



**The NYU HARP Study –PI H Reynolds**  
 Plaque rupture/ulceration located in a normal area of the vessel in 45% of cases

**The finding of angiographically smooth coronary arteries does not preclude an etiologic role of thrombotic disease in MINOCA.**

NYU Cardiovascular Clinical Research Center Reynolds HR et al 2011

**Normal coronary angiogram. A smooth patent covetable left main, LAD, and circumflex projected from the screen. Next to these innocent-appearing vessels was a distinctly sinister IVUS study from the same angiogram demonstrating**

**What we can see is only 5% of the total coronary tree.**

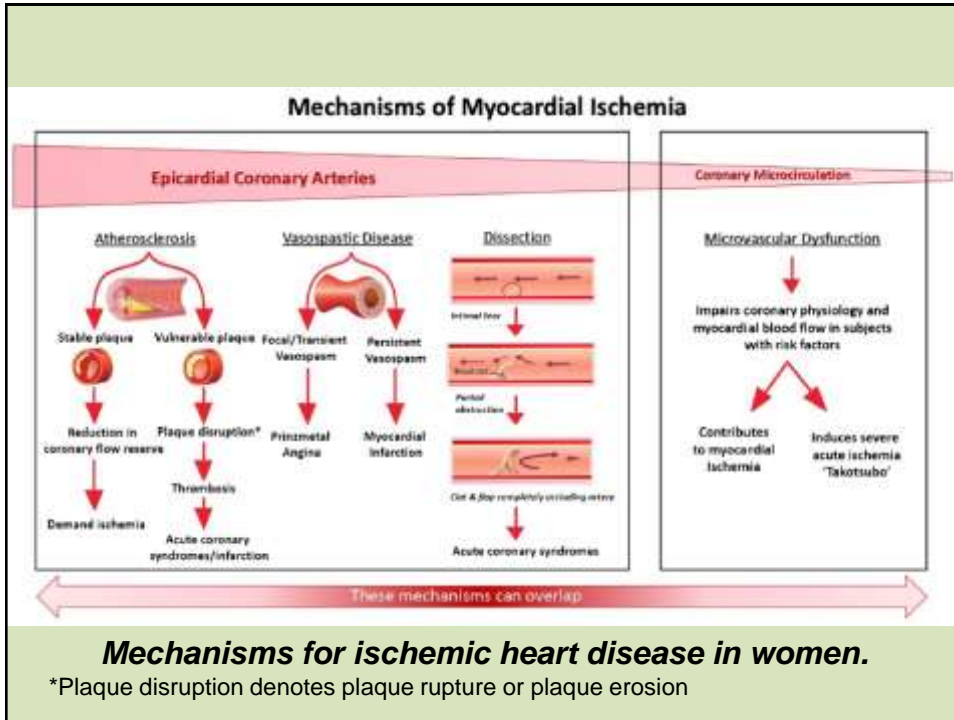
Coronary Circulation: segments

**What you see . . .**

**Non-obstructive Coronary Arteries**

**What you don't see . . .**

**? Coronary Microvascular Dysfunction**



## MINOCA ‘Five Ws and One H’

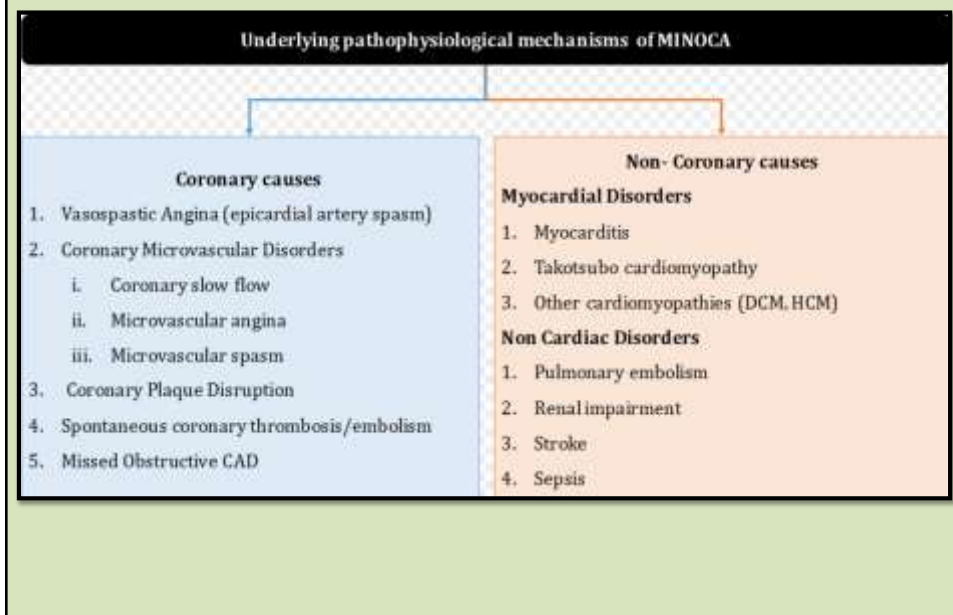
Circulation Journal  
 Official Journal of the Japanese Circulation Society  
<http://www.j-circ.or.jp>

**FOCUS REVIEWS ON CORONARY ARTERY DISEASE**

**The What, When, Who, Why, How and Where of Myocardial Infarction With Non-Obstructive Coronary Arteries (MINOCA)**

Sivabaskari Pasupathy, BSc; Rosanna Tavella, BSc, PhD; John F. Beltrame, BSc, MD, PhD

## MINOCA Etiology



**The diagnosis of MINOCA is made immediately upon coronary angiography in a patient presenting with features consistent with an AMI, as detailed by the following criteria:**

(1) Universal AMI criteria<sup>8</sup>

(2) Non-obstructive coronary arteries on angiography, defined as no coronary artery stenosis  $\geq 50\%$  in any potential IRA

(3) No clinically overt specific cause for the acute presentation

## Diagnostic Criteria of MINOCA

### 1. Acute MI criteria, including:

- a. Positive cardiac biomarker: defined as a rise and/or fall in serial levels, with at least 1 value above the 99<sup>th</sup> percentile upper reference limit.
- b. Clinical evidence of MI, including any of the following:
  - i. Ischemic symptoms (chest pain and/or dyspnea)
  - ii. Ischemic ECG changes (new ST segment changes or left bundle branch block)
  - iii. New pathological Q waves
  - iv. New loss of viable myocardium on myocardial perfusion imaging or
  - v. New regional wall motion abnormality on left ventricular imaging.

### 2. Non-obstructive coronary arteries on angiography

Defined as the absence of obstructive coronary artery disease on angiography. (ie: no coronary artery stenosis  $\geq 50\%$ , in any potential infarct-related artery). This includes both patients with

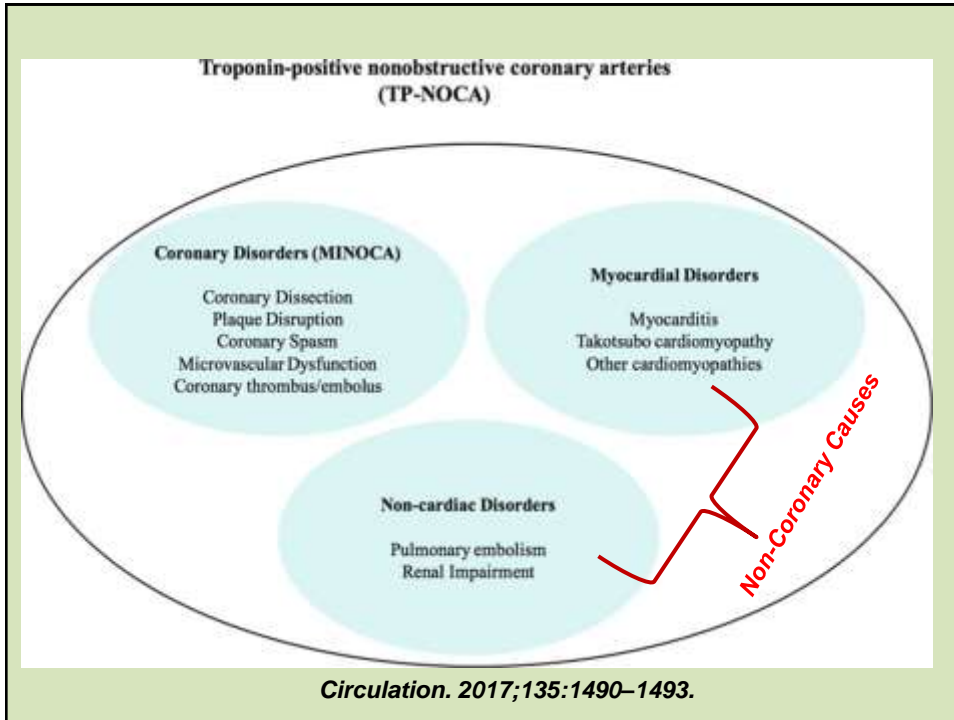
- o normal coronary arteries (no stenosis  $>30\%$ )
- o mild coronary atheromatosis (stenosis  $>30\%$  but  $<50\%$ )

### 3. No clinically overt-specific cause for the acute presentation


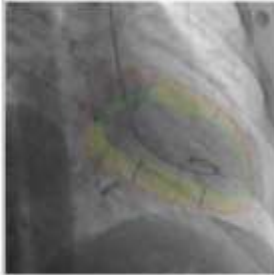

Defined at the time of angiography, the underlying cause of the clinical presentation and myocardial injury is not apparent.



***A potential problem with current AMI criteria is their central focus upon troponins, since clinicians encounter elevated troponins in clinical scenarios other than AMI.***



**MINOCA:**  
*A case study of a 55-year-old woman with an anterior STEMI presentation.*

<p><b>Clinical Presentation</b> 55-year old female presented with sudden onset of central chest pain for 2 hours.</p> <p><b>Troponin T</b> (Reference Range &lt;2ng/L) Initial: 99 ng/L 6 Hours: 301 ng/L</p>	<p><b>Coronary Angiography</b> No significant coronary stenosis</p> 	<p><b>D-Dimer:</b> Negative <b>Left Ventriculogram:</b> Normal</p> 
<p><b>ECG</b> ST elevation in V3-V5</p> 	<p><b>1. Acute Myocardial Infarction</b></p>	<p><b>2. Non-Obstructive Coronary Arteries</b></p>
<p><b>3. No apparent cause for presentation</b></p>		
<p style="font-size: 2em; color: red;">↓</p> <p style="text-align: center;"><b>MINOCA - 'a working diagnosis'</b> Myocardial Infarction with Non-Obstructive Coronary Arteries</p>		



***MINOCA should be considered as a 'working diagnosis', analogous to heart failure, and thus prompts further evaluation regarding its underlying mechanism(s).***

***Current US guidelines do not address MINOCA***

**Myocardial Infarction With Non-Obstructive Coronary Arteries –  
Help From The ESC**

Posted on October 24, 2017 by Tom Wadi MD



European Heart Journal (2017) 38, 143–153  
doi:10.1093/eurheartj/ehw149

**CURRENT OPINION**

## **ESC working group position paper on myocardial infarction with non-obstructive coronary arteries**

**Stefan Agewall<sup>1\*</sup>, John F. Beltrame<sup>2</sup>, Harmony R. Reynolds<sup>3</sup>, Alexander Niessner<sup>4</sup>, Giuseppe Rosano<sup>5,6</sup>, Alida L. P. Caforio<sup>7</sup>, Raffaele De Caterina<sup>8</sup>, Marco Zimarino<sup>8</sup>, Marco Roffi<sup>9</sup>, Keld Kjeldsen<sup>10</sup>, Dan Atar<sup>1</sup>, Juan C. Kaski<sup>6</sup>, Udo Sechtem<sup>11</sup>, and Per Tornvall<sup>12</sup>, on behalf of the WG on Cardiovascular Pharmacotherapy**



ESC

European Society  
of CardiologyEuropean Heart Journal (2017) 00, 1–66  
doi:10.1093/eurheartj/ehz293

ESC GUIDELINES

## 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation

The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC)

### What is new in 2017 STEMI Guidelines

#### 2017 NEW / REVISED CONCEPTS

##### MINOCA AND QUALITY INDICATORS:

- New chapters dedicated to these topics.

##### TIME LIMITS FOR ROUTINE OPENING OF AN IRA:

- 0–12h (Class I); 12–48h (Class IIa); >48h (Class III).

##### STRATEGY SELECTION AND TIME DELAYS:

- Clear definition of first medical contact (FMC).
- Definition of “time 0” to choose reperfusion strategy (i.e. the strategy clock starts at the time of “STEMI diagnosis”).
- Selection of PCI over fibrinolysis: when anticipated delay from “STEMI diagnosis” to wire crossing is  $\leq 120$  min.
- Maximum delay time from “STEMI diagnosis” to bolus of fibrinolysis agent is set in 10 min.
- “Door-to-Ballon” term eliminated from guidelines.

##### ELECTROCARDIOGRAM AT PRESENTATION:

- Left and right bundle branch block considered equal for recommending urgent angiography if ischemic symptoms.

##### TIME TO ANGIOGRAPHY AFTER FIBRINOLYSIS:

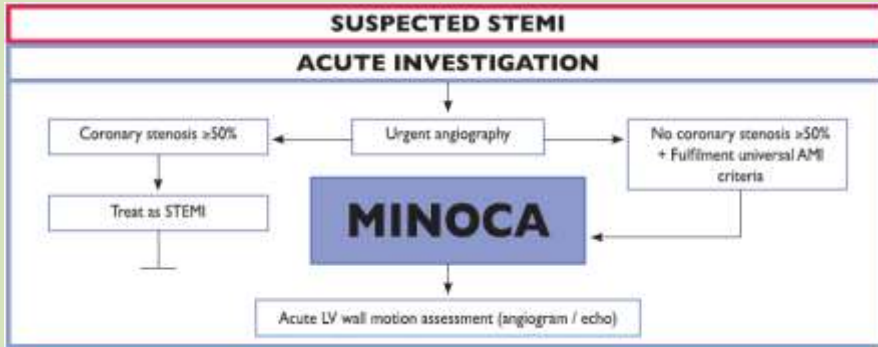
- Timeframe is set in 2–24h after successful fibrinolysis.

##### PATIENTS TAKING ANTICOAGULANTS:

- Acute and chronic management presented.



## Diagnostic test flow chart in MINOCA.



**Figure 7** Diagnostic test flow chart in MINOCA. CHR = Cardiac Magnetic Resonance; IVUS = IntraVascular Ultrasound; LV = Left Ventricle; MINOCA = Myocardial Infarction with Non-Obstructed Coronary Arteries; OCT = Optical Coherence Tomography; STEMI = ST segment Elevation Myocardial Infarction; TCE = Trans-Chestigated Echocardiography; TTE = Trans-Thoracic Echocardiography. Takotsubo syndrome cannot be diagnosed with certainty in the acute phase as the definition requires follow up imaging to document recovery of left ventricular function. IVUS and OCT frequently show more atherosclerotic plaque than may be appreciated on angiography. They also increase sensitivity for dissection. If intracoronary imaging is to be performed, it is appropriate to carry out this imaging at the time of the acute cardiac catheterisation, after diagnostic angiography. Patients should be made aware of the additional information the test can provide and the small increase in risk associated with intracoronary imaging.

1 • Provocative testing for coronary artery spasm might be considered in selected patients with a recent AMI with suspected vasospastic angina. Provocative manoeuvres have to be always performed by operators with experience and not necessarily in the acute phase of STEMI.

2 • Clinically suspected myocarditis by ESC Task Force criteria = No angiographic stenosis  $\geq 50\%$  plus non ischaemic pattern on CMR. Definite myocarditis by ESC Task Force criteria = No angiographic stenosis  $\geq 50\%$  plus endomyocardial biopsy confirmation (histology, immunohistology, polymerase-chain reaction based techniques to search for genome of infectious agents, mainly viruses).

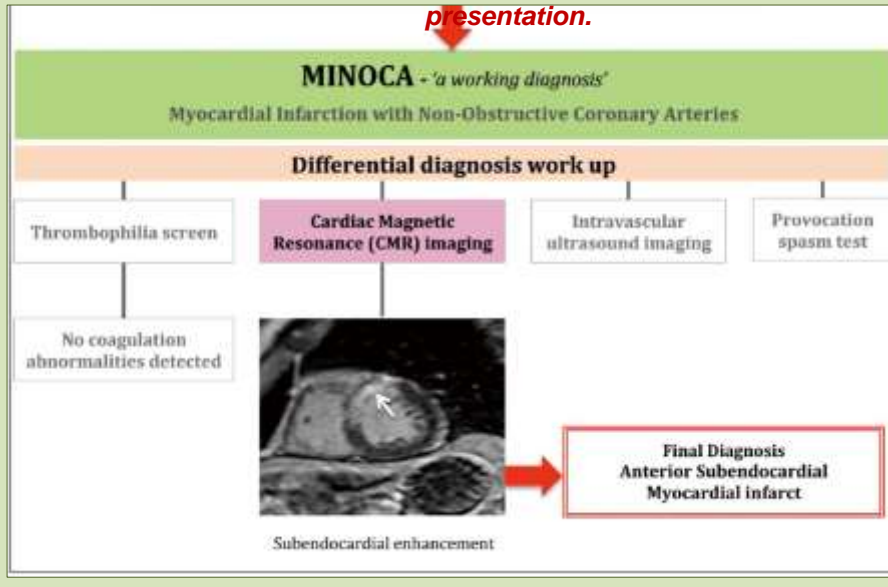
## Diagnostic test flow chart in MINOCA , Cont.

<b>SUSPECTED DIAGNOSIS AND FURTHER DIAGNOSTIC TESTS</b>		
	Non-invasive	Invasive
<b>Myocarditis</b>	<b>TTE Echo</b> (pericardial effusion) <b>CMR</b> (myocarditis <sup>1</sup> , pericarditis)	<b>Endomyocardial biopsy</b> (myocarditis)
<b>Coronary (epicardial/microvascular)</b>	<b>TTE Echo</b> (Regional wall motion abnormalities, embolic source) <b>CMR</b> (small infarction) <b>TOE/Bubble Contrast Echo</b> (Patent foramen ovale, atrial septal defect)	<b>IVUS/OCT</b> (plaque disruption/dissection) <b>Ergonovine/Ach test<sup>1</sup></b> (spasm) <b>Pressure/Doppler wire</b> (microvascular dysfunction)
<b>Myocardial disease</b>	<b>TTE Echo</b> <b>CMR</b> (Takotsubo, others)	
<b>Pulmonary Embolism</b>	<b>D-dimer</b> (Pulmonary embolism) <b>CT scan</b> (Pulmonary embolism) <b>Thrombophilia screen</b>	
<b>Oxygen supply/demand imbalance- Type 2 MI</b>	<b>Blood tests, Extracardiac investigation</b>	

Again, back to our case.....

## MINOCA:

A case study of a 55-year-old woman with an anterior STEMI presentation.



## JACC: Cardiovascular Imaging

January 2017

DOI: 10.1016/j.jcmg.2016.11.010

[PDF Article](#)

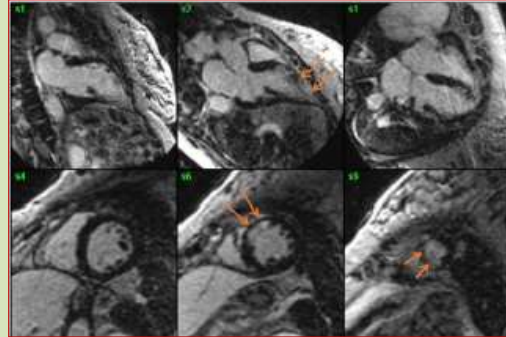
### Myocardial Infarction With Nonobstructed Coronary Arteries

Impact of CMR Early After Presentation

***CMR imaging is a key investigation in identifying the underlying cause***



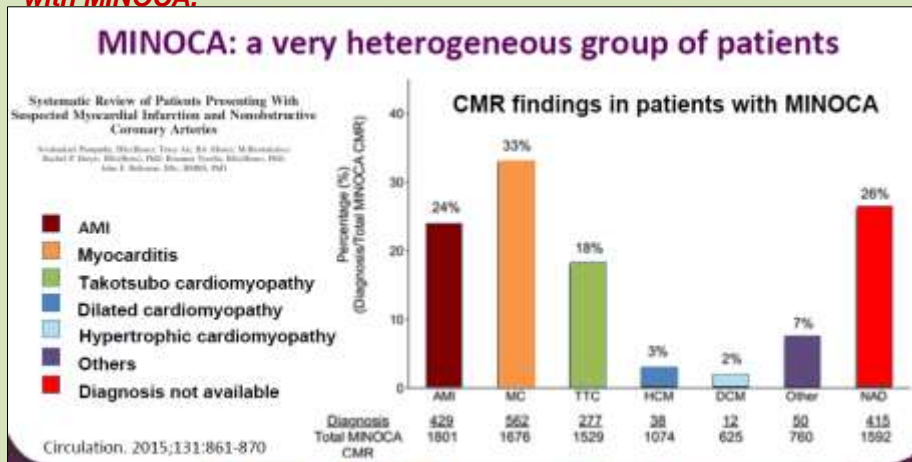
**Coronary angiography portraying subtle lesion (arrow) involving the mid LAD**



**Cardiac MRI revealing LGE of the mid to distal anteroseptal wall (arrows). Still frames from horizontal long axis (top row) and short axis (bottom row) are consistent with mid to distal LAD infarction**

Ann Clin Lab Res. 2016, 4: 3.

**Cardiac magnetic resonance (CMR) imaging findings in patients with MINOCA.**



**Bar graph of published studies showing the diagnostic significance of CMR imaging in MINOCA patients.**

Data presented as percentage (%).

# Management

A fundamental consideration is identifying the underlying cause of this heterogeneous syndrome because that will determine appropriate therapy.

## *MINOCA : is not a benign condition?*

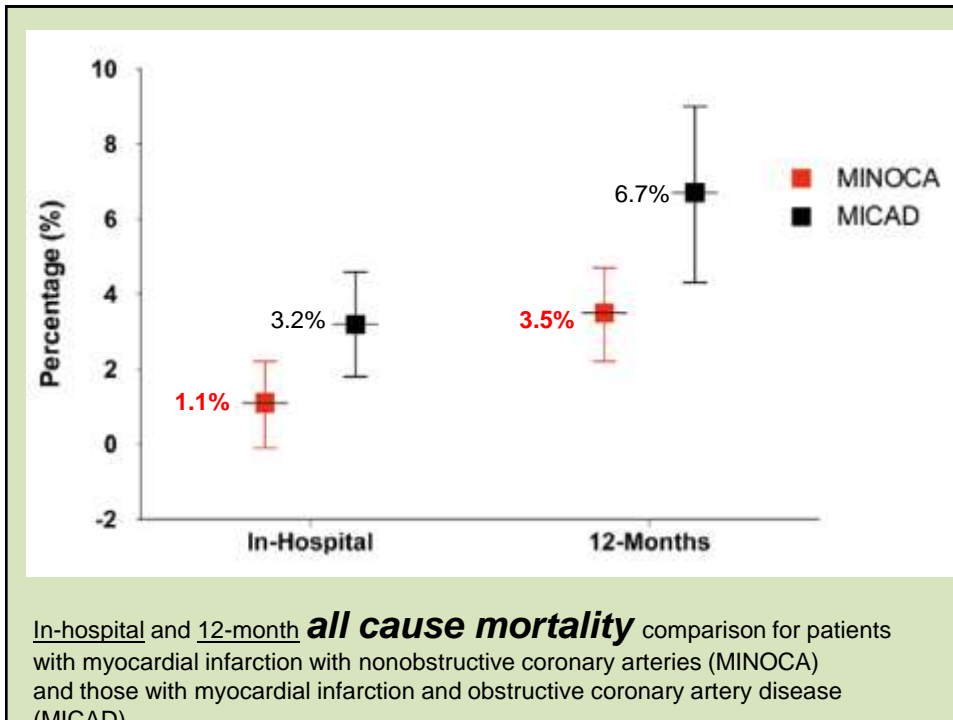
### All-Cause Mortality in Patients With MINOCA or MI-CAD

All-Cause Mortality	Comparative Studies			All MINOCA Studies
	MI-CAD % (95% CI)	MINOCA % (95% CI)	OR (95% CI) P Value	
In-hospital	3.2% (1.8%, 4.6%)	1.1% (-0.1%, 2.2%)	0.37 (0.2–0.67) P=0.001	0.9% (0.5%, 1.3%)
12-month	6.7% (4.3%, 9.0%)	3.5% (2.2%, 4.7%)	0.59 (0.41–0.83) P=0.003	4.7% (2.6%, 6.9%)

Data presented as percentage (%) and 95% confidence intervals (%) with odds ratio (OR) and P values.

MI-CAD indicates myocardial infarction with coronary artery disease; and

MINOCA, myocardial infarction with nonobstructive coronary arteries  
*Circulation 2015;131(10):861–870*



## Guarded Prognosis

Although the outcome of MINOCA strongly depends on the underlying cause, **its overall prognosis is serious, with a 1 year mortality of about 3.5%.**

**Hence patients with MINOCA should receive the same clinical attention as AMI patients who have single- or double-vessel disease and not merely dismissed as having an insignificant clinical condition.**

*This is crucial since many patients, particularly those with angiographically normal coronary arteries, are often labelled as 'non-cardiac', therefore missing the chance for appropriate treatment. And this group of patients characterizes substantially worse outcome than previously it was believed.*

ORIGINAL RESEARCH ARTICLE

**Medical Therapy for Secondary Prevention and Long-Term Outcome in Patients With Myocardial Infarction With Nonobstructive Coronary Artery Disease**

*Circulation. 2017;135:1481–1489*

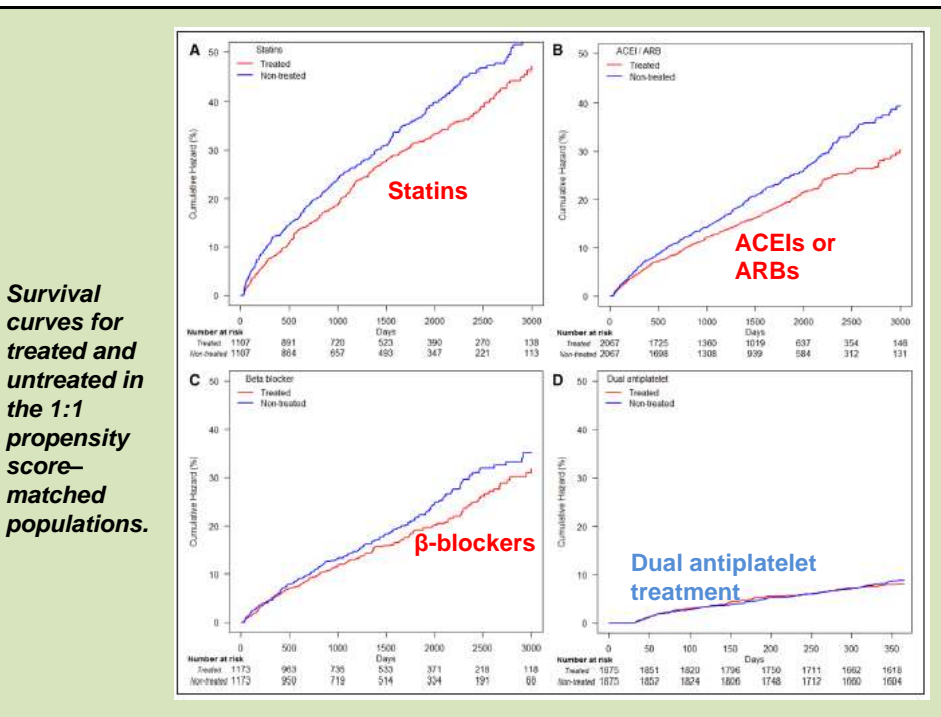
### Clinical Perspective

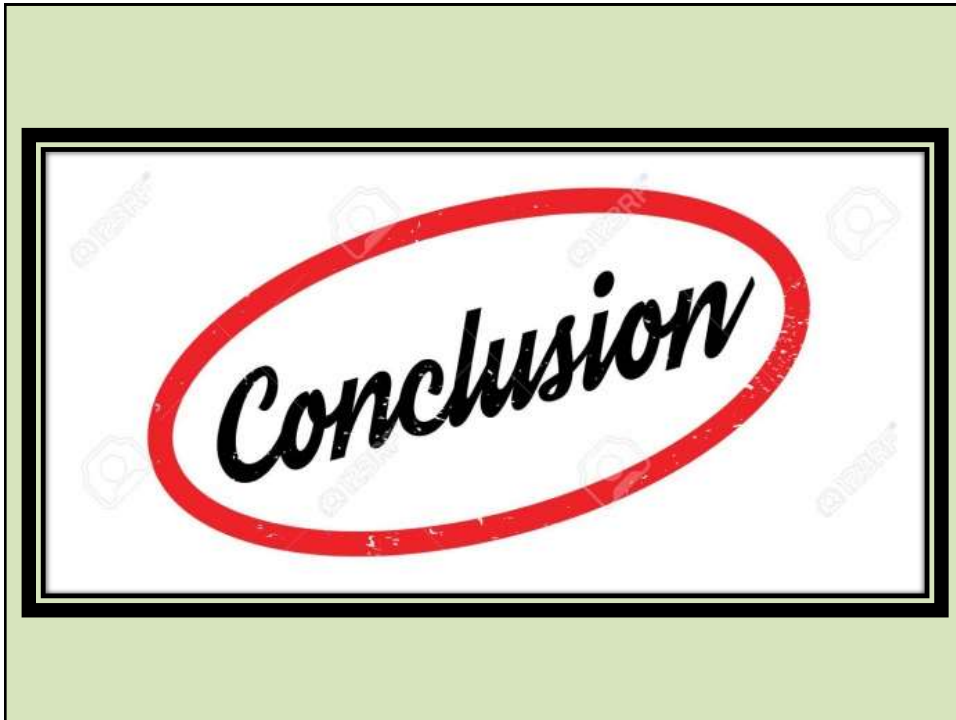
#### What Is New?

- This is the first study evaluating secondary prevention treatments in a large group of patients with myocardial infarction with nonobstructive coronary arteries.
- Patients treated with statins and renin-angiotensin system blockers had a significantly 23% and 18% lower risk of a major adverse cardiac event during follow-up.
- In contrast, there were no significant reductions in risk of major adverse cardiac events after treatment with  $\beta$ -blockers and dual antiplatelet therapy.

#### What Are the Clinical Implications?

- The results indicate that long-term treatment with statins and renin-angiotensin system blockers may be beneficial in patients with myocardial infarction with nonobstructive coronary arteries.
- Treatment with  $\beta$ -blockers and dual antiplatelet therapy seem less likely to reduce the risk of new cardiovascular events in patients with myocardial infarction with nonobstructive coronary arteries.





- *MINOCA occurs dominantly in women*
- *MINOCA is not a false positive MI*
- *Additional diagnostics should be used (IVUS, MRI, OCT, CTA)*
- *Differential can include plaque rupture, plaque erosion, coronary dissection, Takotsubo cardiomyopathy, vasospasm, pro-thrombotic disorder, myocarditis)*
- *RAS blocker and high intensity statin therapy makes sense*

