

**High Sensitivity Troponin (hs-TnT)  
&  
Emergency Department Risk Stratification  
of Acute Coronary Syndromes (ACS)**



# High Sensitivity Troponin (hs-TnT) is here!

## Situation:

- **All BSW facilities will adopt the Roche Gen 5 Elecsys troponin T (hs-TnT) assay over the next 18 months**
- Our new assay has improved sensitivity and precision which will allow for more rapid risk stratification and identification of acute MI. The new assay will also detect myocardial injury in patients without ACS more frequently.
- **It is critical that we all gain proficiency in appropriate hs-TnT use to avoid harm & unnecessary testing.**

## Background:

- **A multidisciplinary BSW committee has approved an updated ACS HEART pathway utilizing hs-TnT & validated ED risk stratification using the HEART score**
- The new pathway will support accelerated ACS rule outs **(0/1hr ± 3hr)** in patients presenting to our EDs with chest pain
- hs-TnT order sets have been built into Epic to assist with calculation of absolute and delta values.



# High Sensitivity Troponin (hs-TnT) is here!

## Assessment:

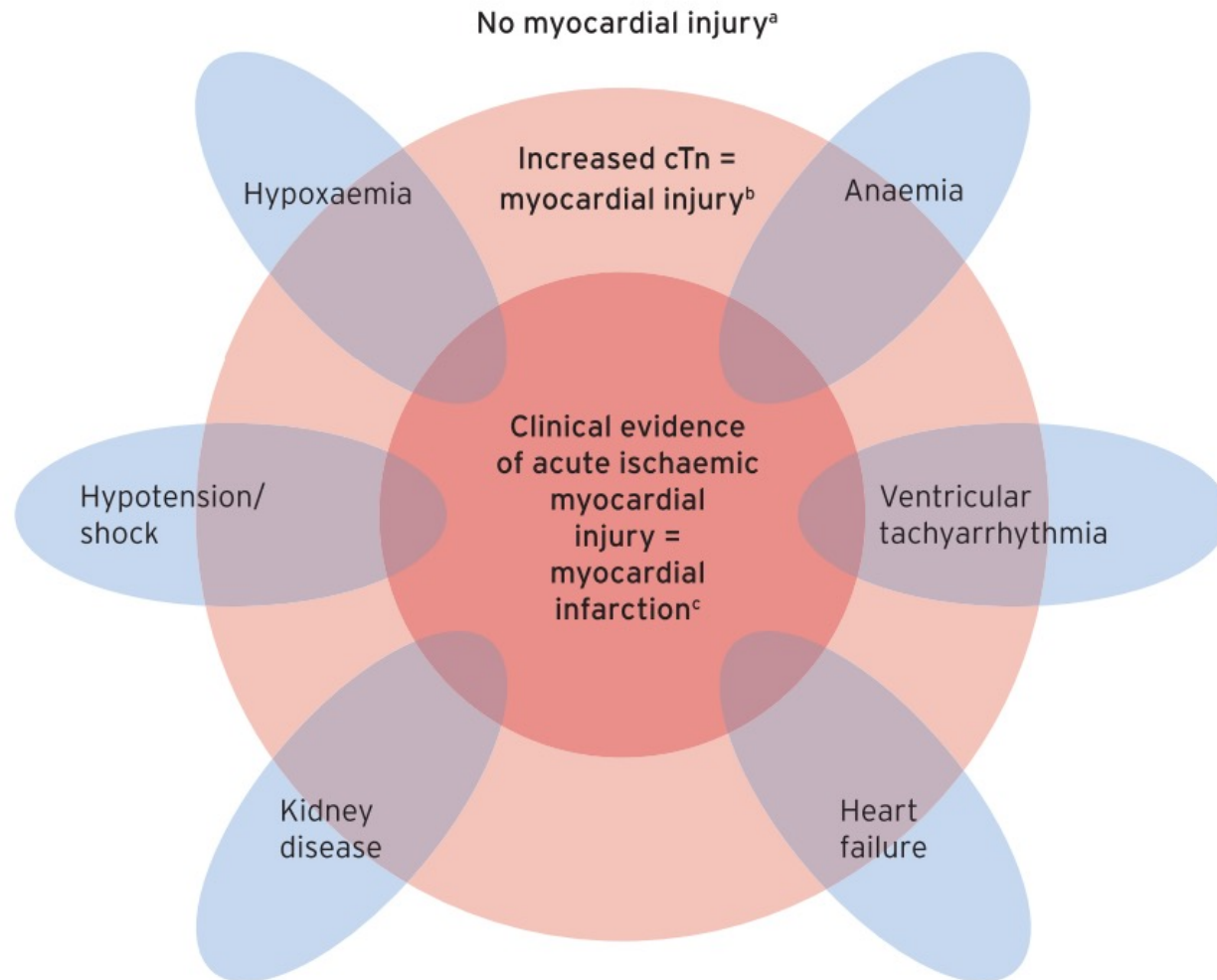
- Implementation of our new hs-TnT assay is an opportunity to expedite and improve the quality of care delivered to our chest pain patients
- Up to 50% of patients without ACS will have a detectable hs-TnT, so it is critical to learn how to interpret these values

## Recommendation:

- All acute care providers should promptly familiarize themselves with the updated HEART pathway and become proficient in appropriate use of the new hs-TnT assay



# Myocardial Injury & Infarction are not the same!



**Spectrum of myocardial injury:  
From no injury to infarction...**

**4th Universal Definition of MI. JACC 2018. PMID: 30153967.**



# Myocardial Injury: Definition

- Elevated troponin (cTn > 99% URL)
- Myocardial injury is **acute** if there is a **rise and fall** of troponin levels



4th Universal Definition of MI. JACC 2018. PMID: 30153967.



# Acute Myocardial Infarction: Definition

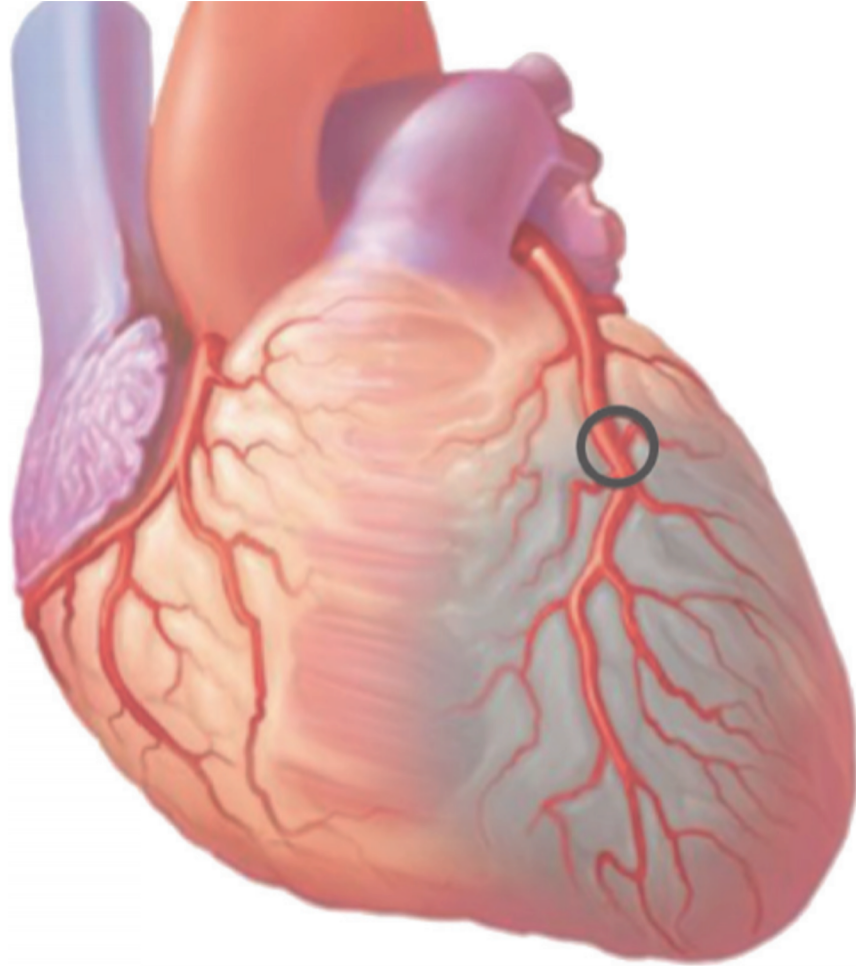
Clinical evidence of acute myocardial ischemia + acute myocardial injury (rise/fall of cTn) with at least one of the following:

- Symptoms of myocardial ischemia
- New ischemic ECG changes
- New pathological Q waves
- New wall motion abnormalities
- Thrombus on angiography or autopsy

**4th Universal Definition of MI. JACC 2018. PMID: 30153967.**



# Acute MI: Type I



Plaque rupture/erosion with occlusive thrombus

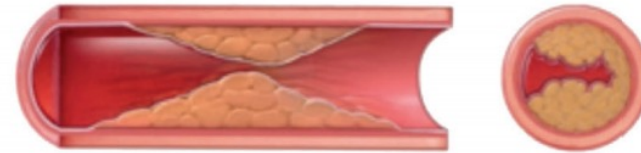
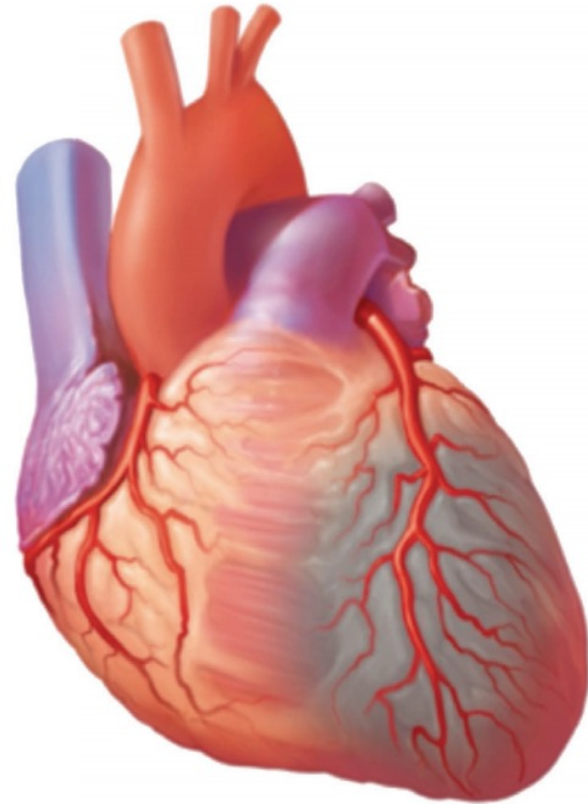


Plaque rupture/erosion with non-occlusive thrombus

**4th Universal Definition of MI. JACC 2018. PMID: 30153967.**



# Acute MI: Type II



Atherosclerosis and oxygen supply/demand imbalance



Vasospasm or coronary microvascular dysfunction



Non-atherosclerotic coronary dissection



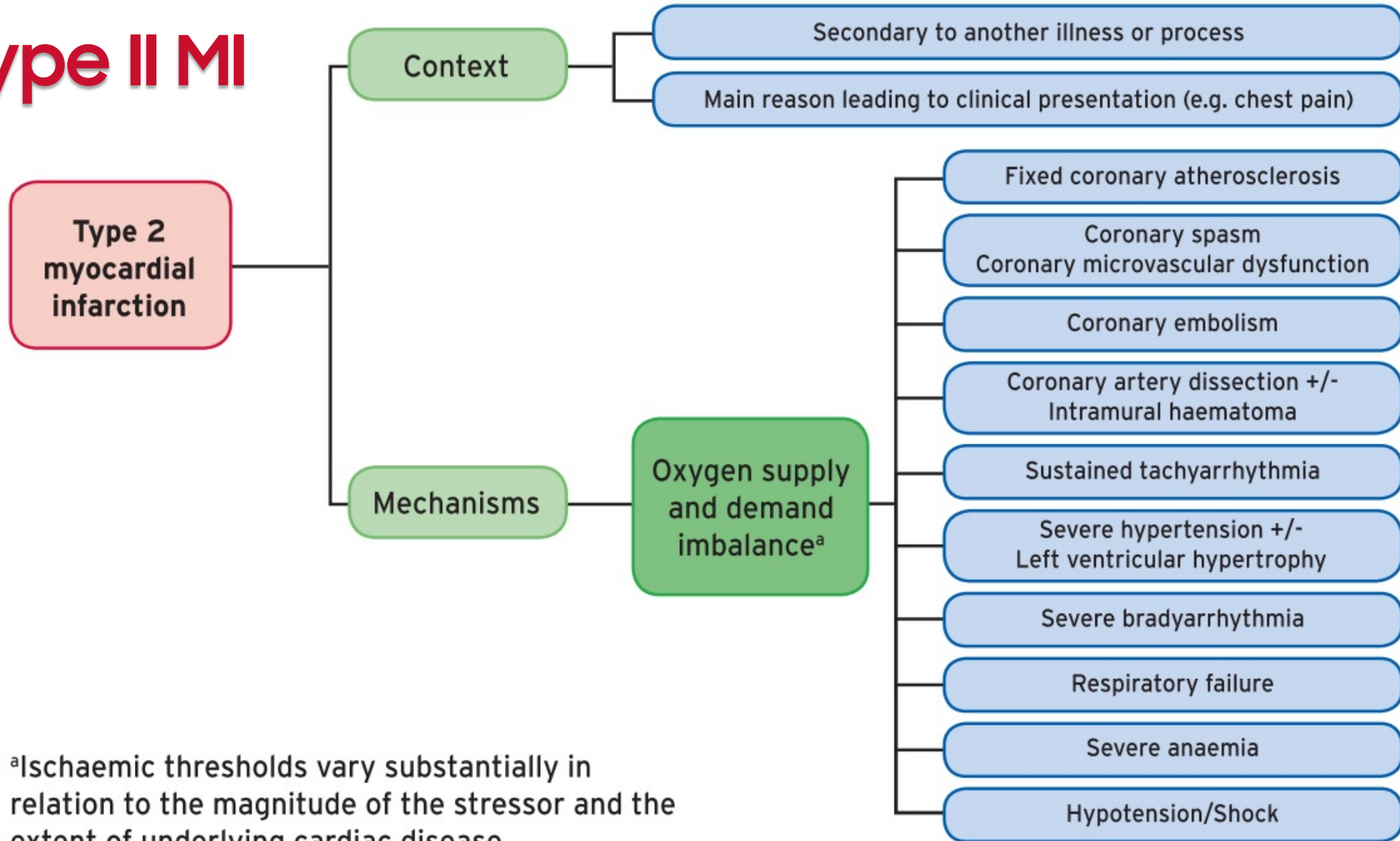
Oxygen supply/demand imbalance alone

**4th Universal Definition of MI. JACC 2018. PMID: 30153967.**





# Type II MI



<sup>a</sup>Ischaemic thresholds vary substantially in relation to the magnitude of the stressor and the extent of underlying cardiac disease.

**4th Universal Definition of MI. JACC 2018. PMID: 30153967.**



# hs-TnT: So, what's different?

Improved detection of MI – able to detect much lower concentrations of troponin protein, shortening time interval required to identify myocardial injury

- Will result in more detectable levels; critical we know how to interpret

System wide implementation starting with BUMC go live on 7/27/21

- Used outside US since 2011; received FDA clearance January 2017

No more decimals!

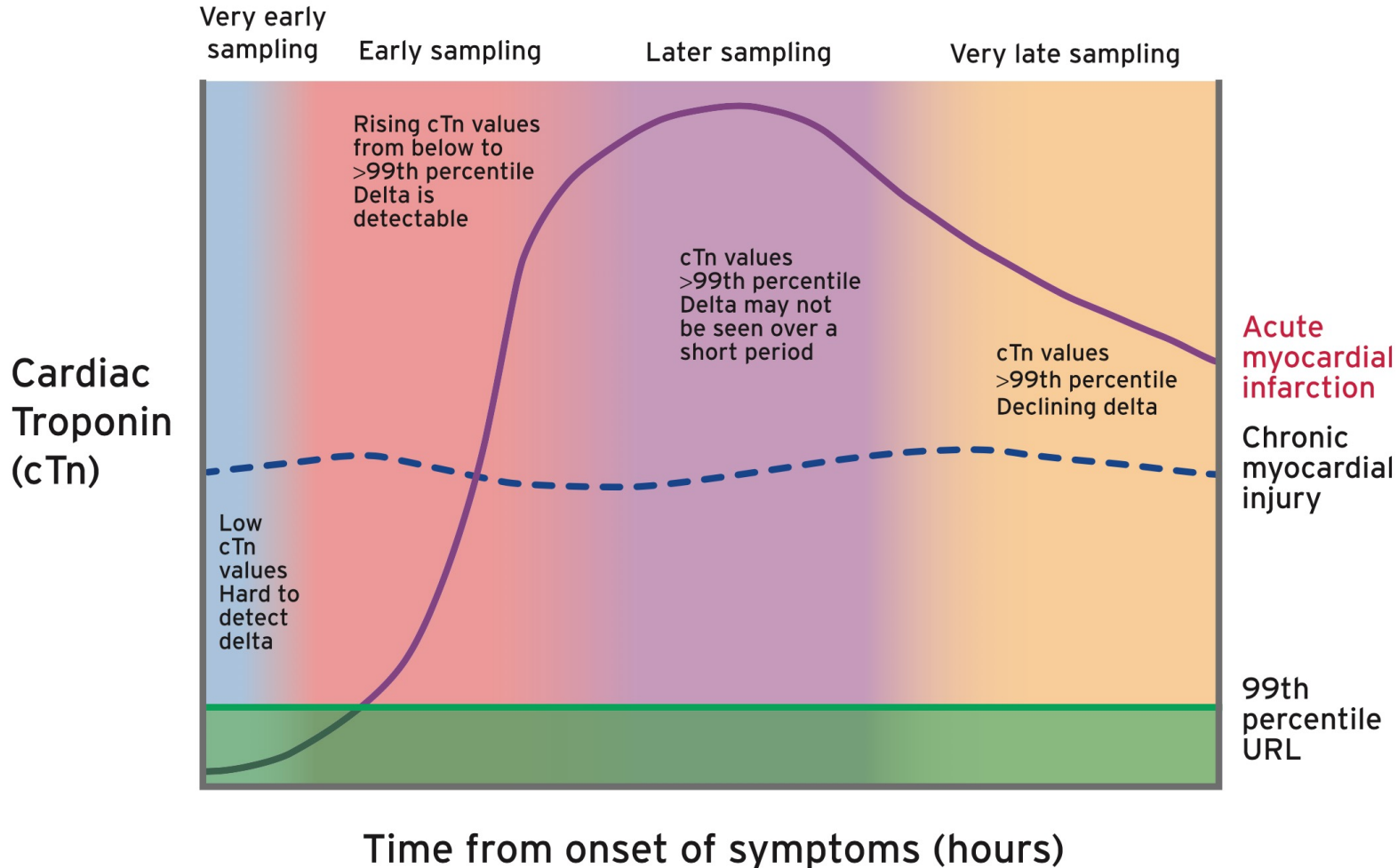
- 0.1 ng/mL → 100 ng/L
- $\geq 52$  ng/L,  $\Delta > 5$  ng/L @ 1hr or  $> 7$  ng/L @ 3hrs is abnormal!

Sex-specific thresholds for 99<sup>th</sup> URL

- Prior:  $>0.05$  ng/mL 99<sup>th</sup> URL, hs-TnT  $< 6$  ng/L = below LOQ
- Female:  $< 14$  ng/L &  $\Delta < 3$  ng/L @ 1hr,  $\Delta < 5$  @ 3hrs =  $< 99^{\text{th}}$  URL
- Male:  $< 22$  ng/L &  $\Delta < 3$  ng/L @ 1hr,  $\Delta < 5$  @ 3hrs =  $< 99^{\text{th}}$  URL



# Timing & serial sampling matters!



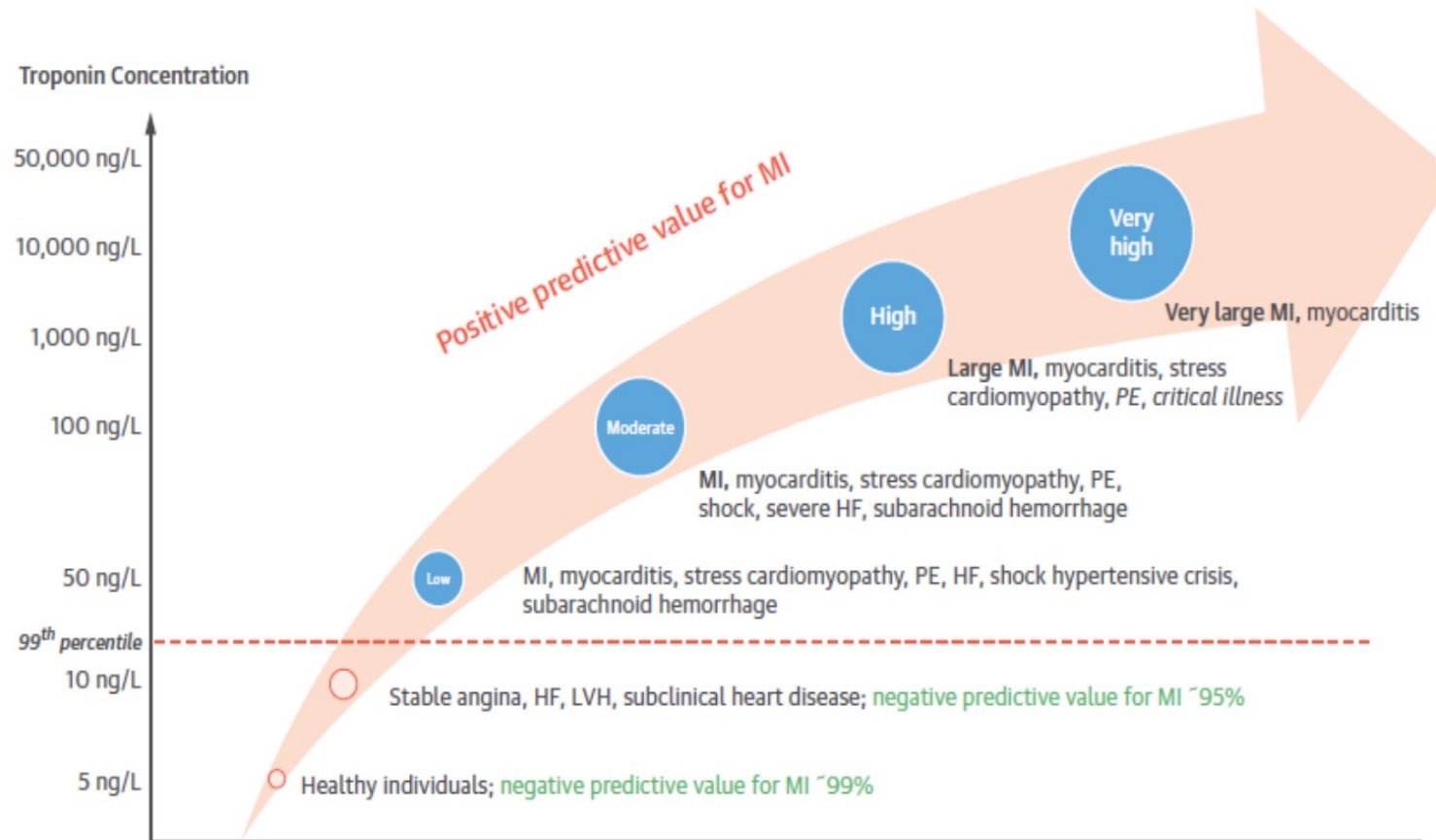
A decrease in troponin over time can indicate acute injury that occurred days ago....this is less specific for ACS & more often associated with non-ACS conditions.

When troponin is declining during serial testing, you need to have clinical criteria (see AMI definition) to make the diagnosis of ACS/MI.

**KEY CLINICAL PEARL:** When an initial hs-TnT is ordered, always consider routinely ordering another 1hr delta...unless patient is VERY LOW RISK for ACS, onset is > 3hrs from arrival, AND the initial hs-TnT = < 6 ng/L.



# Positive Predictive Value of hs-TnT



When your clinical suspicion for ACS is below a testing threshold...DO NOT order the troponin!

**KEY CLINICAL PITFALL:** Just like acute MI, unstable angina does not necessarily manifest with any ECG abnormalities and may have a normal initial hs-TnT... beware in patients with concerning symptoms with a normal or nonspecific initial ECG!



# Negative Predictive Value of hs-TnT

## Circulation

Volume 143, Issue 17, 27 April 2021; Pages 1659-1672  
<https://doi.org/10.1161/CIRCULATIONAHA.120.049298>



## ORIGINAL RESEARCH ARTICLE

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### **Diagnostic Performance of High-Sensitivity Cardiac Troponin T Strategies and Clinical Variables in a Multisite US Cohort**

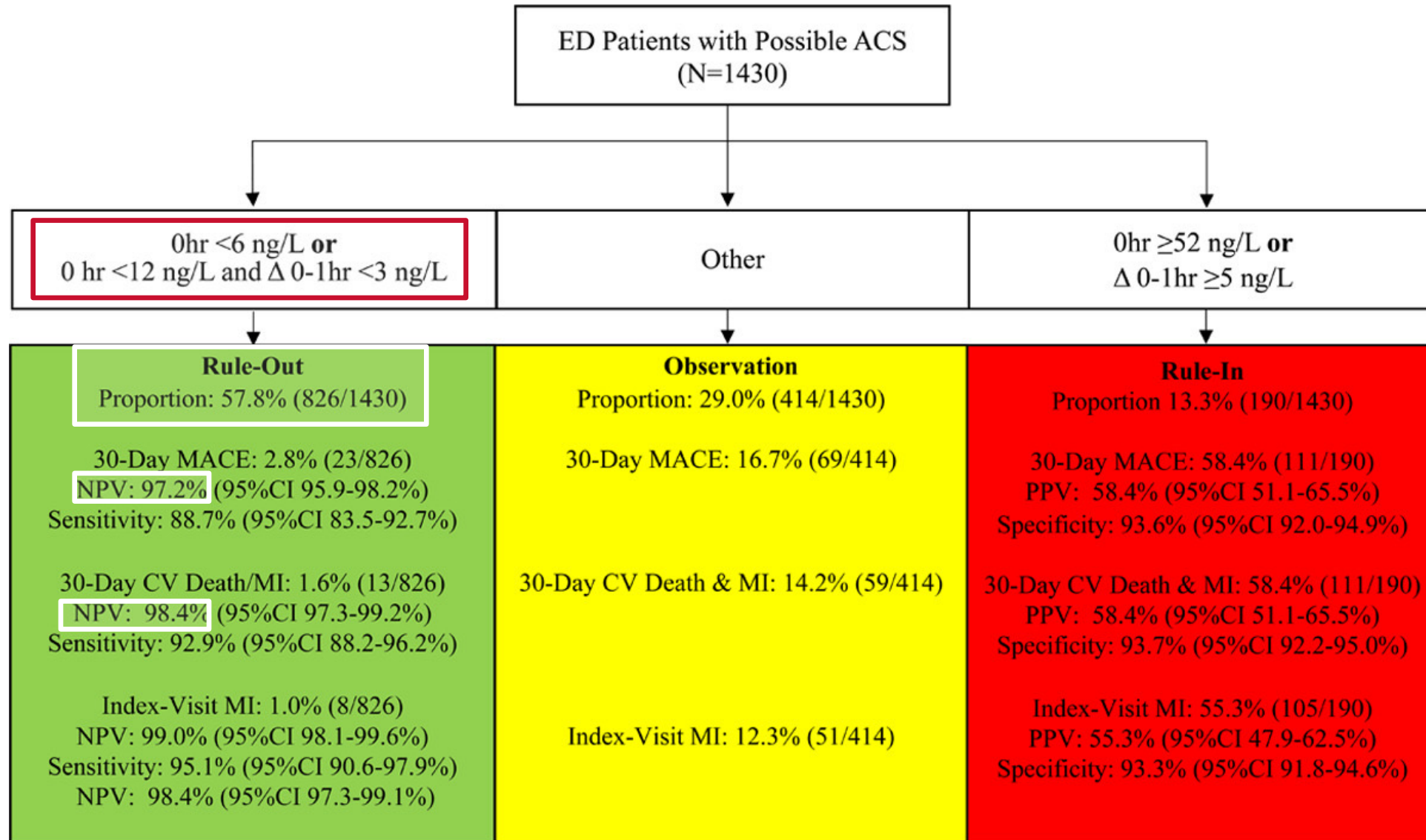
**Largest prospective multisite US study of hs-TnT strategies to date!**  
(n=>1450, 14.4% MACE):

- Initial hs-TnT below LOQ (<6 ng/L) alone; NPV= 98.3% for 30-day MACE, 99% index MI/death & ruled out 32.8%

**Circulation 2021. PMID: 33474976.**



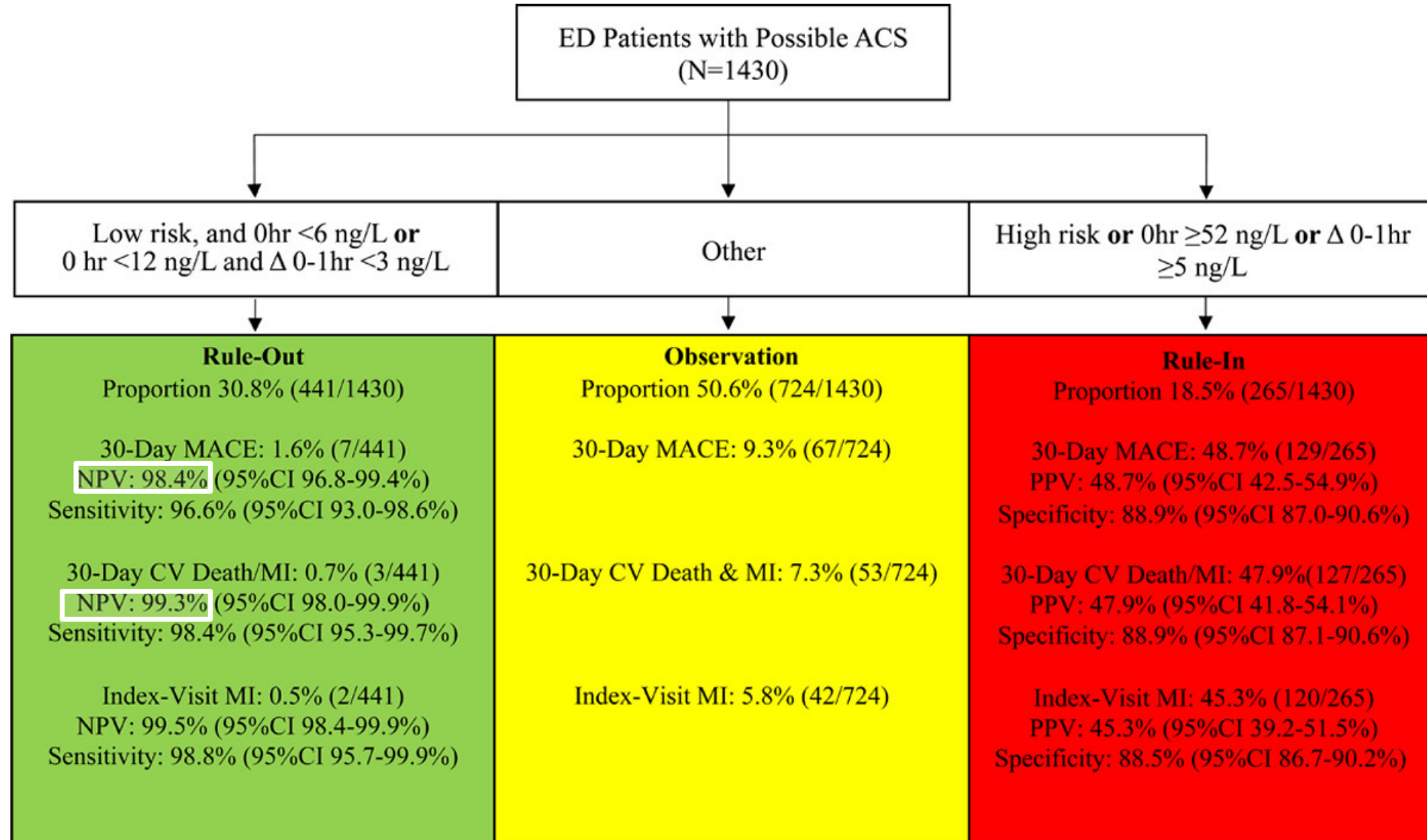
# 0/1h hs-TnT for 30d MACE, index MI, & death



**Circulation 2021. PMID: 33474976.**



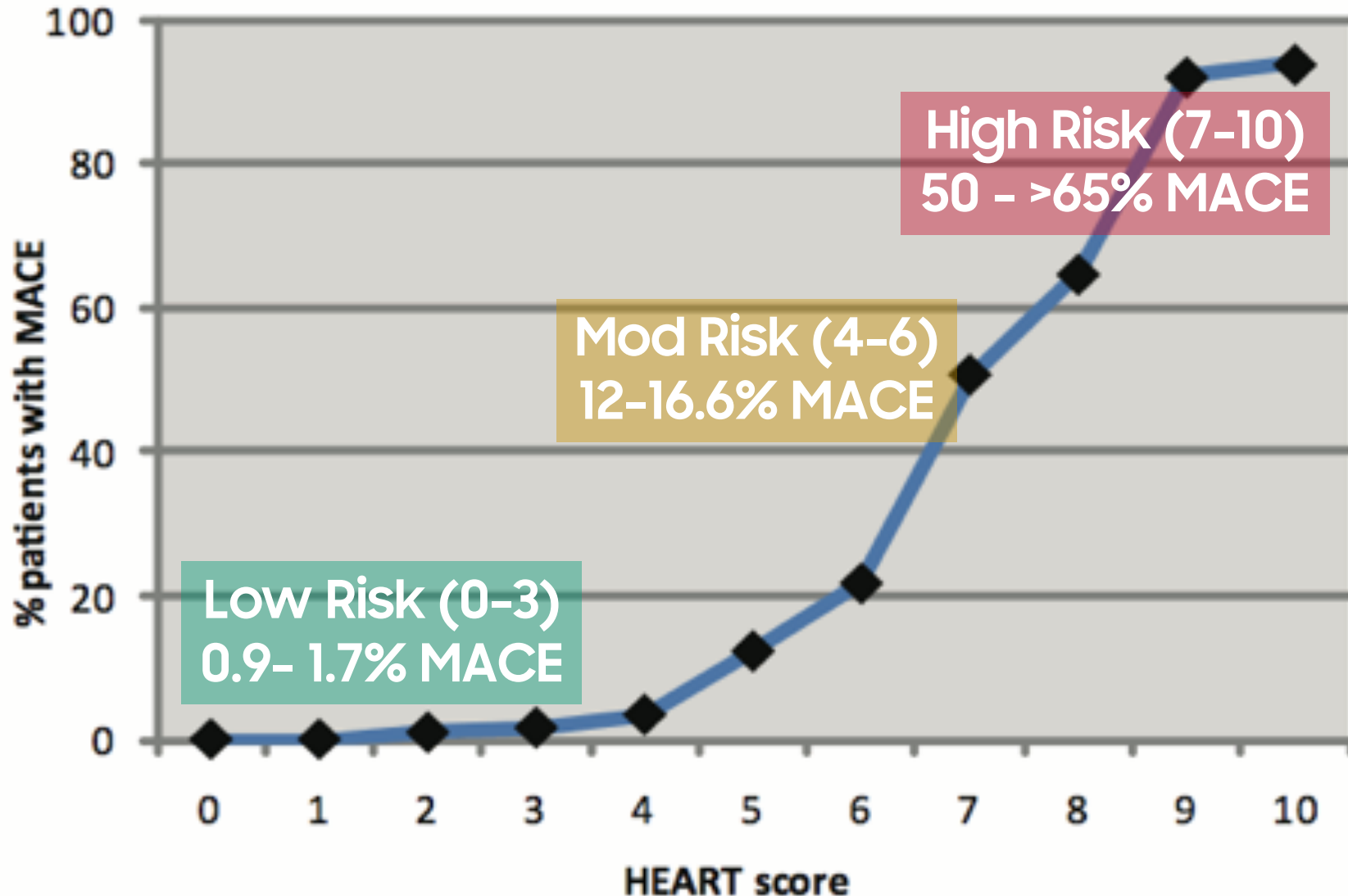
# 0/1h hs-TnT + HEART for 30d MACE, index MI, & death



**Circulation 2021. PMID: 33474976.**



# Risk stratify using hs-TnT & the HEART score!



## KEY CLINICAL PITFALL:

Take caution in scoring patients with a highly suspicious history (2-point Hx) or acute ECG changes suggestive of ischemia (2-point ECG) as low risk regard less of total score!





# Emergency Department Chest Pain ADP

<sup>1</sup> Applies to patients with an initial concern for ACS **except** those with:

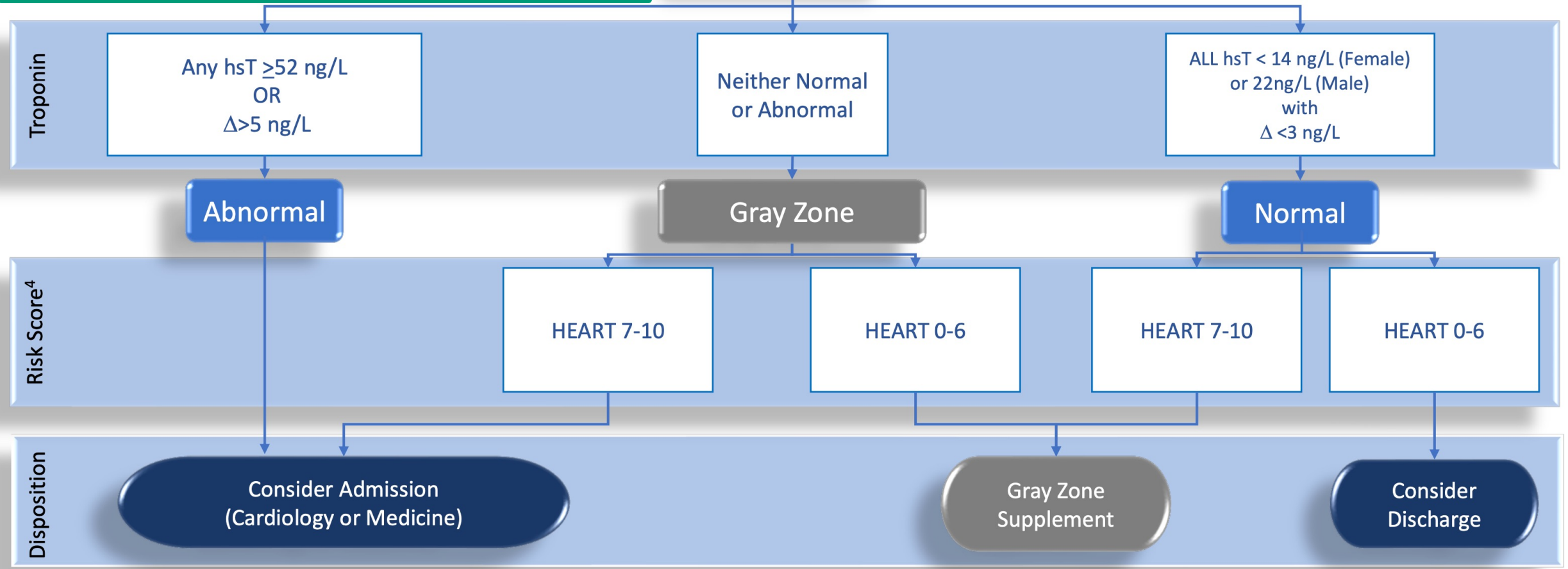
- STEMI (do not wait for troponin results for PCI)
- Renal Failure (comparisons of time 0 troponin to prior values using the same assay or delta troponin may be more useful)
- Highly likely non-ACS alternative diagnosis subsequently made during ED evaluation

<sup>2</sup> Patients with symptoms onset > 3 hours prior to arrival may be discharged if the initial troponin value is non-detectable (<6 ng/L) AND HEART score is 0-3 (low risk)

Patient arrives with chest pain or anginal equivalent concerning for ACS <sup>1</sup>

Order high sensitivity Troponin (hsT) and EKG at presentation and 1 hour later <sup>2,3</sup>

**KEY CLINICAL PITFALL:**  
If your history is not at least slightly suspicious for ACS, then do not order a hs-TnT for the evaluation of ACS, the patient can be excluded from the pathway!



# How suspicious is the HISTORY for ACS?

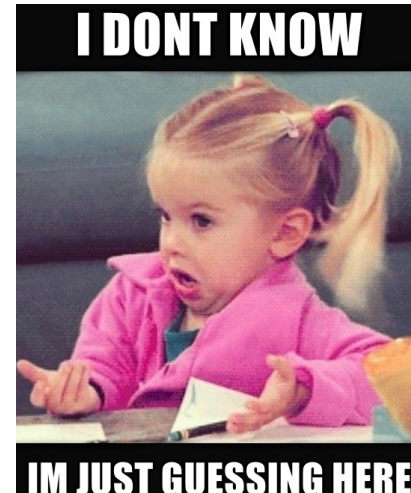
**Textbook HPI:** Aged with acute onset CP radiating to the left arm, shoulder, or jaw...with associated diaphoresis, vomiting, SOB, often with or without exertion or stress

- **ACS is notorious for atypical presentations, especially among women, diabetics, the elderly, and non-white populations**
- **33% of both STEMI & NSTEMI, as many as 75% of patients > 75 years old, and 40% of women with AMI present without any chest pain whatsoever!**
- **All of the following patient descriptions of chest discomfort are associated with the same incidence of AMI:** Burning, pressure, squeezing, indigestion, crushing, tightness, numbness, and nondescript chest discomfort
- Only "stabbing" chest discomfort is associated with a lower probability of ACS
- Clinical severity of symptoms ranges from silent MI, to vague complaints in well appearing patients, to electrical or hemodynamic instability or sudden cardiac arrest

# How good is your guess?

**Physician Gestalt** (blinded to everything except initial history and physical) showed the following categories and likelihood ratios for ACS:

- "Definite" (4.0)
- "Probable" (1.8)
- "Could be" (0.66)
- "Probably not" (0.20)
- "Definitely not" (0.36)



**KEY CLINICAL PEARL:** Compare this with structured ED risk assessment with the HEART score, which was very useful for the diagnosis of ACS (13.0), and identifying patients at low risk of ACS (0.20)!

## Most useful features & findings that ↑ the likelihood of ACS (+LR):

- **High-risk HEART score > 6 (13.0)** vs. High-risk overall gestalt (4.0)
- Abnormal previous stress test (3.1), Prior known CAD (2.0)
- Hx of peripheral arterial disease (2.7)
- **Pain radiating to right or bilateral arms (2.6), shoulder and jaws**
- **Exertional chest pain**
- **Diaphoresis**
- **Vomiting**
- Pain like prior ischemia (2.2)
- Change in pattern over previous 24h (2.0)
- Older age

## Most useful features & findings that ↓ the likelihood of ACS (-LR):

- **Low risk HEART score  $\leq 3$  (0.20)**
- **Pain fully reproducible by palpation (0.28)**
- **Sharp/Stabbing pain**
- **Pain localized to a fingertip area**
- Pain that is fully pleuritic or fully positional
- Symptoms that last only for a second
- Improvement with exertion
- Constant pain lasting many hours without ECG or troponin changes
- Younger age

# HPI in ACS – Pearls & Pitfalls

## Key Clinical Pearls:

- **Ask the questions that matter and will change the probability of ACS**
- Figure out how suspicious the history is for ACS. Document presence or absence of signs and symptoms that matter & translate to a score of slightly suspicious (0), moderately (1), or highly (2) suspicious.
- **If the history is not at least slightly suspicious for ACS, do not order unwarranted tests, and find an alternative cause of symptoms. Be cautious of classifying any patient scored a 2 for history (highly suspicious) as low risk even if the HEART score total is  $\leq 3$ .**

## Key Clinical Pitfalls:

- Antacids should not be used as a diagnostic test for ruling in or out ACS. In fact, antacids may cause pain relief in as many as 25% of acute MI cases.
- Nitroglycerin should also not be used as a diagnostic test for ruling in or out ACS, as response to nitro has been found to be unhelpful (LR  $\sim 1.0$ )
- Be cautious when diagnosing chest pain as a GI etiology, cardiac ischemia can produce symptoms that mimic GI pathology and vice versa.
- **No single risk factor, symptom, sign, or physical exam feature in isolation has a high enough sensitivity or specificity for the diagnosis of ACS**



# Calculating HEART score using hs-TnT

## HISTORY

How suspicious is the Hx for ACS? \*

- 2: Highly Suspicious
- 1: Moderately Suspicious
- 0: Slightly Suspicious

## ECG

Obtain STAT initial ECG within 10 minutes of arrival & compare to prior/EMS ECGs.

- 2: Significant ST deviation not due to LBBB, LVH, digoxin, etc.
- 1: No significant ST deviation, repolarization changes
- 0: Normal ECG

## Age & Risk Factors

Age

- 2:  $\geq 65$
- 1: 45-64
- 0:  $< 45$

Risk Factors: HTN, HLD, DM, BMI  $> 30$ , smoking, +FHx  $< 55$

- 2:  $\geq 3$  RFs or Hx of atherosclerotic disease (MI, PCI/CABG, CVA/TIA, PVD, etc.)
- 1: 1-2 RF's
- 0: No known or discovered RF's

## Troponin

- 2:  $> 3x$  upper limit normal
- 1: 1-3 x upper limit of normal
- 0:  $<$  upper limit of normal

Troponin utilizing hs-TnT is scored:

- 0 =  $< 99^{\text{th}}$  URL ( $< 14$  ng/L (F) or  $< 22$  ng/L (M))
- 1 = 14-41 ng/L (F) or 22-51 ng/L (M)
- 2 =  $\geq 42$  ng/L (F) or  $\geq 52$  ng/L (M)

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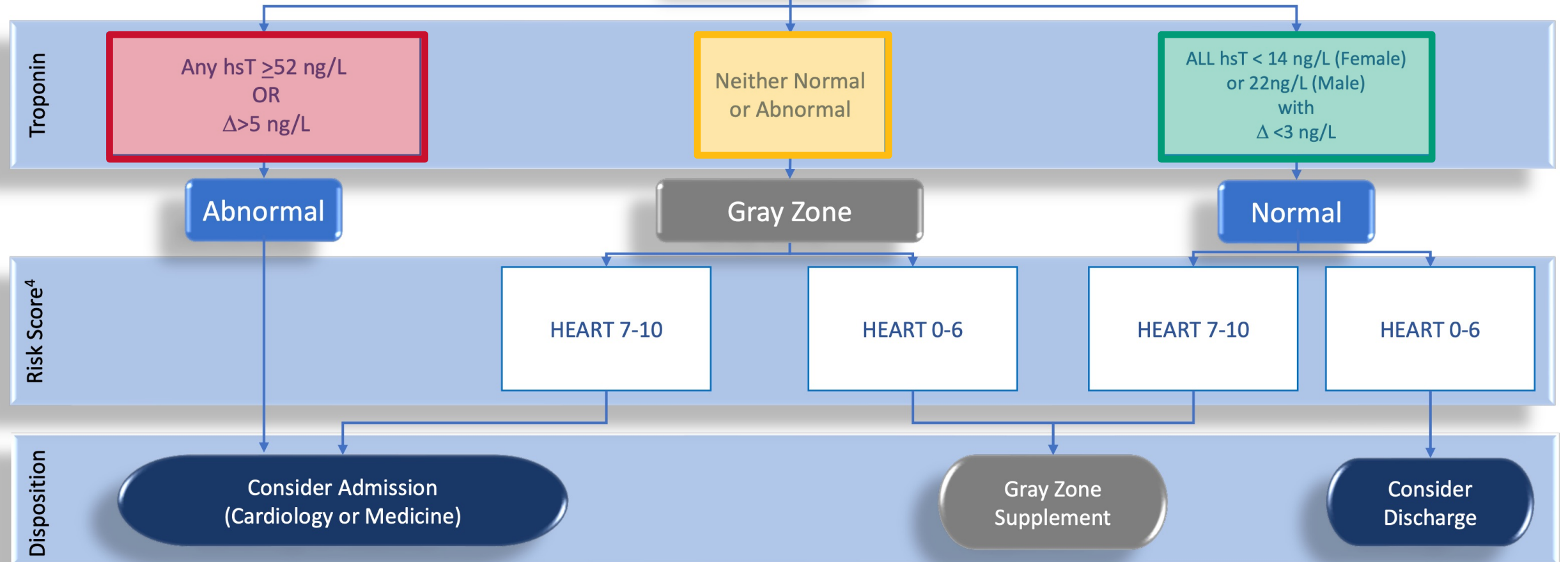
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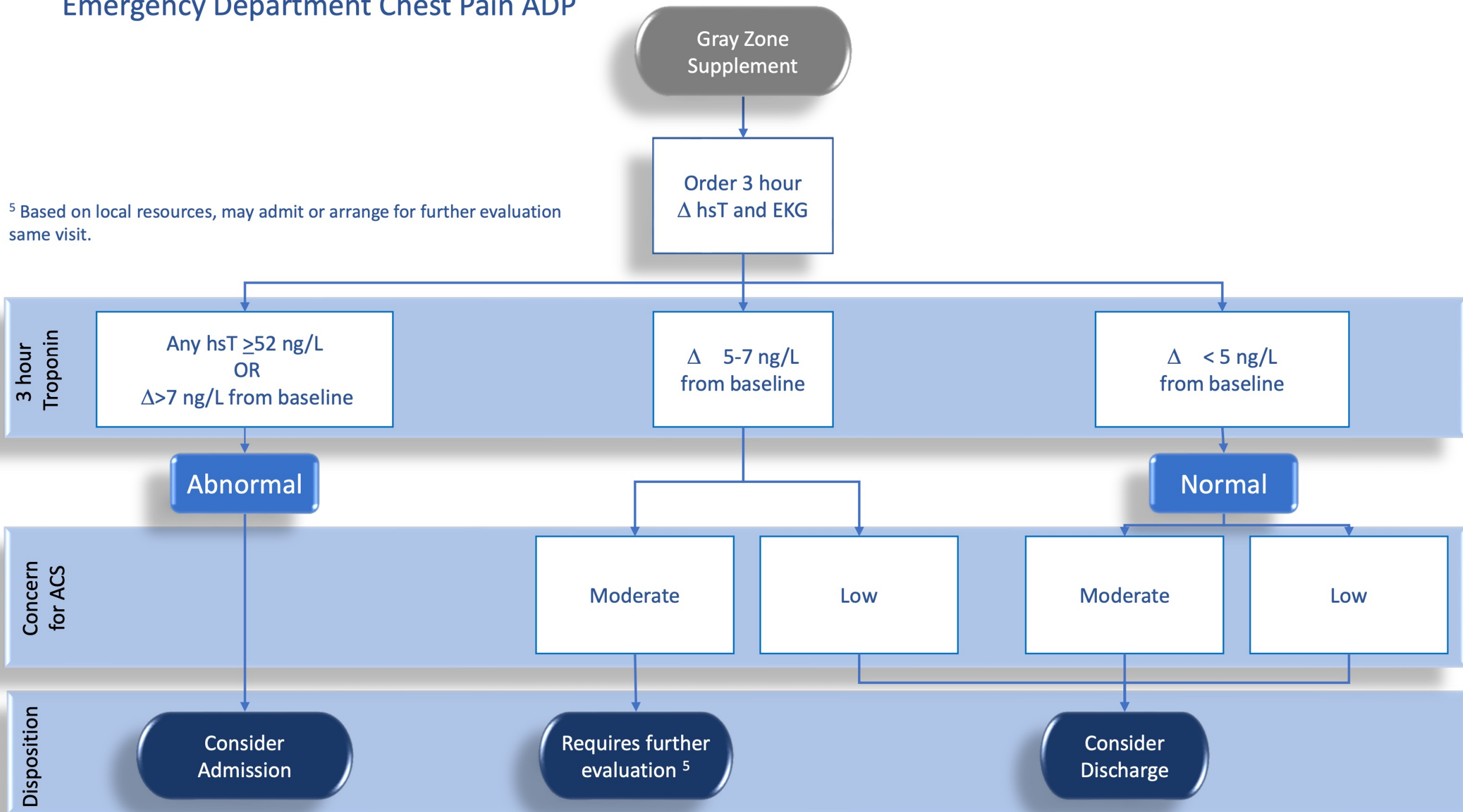
<sup>3</sup> If patient arrival <3 hours since symptoms onset, send to Gray Zone, regardless of risk if initial troponin is normal





# Emergency Department Chest Pain ADP

<sup>5</sup> Based on local resources, may admit or arrange for further evaluation same visit.



# hs-TnT Orders and EPIC Documentation

Troponin T, High sensitivity, ED Chest Pain Profile

For ED use only. The delta ranges are not applicable to inpatients and should not be used outside of the context of evaluating ED patients for acute coronary syndrome.

Troponin T, High-sensitivity, Baseline  
Once, today at 0845, For 1 occurrence

Troponin T, High-sensitivity, 1 Hour  
Once, today at 0845, For 1 occurrence

Troponin T, High-sensitivity, 3 Hour  
Once, today at 0845, For 1 occurrence

**Results Review** Last Refresh: 4/28/2021 1554 Time Mark Back Forward View Hide Tree Ref Range Load All Flowsheet Graph

Search:   Hide data prior to: 4/27/2021 Use Date Range Wizard **Newest First** Oldest First

ALL TOPICS

- Results
  - LABORATORY RESULTS
    - CHEMISTRY
  - OTHERS
    - SARS-COV-2 INTERPRETATION
    - SARS-COV-2 OVERALL RESULT

	1	2	3	4	5 ...
	4/23/2021 1120	4/23/2021 1102	4/23/2021 1102	4/23/2021 1101	4/23/2021 1039
<b>CHEMISTRY</b>					
SYMPTOM DURATION	Greater than or...			3	
HSTNT BASELINE	<6.00			5.00	
HSTNT 1 HR		5.00			
HSTNT 3 HR			6.00		
DELTA FROM BASELINE		0.00	1.00		
HSTNT INTERPRETATION		Normal	Normal		
HSTNT					5.00



# hs-TnT Orders and EPIC Documentation

**HEART Score**

Time taken: 420/2021 1118 Responsible  Show Raw Info  Show Last Filed Value  Show All Choices

**High Sensitivity Troponin HEART score**

Another reason for the patient's symptoms was identified.

History  
 2=Highly suspicious  1=Moderately suspicious  0=Slightly suspicious

EKG  
 2=Significant ST-depression  1=Non specific repolarisation disturbance  0=Normal

Age  
 2=> or equal to 65  1=45-64  0=< 45

Risk Factors  
 2=> or equal to 3 risk factors or history of atherosclerotic disease  1=1-2 risk factors  0=No risk factors known

Risk factors include  

- Hypercholesterolemia
- Hypertension
- Diabetes Mellitus
- Cigarette smoking
- Positive family history
- Obesity

Troponin  
 2=> 3x normal limit  1=1-3x normal limit  0=< or equal to normal limit

HEART Score

When calculating HEART score utilizing a hsT, the "T" is s  
0 = Normal  
1 = 14-42 ng/L (Female) or 22-52 ng/L (Male)  
2 = > 42 ng/L (Female) or >52 ng/L (Male)

There will be both the old HEART scoring tool, and a hs-TnT HEART scoring tool until all BSW sites implement the new assay, make sure to select hs-T when your site goes live!



# Final Take-home Points

- Our goal in the ED is to quickly identify patients with acute coronary occlusion MI who may benefit from immediate reperfusion therapy. In ACS without acute occlusion, reperfusion therapy has not proven beneficial and can in-fact be harmful, making early distinction critical!
- Many patients with ACS will present with initial ECGs that show no evidence of acute ischemia, much less STEMI. Non-specific ECG abnormalities that are non-diagnostic in patients with concerning history or symptoms must be repeated
- Always compare repeat ECGs with the initial & prior/EMS ECGs. When in doubt, always perform serial ECGs looking for dynamic changes! Practice recognizing ECG patterns suggestive of OMI to more accurately identify patients that need emergent reperfusion.
- For a patient to be considered low risk (HEART score 0-3) and eligible for early discharge, our pathway requires; a detailed history not highly suspicious for ACS, expert ECG interpretation that is not suggestive of acute ischemia, and troponin results that meets rule out criteria
- This pathway supports sound clinical judgement and is not designed to promote early discharge in patients where clinical concerns persist. Discharging any patients with high clinical suspicion for ACS/UA even when initial troponins and ECGs are normal is strongly discouraged



# Questions or comments?

See .pdf  
supplement for  
detailed  
references and  
recommended  
reading.



Feel free to reach  
out to me anytime!

**Ali Farzad, MD - [afarzad@ies.healthcare](mailto:afarzad@ies.healthcare)**

**Disclaimer: Ultimately, a thorough history, physical, and expertise in ECG interpretation will guide management of ACS. Clinical decision rules and pathways should not be used in isolation and clinical judgment may be used to override them at the discretion of the provider.**

