.

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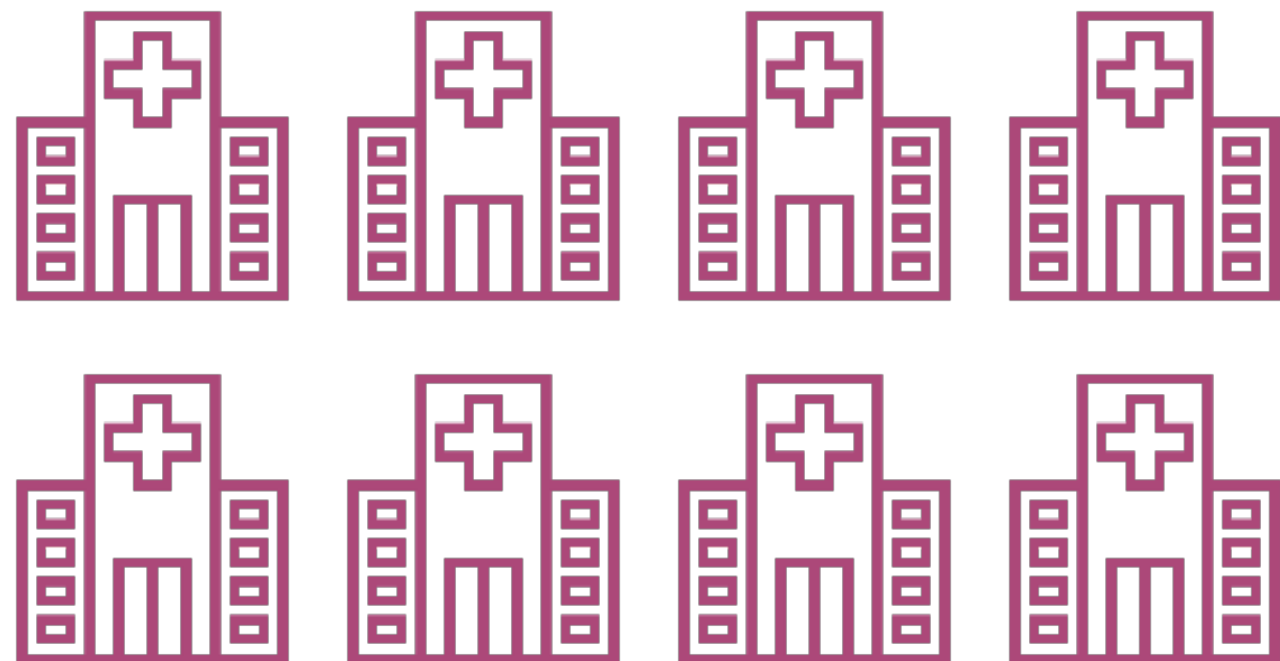
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Unresolved Angina Adds Burden to Hospital Systems

Potential Consequences of Undiagnosed CMD

8 hospitalizations within 1 year for an example patient not unblinded to CMD test results¹



Hospitalizations Drive Additional Costs²

\$2,100 - \$7,300



Each new hospitalization adds \$2,100 (Netherlands) to \$7,300 (US) of cost to healthcare systems

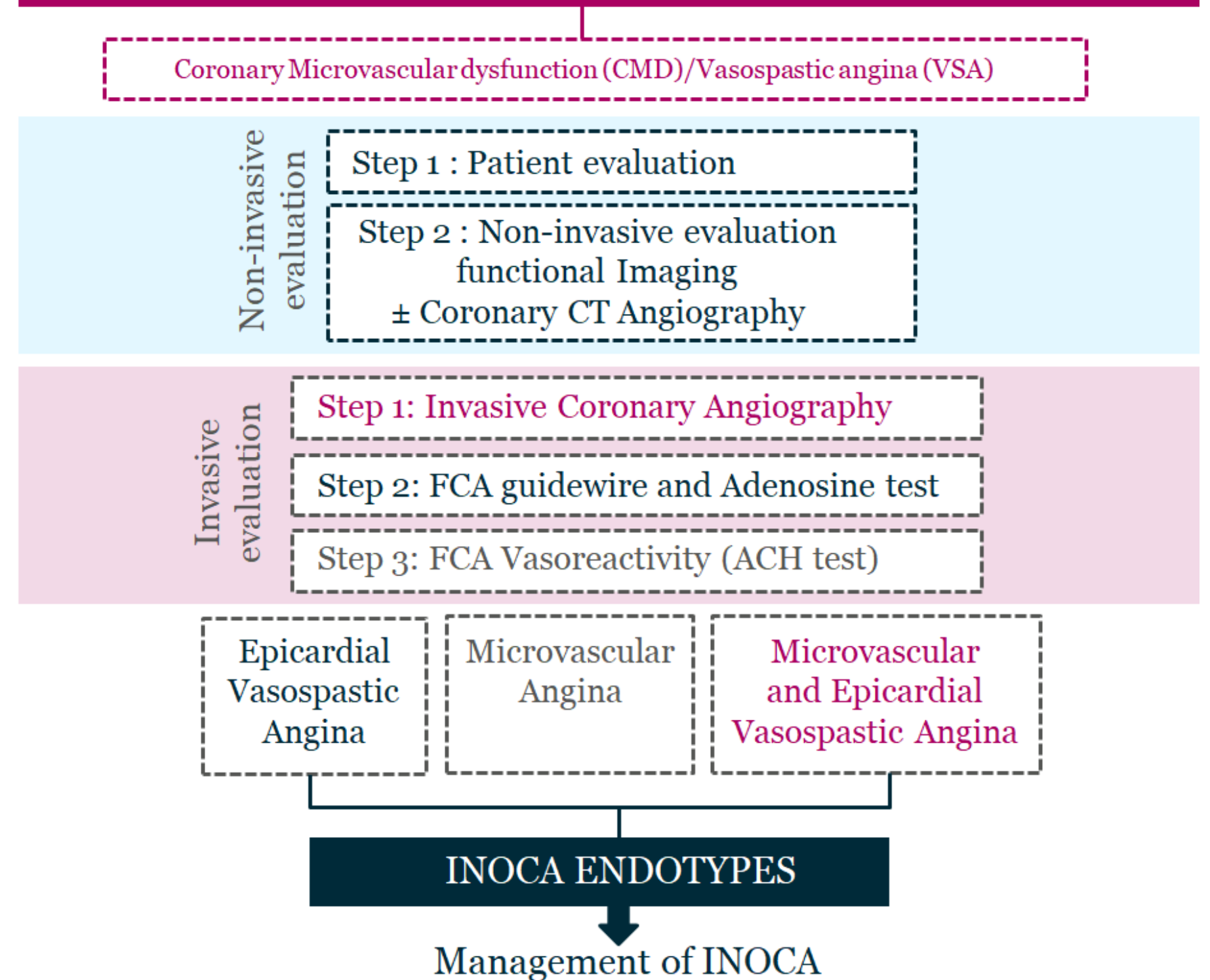
1. Example from Ford et al. CorMicA. EuroPCR 2019. While few data on number of repeat hospitalizations exist, forthcoming CorMicA publications will include such analyses.

2. Omerovic E. (2015, October). FFR Guided Complete Revascularization during Primary Angioplasty is cost-effective . Presented at EuroPCR 2017, Paris.

How to Evaluate INOCA?

- **The EAPCI Consensus Document¹** endorsed by EAPCI, COVADIS and ESC group reviews the importance of INOCA.
- Guidance on diagnostic criteria and management is provided.

Ischemia with non obstructive coronary arteries (INOCA)



1. Kunadian, Vijay; EAPCI Expert Consensus Document *EHJ & Eurointervention* 2020: ehaa503

Recommendations to Diagnosing CMD

ESC guidelines recommend a guidewire-based approach¹

Recommendations	Class ^a	Level ^b
Guidewire-based CFR and/or microcirculatory resistance measurements should be considered in patients with persistent symptoms, but coronary arteries that are either angiographically normal or have moderate stenosis with preserved iwFR/FFR. ^{412,413}	IIa	B

EAPCI Consensus Document lists cutoffs of **CFR < 2.0 and IMR ≥ 25** for CMD diagnosis of INOCA patients²

Table 1 Diagnostic criteria for microvascular angina		
Criteria	Evidence	Diagnostic parameters
1	Symptoms of myocardial ischaemia ^a	Effort or rest angina Exertional dyspnoea
2	Absence of obstructive CAD (<50% diameter reduction or FFR >0.80)	Coronary CTA Invasive coronary angiography
3	Objective evidence of myocardial ischaemia ^b	Presence of reversible defect, abnormality or flow reserve on a functional imaging test
4	Evidence of impaired coronary microvascular function	Impaired coronary flow reserve (cut-off <2), invasive or noninvasively determined Coronary microvascular spasm, defined as reproduction of symptoms, ischaemia ECG shifts but no epicardial spasm during acetylcholine testing Abnormal coronary microvascular resistance indices (e.g. IMR ≥ 25)

Definitive microvascular angina is only diagnosed if criteria 1,2,3 and 4 are present. CAD, coronary artery disease; CCTA, coronary computed tomographic angiography; ECG, electrocardiogram; FFR, fractional flow reserve; IMR, index of microcirculatory resistance.
^a Many patients with heart failure with preserved ejection fraction would fulfil these criteria: dyspnoea, no obstructive CAD and impaired CFR. For this reason, consider measuring LV end-diastolic pressure (normal ≤ 10mmHg) and NT -proBNP normal <125pg/ml.¹⁶
^b Signs of ischaemia may be present but are not necessary. However, evidence of impaired coronary microvascular function should be present.

1. Knuuti et al. 2019 ESC guidelines for the diagnosis and management of CCS. *EHJ* 2019.
2. Kunadian, Vijay; EAPCI Expert Consensus Document *EHJ & Eurointervention* 2020: ehaa503

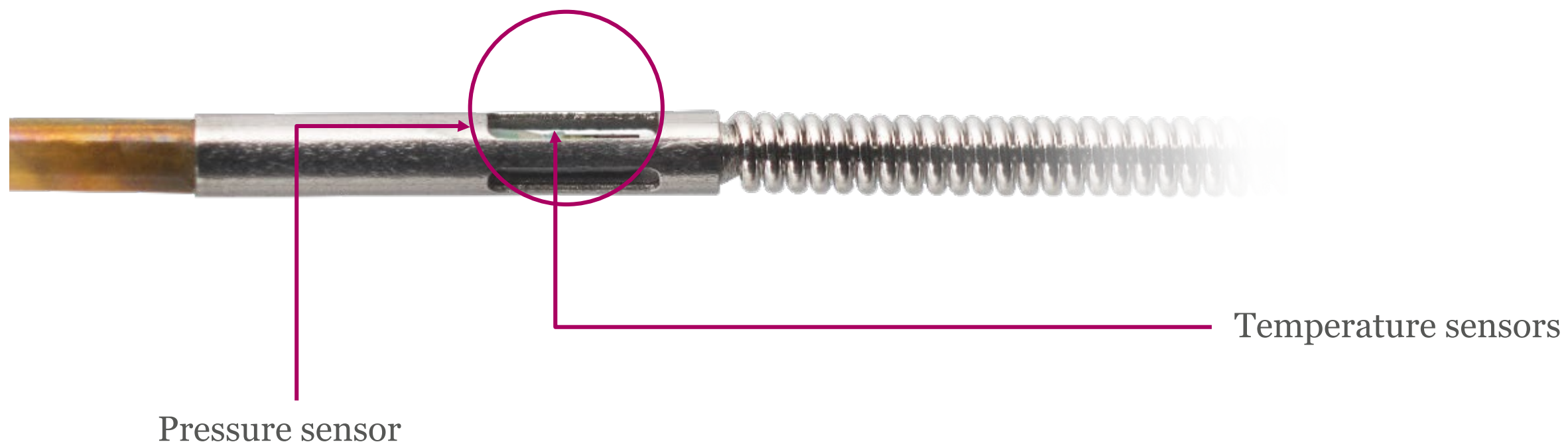
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How to Diagnose CMD with Abbott?

Abbott's PressureWire™ X Guidewire and the Coroventis‡ CoroFlow ‡ Cardiovascular System are the **only** solution for diagnosing CMD in the cath lab^{1,2}



Measuring IMR is easy and reproducible³

1. Data on file at Abbott. PressureWire X Guidewire IFU. Coroventis Coroflow IFU.
2. Ford T et al. JACC. 2018; 72(23):2841-55 and online appendix
3. Fearon WF, Kobayashi Y. *Circ Cardiovasc Interv.* 2017; 10(12).

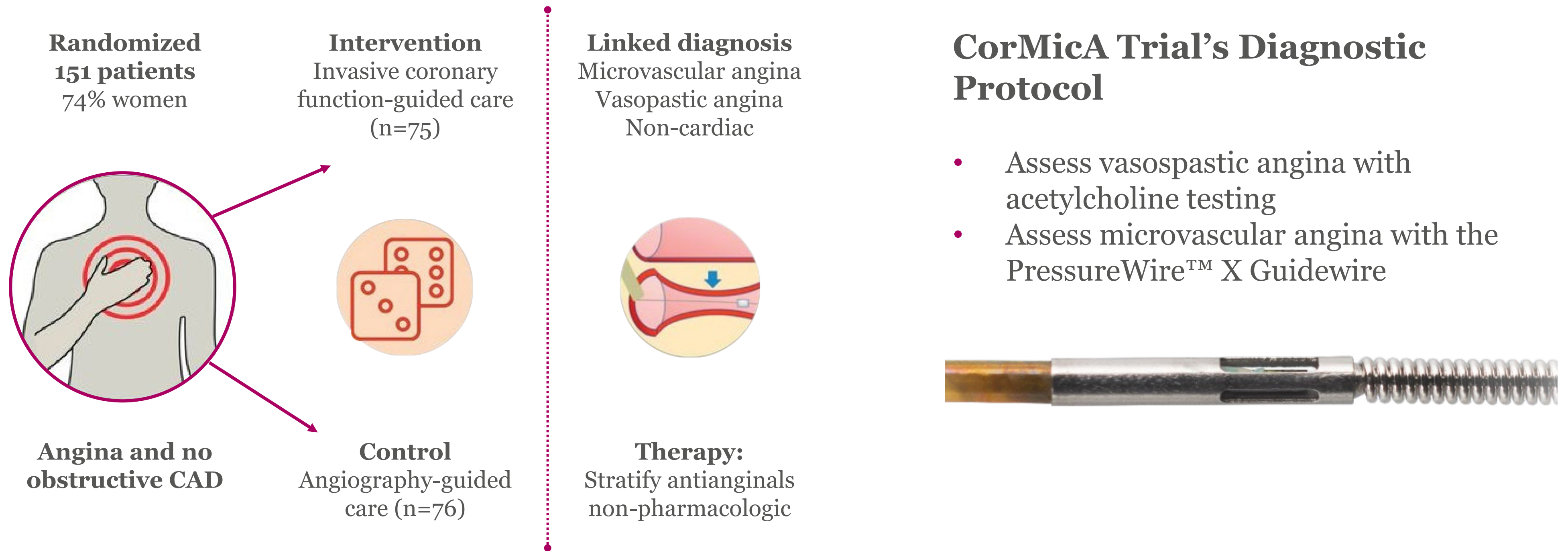
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How Might CMD be Treated?

The CorMicA trial provides a hypothesis-generating diagnostic and treatment approach



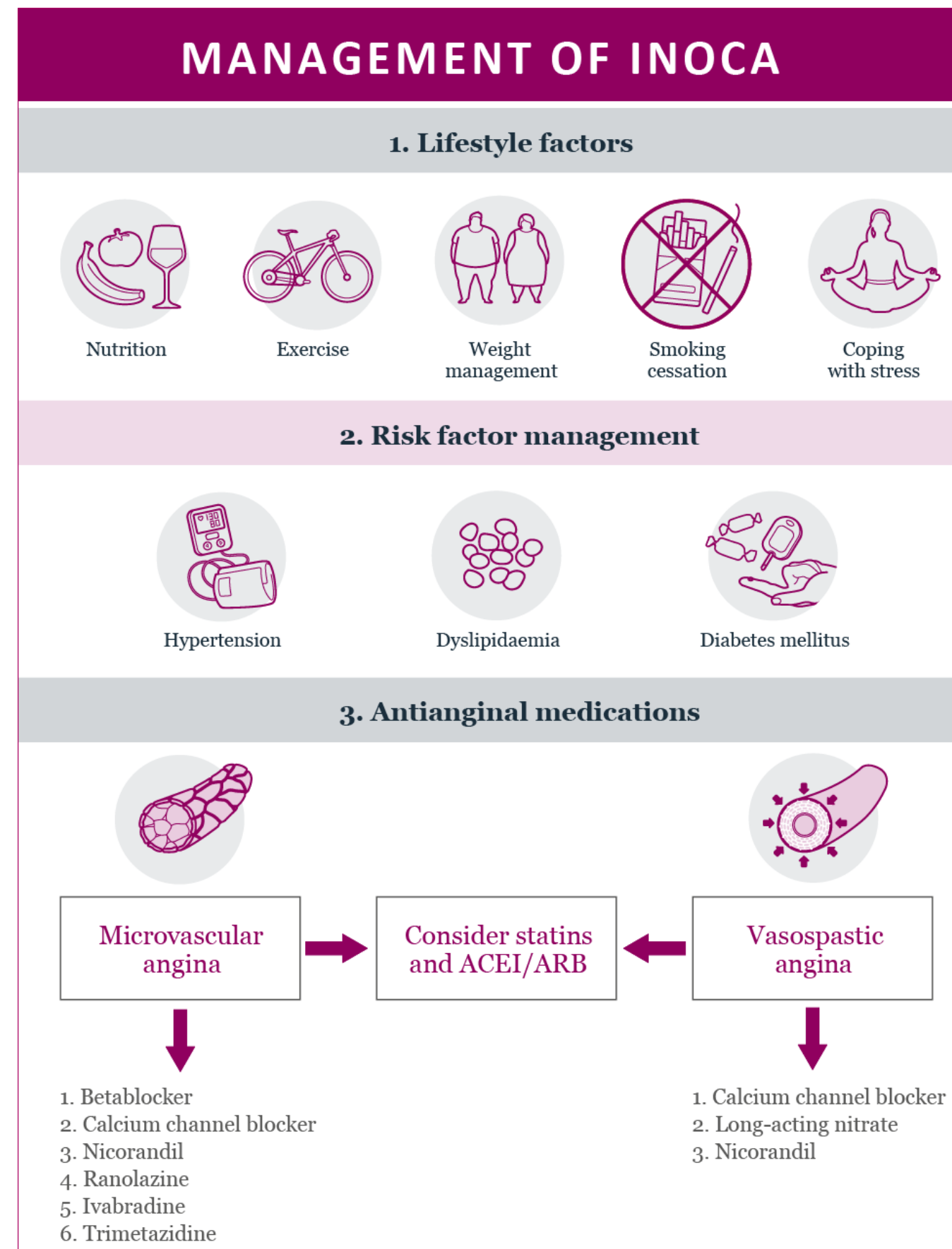
Ford, T.J. et al *J Am Coll Cardiol Interv.* 2020;13(1):33-45.

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Management Consensus for the INOCA Patient



Kunadian, Vijay; EAPCI Expert Consensus Document
EHJ & Eurointervention 2020: ehaa503

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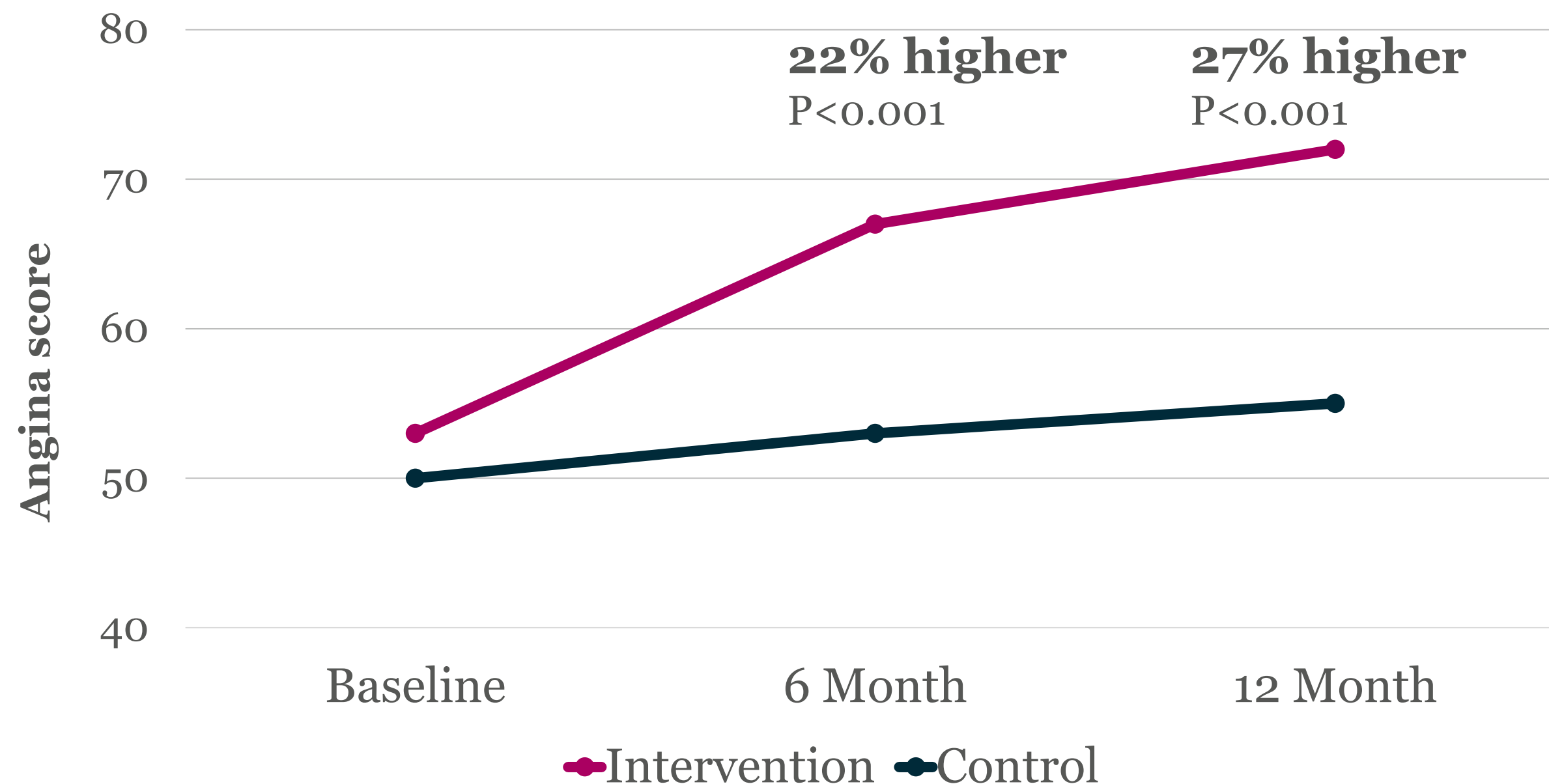
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Treatment of CMD Improves Patient Outcomes

The CorMicA trial provided some promising answers and drove guideline changes

Main Results – 27% improvement in angina score



Treatments prescribed in CorMicA:

- Guideline directed therapy for microvascular angina – e.g., beta-blocker & lifestyle
- Guideline directed therapy for vasospastic angina – e.g., calcium-channel blocker & lifestyle
- Cease antianginal therapy for non-cardiac chest pain +/- non-cardiac Ix

Ford, T.J. et al *J Am Coll Cardiol Interv.* 2020;13(1):33-45.

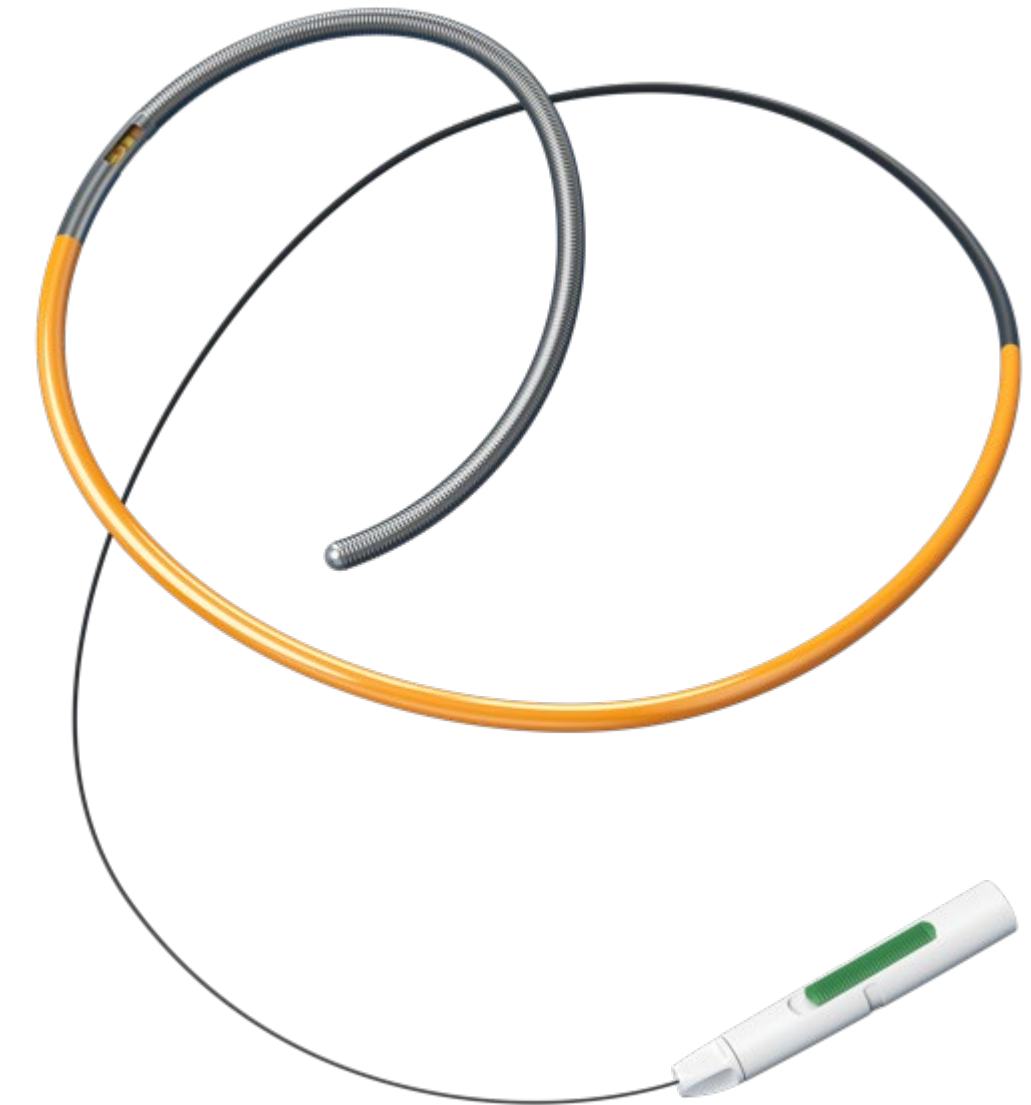
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Summary

- Chest pain has a challenging differential diagnosis¹
- INOCA is not always benign and may be a sign of Coronary Microvascular Dysfunction (CMD)¹
- Individualized medical therapy may be optimized with a CMD diagnosis to improve angina and quality of life²
- The Abbott's PressureWire™ X Guidewire is the only commercially available device that can diagnose CMD in the cath lab³



Abbott PressureWire™ X Guidewire

1. Kunadian, Vijay; EAPCI Expert Consensus Document *EHJ & Eurointervention* 2020: ehaa503. 2. Ford, T.J. et al *J Am Coll Cardiol Interv.* 2020;13(1):33-45.
3. Data on file at Abbott. PressureWire X Guidewire IFU. Corovantis CoroFlow IFU.

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