Role of Clinical Factors and ECG:

My hospital has hs-cTn do I still need to talk to patients and look at their ECGs?

Simon A. Mahler, MD, MS, FACEP
Professor & Director of Clinical Research
Department of Emergency Medicine
Wake Forest School of Medicine

Wake Forest® School of Medicine

Disclosures

- Research funding:
  - NHLBI
  - PCORI
  - AHRQ
  - Roche
  - Abbott
  - Ortho Clinical
  - Creavo Medical Technologies
  - Donaghue Foundation
- Author for Up-to-Date
- CMO: Impathiq Inc.

Is hs-cTn all we need?

What about the

- ECG?
- Clinical history?
- Risk scores or multivariate ADPs?

ECG

History

- Does a “classic story” matter?
  - Unstable angina?

ECG

TRAPID-AMI cohort
N=1,282 patients across 12 sites
MACE outcome: death (all cause), index and incident MI, & revascularization following rehospitalization within 30 days.

	Missed	30-day MACE rate
Initial hs-cTnT < LOB +ECG	1.4% (6/419)	1.1% (4/350)
Initial hs-cTnT < LOD +ECG	1.4% (8/560)	1.3% (6/471)
Initial hs-cTnT < URL +ECG	4.1% (35/895)	2.4% (17/694)

Body R, et al. Acad Emerg Med 2016;23:1004-13.

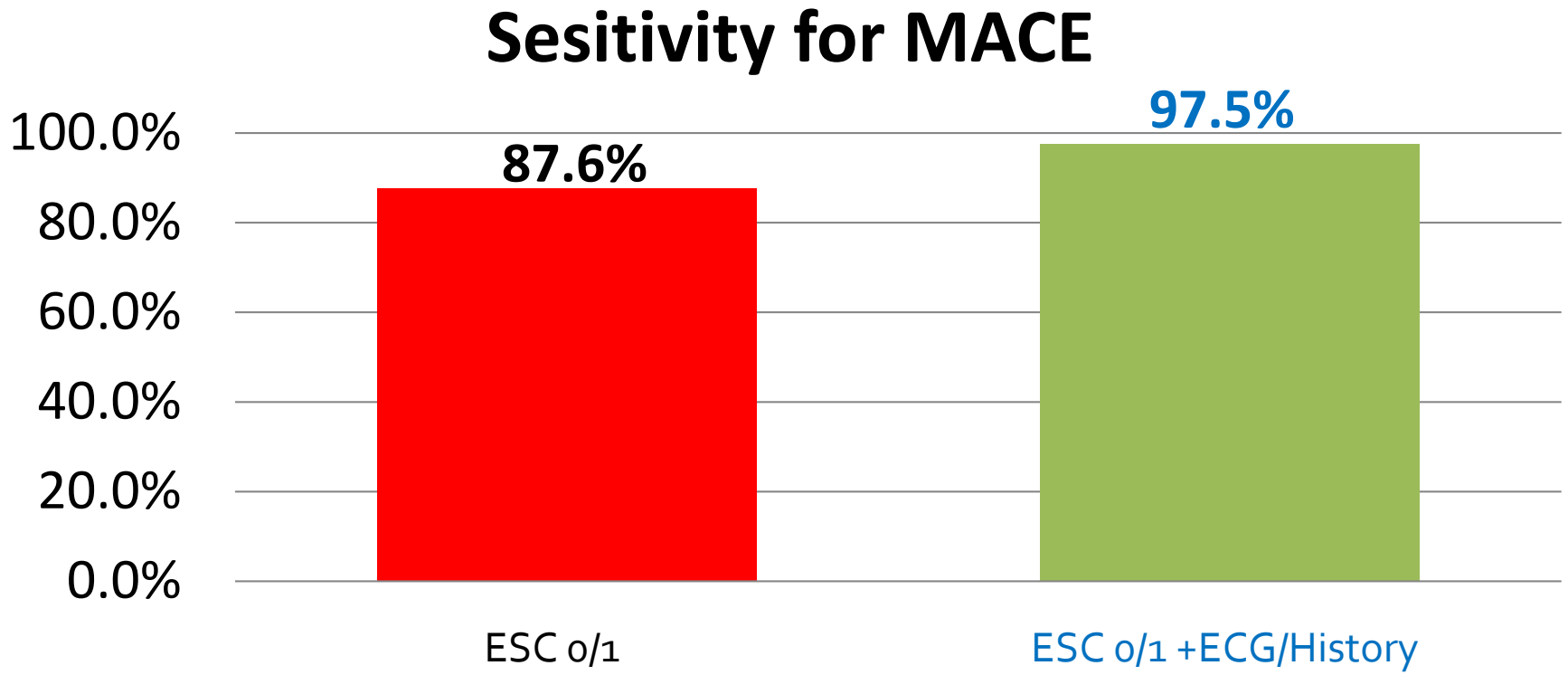
History

1038 patients with CP followed for 30 day events in Sweden

ESC 0/1-hr hs-cTnT algorithm

vs

ESC 0/1-hr hs-cTnT algorithm + ECG + Physician History Assessment



Mokhtari et. al, JACC, 2016

Risk Scores & Multivariable ADPs

EDACS
HEART

Derived and validated with contemporary cTn;
prior to widespread hs-cTn use.

Are they still needed?
Are these the right sores for hs-cTn ADPs?

EDACS

Age	Score
18-45	+2
46-50	+4
51-55	+6
56-60	+8
61-65	+10
66-70	+12
71-75	+14
76-80	+16
81-85	+18
86+	+20

Clinical Characteristic	Score
Male Sex	+6
Aged 18-50 years and either: (i) known CAD or (ii) >= 3 risk factors	+4
Symptoms and Signs	**Score**
Diaphoresis	+3
Radiates to arm or shoulder	+5
Pain occurred or worsened with inspiration	-4
Pain is reproduced by palpation	-6

Low Risk: EDACS <16

Not Low Risk EDACS ≥16

EDACS-ADP

Low-risk*	**Meets all criteria:** **(i) EDACS <16** **(ii)No new ischemia on ECG** **(iii)negative serial troponins**
At-risk	**Meets any of criteria:** **(i) EDACS ≥ 16** **(ii)New ischemia on ECG** **(iii)Positive Serial troponin**

*Caveats: Patient not low-risk if ongoing pain or crescendo of symptoms

HEART Score

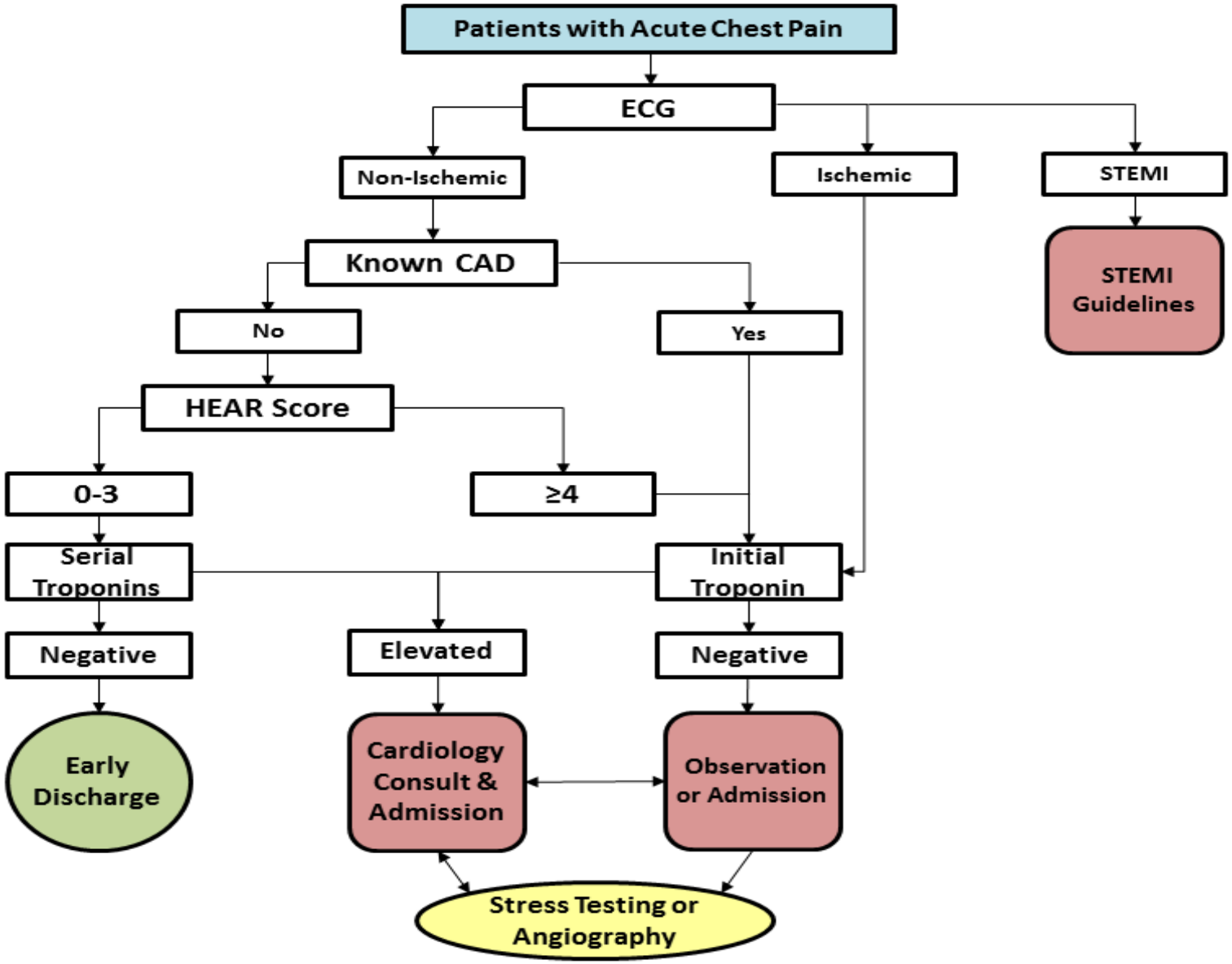
HEART Score		Points
History	Highly Suspicious	2
	Moderately Suspicious	1
	Slightly Suspicious	0
ECG	Significant ST-depression	2
	Non-specific repolarization abnormality	1
	Normal	0
Age	≥ 65	2
	45-65	1
	≤ 45	0
Risk factors	3 or more risk factors	2
	1-2 risk factors	1
	No risk factors	0
Troponin	≥ 3x normal limit	2
	1-3x normal limit	1
	≤ normal limit	0
Total		

Low: 0-3
Moderate: 4-6
High: 7 or more

HEART Pathway

ADP version of the HEART score

- No ischemic ECG changes
- No known CAD
  (prior AMI, revascularization, >70% coronary stenosis)
- Low risk = HEAR(t) score: 0-3
- Negative serial troponins



Mahler et. al, Crit Path Cardiol, 2011
Mahler et. al, Int J Cardiol, 2013
Mahler et al, Circ CVQO J, 2015
Mahler et al, Circulation, 2018

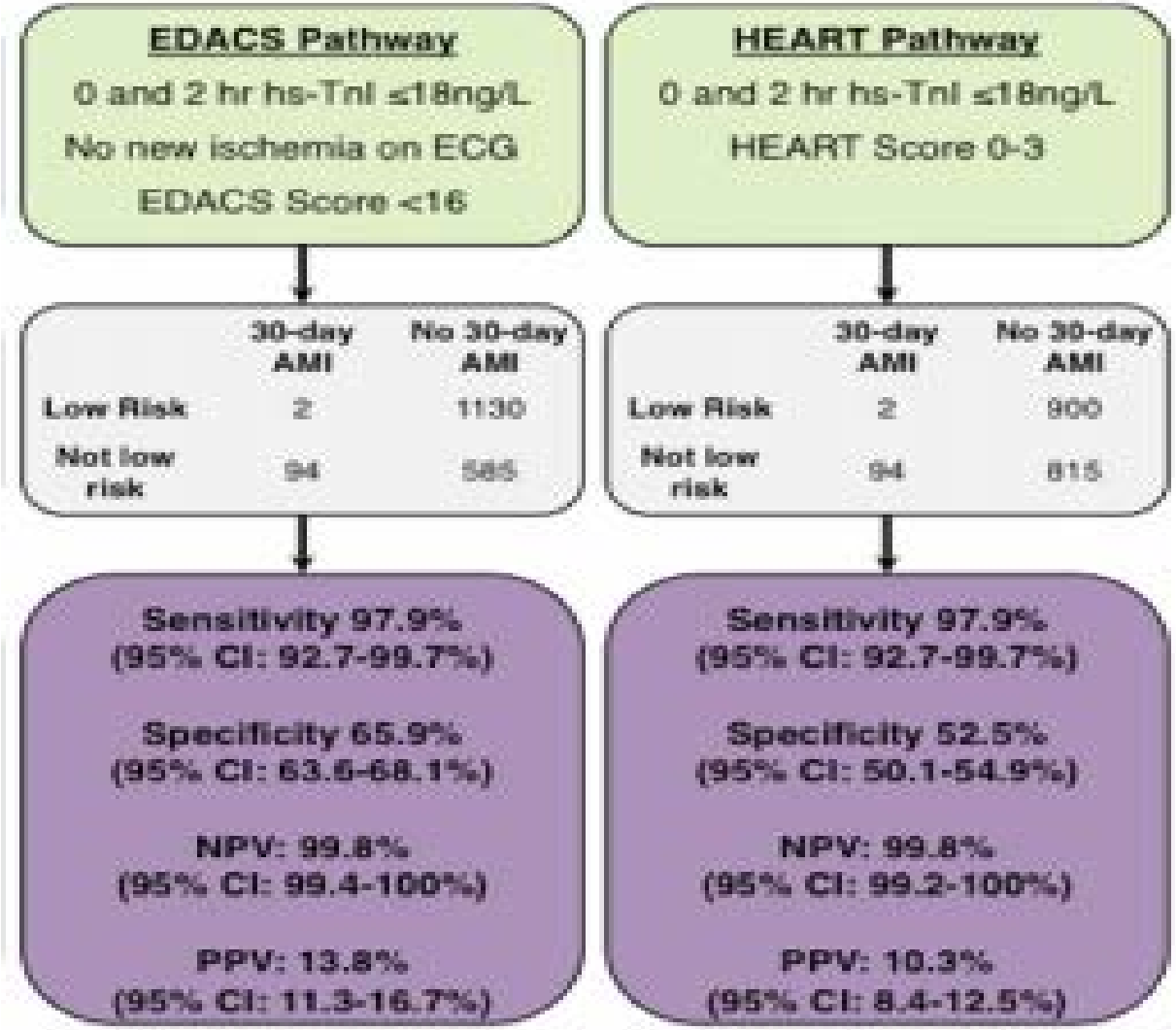
Multivariate hs-ADPs

1,811 patients in Australia

0 and 2 hour samples

Beckman Coulter hs-cTnI

Greenslade et al., Annals of Emerg Med, 2017



Adding Risk Scores to hs-cTn Algorithms

Data is limited and varies

1,886 patients
Abbott ARCHITECT hs-cTnI
Outcome: 30-day cardiac death or Type I MI

	NPV	Sensitivity	Low-Risk%
ESC 3-h ADP	97.9%	89.9%	70.4%
ESC 3-h+HEART	99.7%	99.4%	24.8%
ESC 3-h+EDACS	99.2%	97.6%	42.4%

Chapman et al., Circulation 2018

Risk Scores…

2,716 patients from APACE cohort
Roche hs-cTnT and Siemens hs-cTnI

ESC 0/1 vs
ESC 0/1 + mHEART

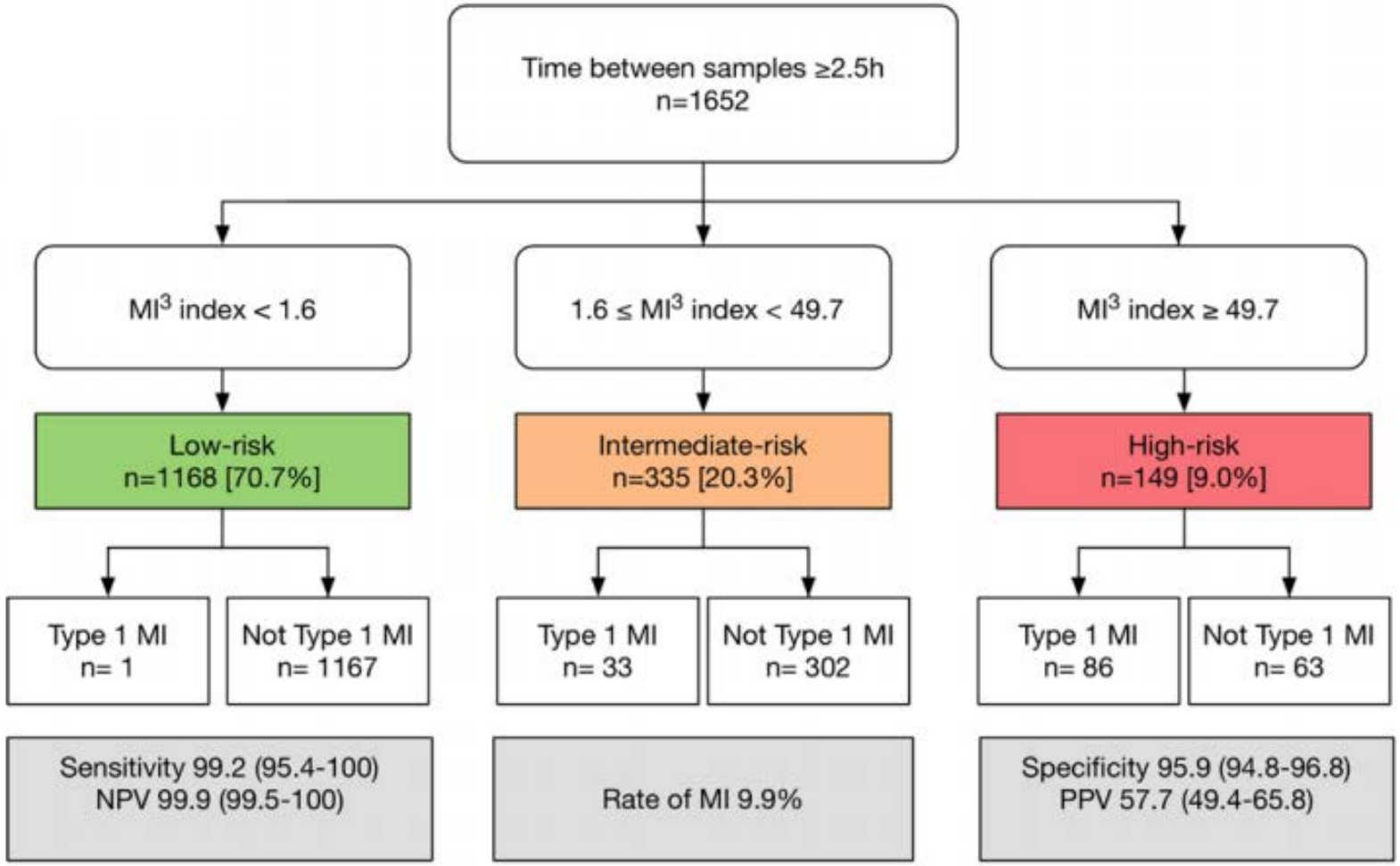
No significant improvement in NPV for MI

Incremental improvement in NPV for death and MI for hs-cTnI

Morawiec et al, JACC 2019

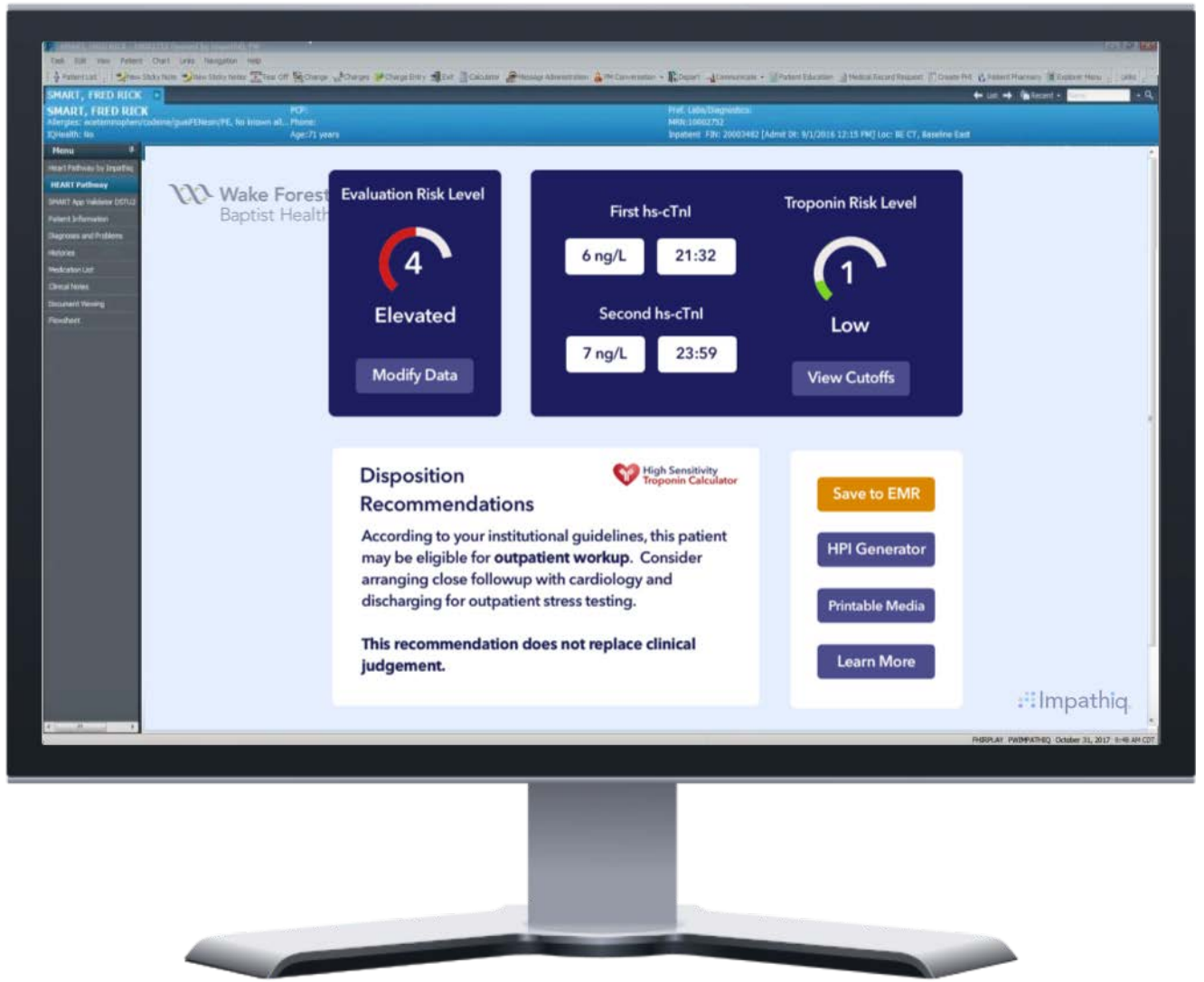
Machine Learning

MI^3
Variables:
Age
Sex
Serial hs-cTn measures (absolute, delta, and timing)

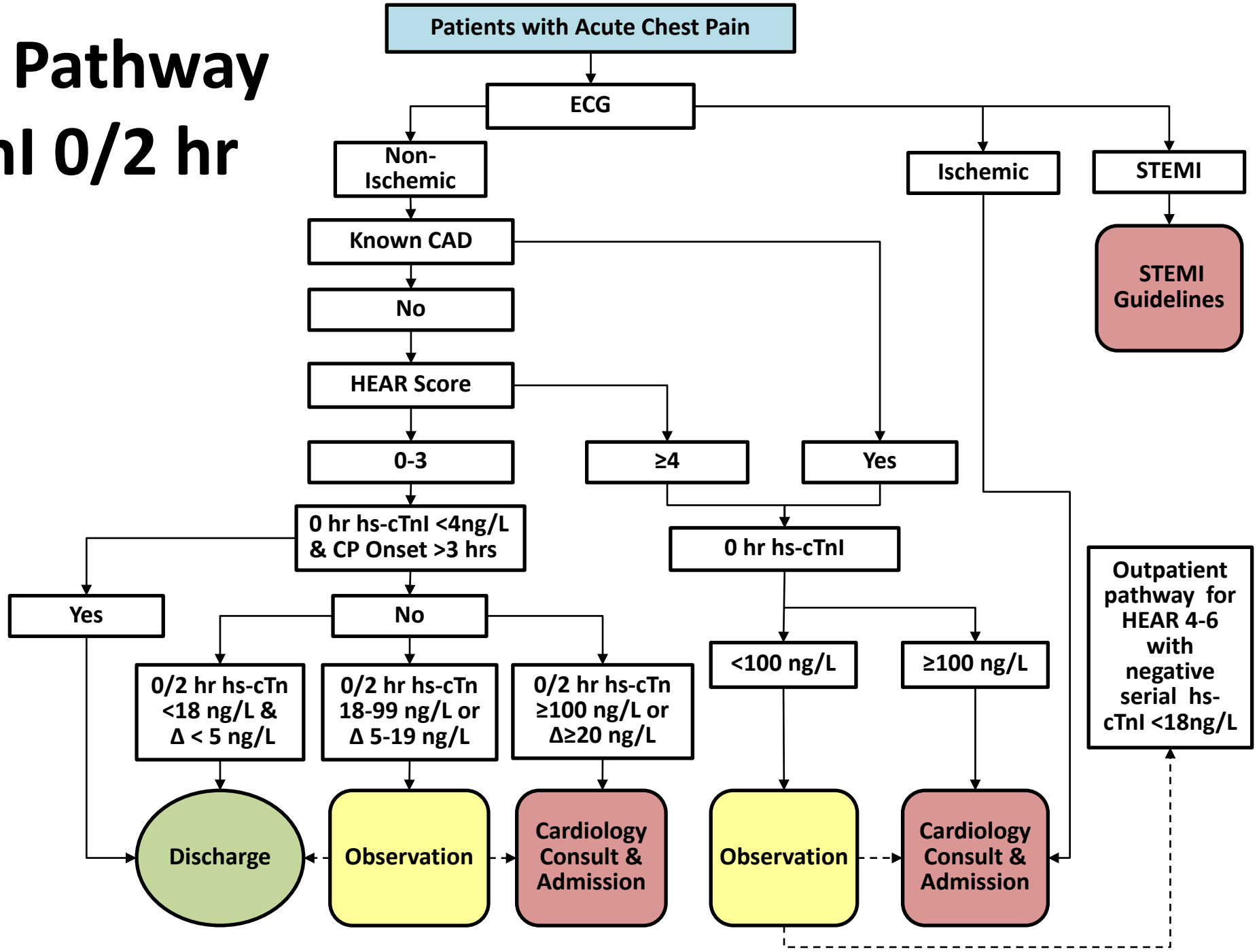


Than et al., Circulation 2019

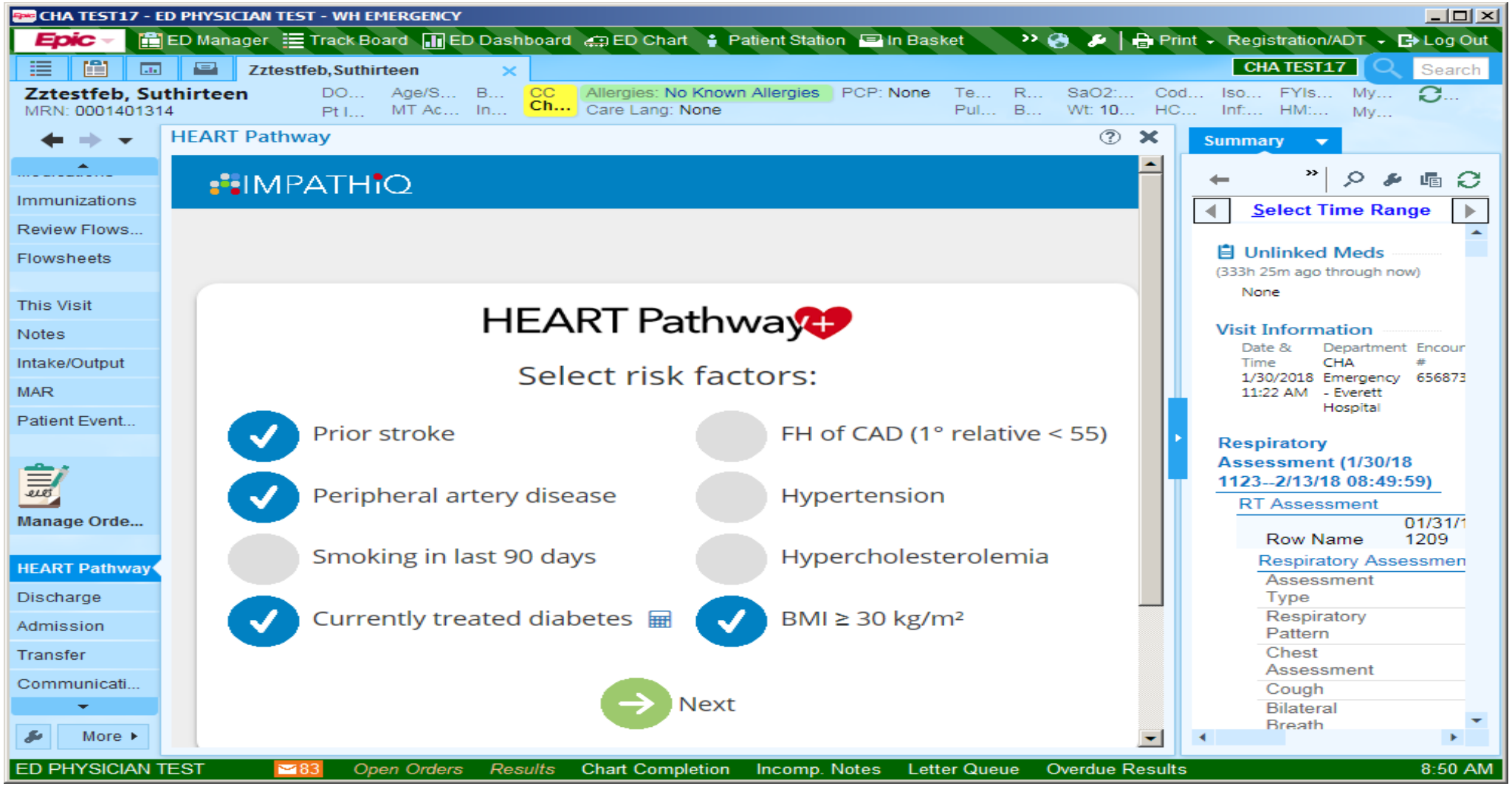
Integrated Decision Support



HEART Pathway hs-cTnI 0/2 hr



Integrated HEART Pathway Decision Support



Summary

- You still need the ECG and clinical history
- EDACS and HEART Pathway are frameworks for an objective multivariable ADP for hs-cTn use
- Future multivariate models are likely to incorporate machine learning and will require integrated electronic-clinical decision support