Chest Pain Evaluation: Red herring or the real deal?

ZACHARY HARTSELL, DHA, PA-C

Learning Objectives

Upon conclusion of this lecture, the participant will be able to:

1. Describe cardiac vs. non-cardiac chest pain
2. Discuss risk stratification for patients with suspected cardiac chest pain
3. Understand appropriate and optimal testing for both cardiac and non-cardiac etiologies of chest pain
4. Describe the treatment of common causes of chest pain

Cardiac Chest Pain

Myocardial ischemia
- ACS
- Stable angina

Aortic dissection

Pericarditis

Myocarditis

Pericardial tamponade

Heart failure

Arrhythmia

Mr. N

68-year-old male with HTN, HLD, GERD, and ongoing tobacco abuse presents to the ED with substernal chest pain.

He describes the pain as “tightness and pressure”, which began two hours ago while sitting at his desk. The pain lasted an hour and radiated to his left shoulder and arm. He is currently pain-free.

Mr. N

On exam:

- BP 145/87 (R) 141/85 (L), HR 74, RR 16, O_2 99% RA
- General → WDWN. NAD. A&Ox3.
- Heart → RRR without MRG.
- Lungs → CTA B/L.
- Abdomen → +BS. Soft. ND. NT.
- Extremities → Peripheral pulses 2+ B/L. No pedal edema B/L.

What is your differential diagnosis?

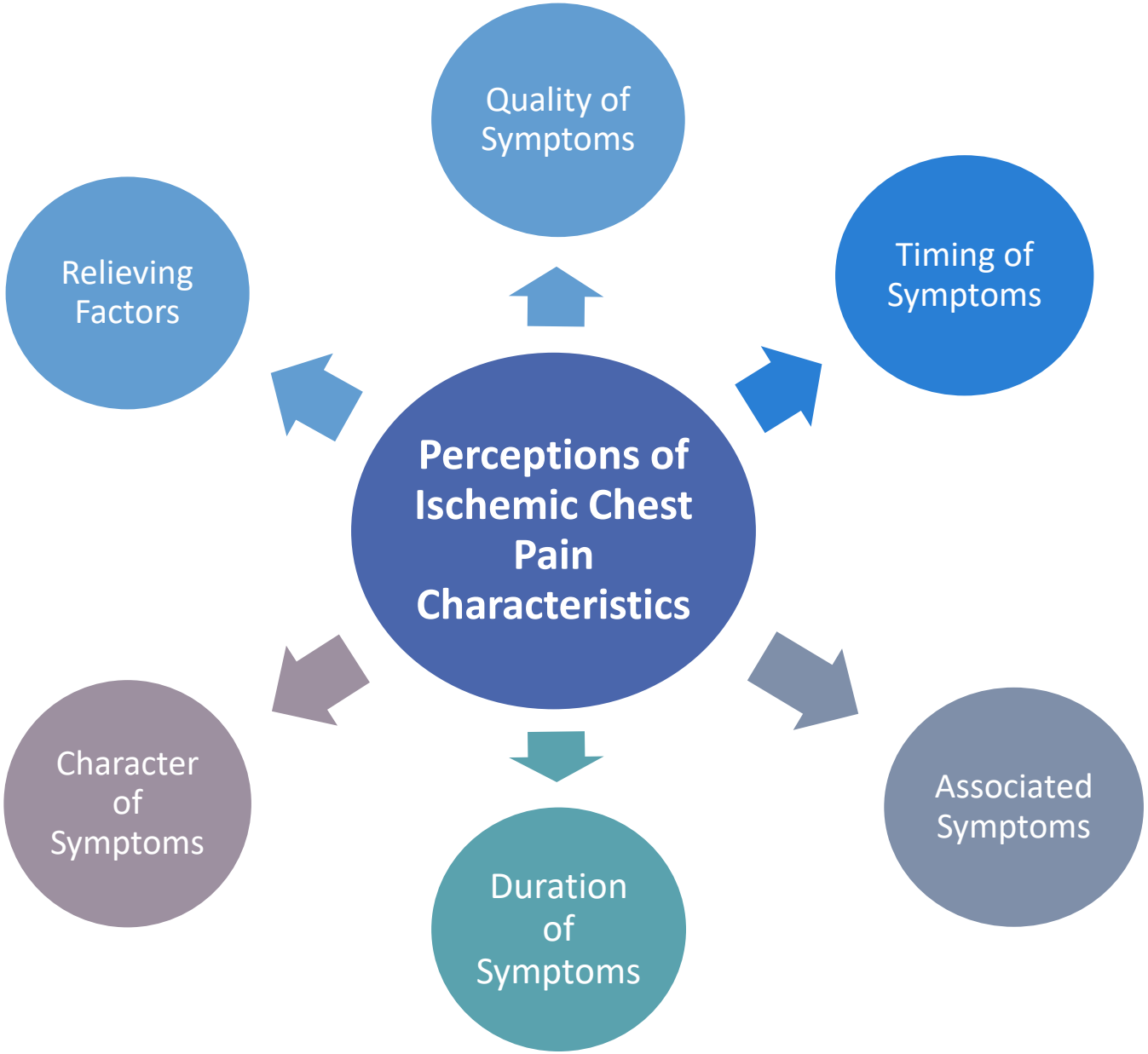
Chest Pain

Common presenting compliant in all settings

- More than **8% of** ED visits each year as a result of acute CP
  - Less than 10% of these have ACS

- Approximately 1%- 20% of primary care present with chest pain
  - 2-4% of patients presenting to primary care will have ACS

Source: Slankamenac (2019). *Journal of Clinical Cardiology*; Dundas (2022). *Cardiology Advisor*.


Quality of Symptoms
Timing of Symptoms
Relieving Factors
Perceptions of Ischemic Chest Pain Characteristics
Character of Symptoms
Associated Symptoms
Duration of Symptoms

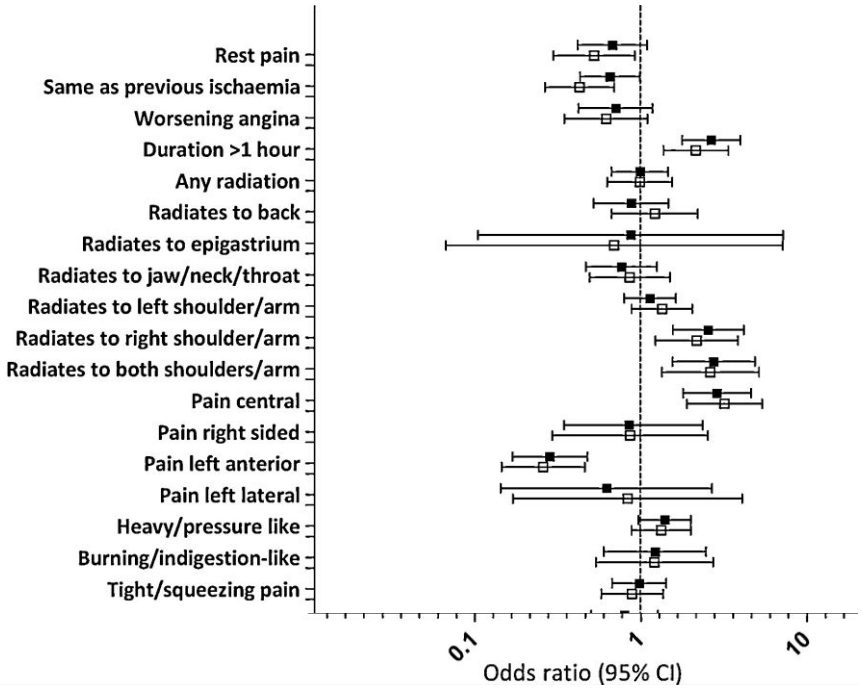
Features With Increased Probability of MI

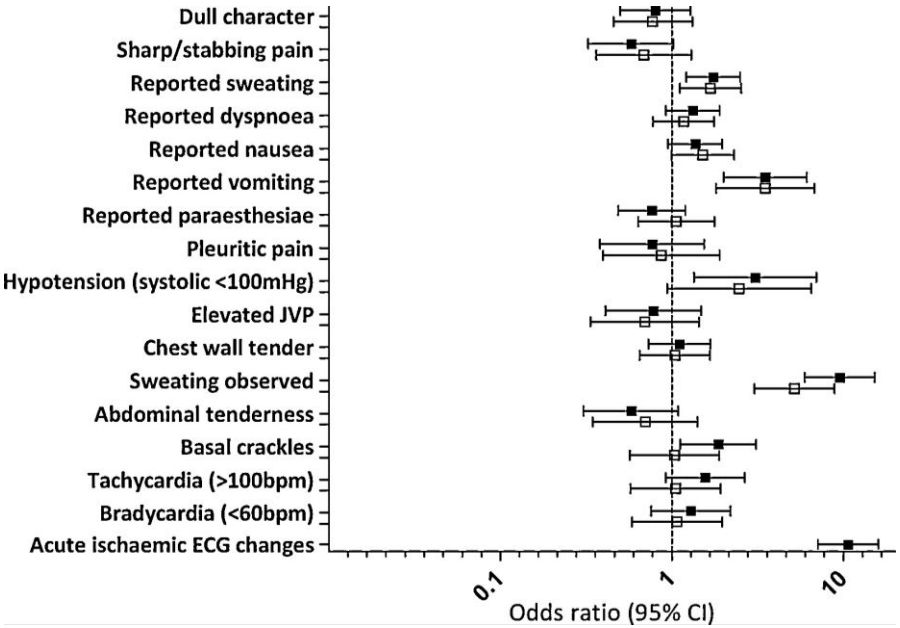
Table 2. Value of Specific Components of the Chest Pain History for the Diagnosis of Acute Myocardial Infarction (AMI)

Pain Descriptor	Reference	No. of Patients	Positive Likelihood Ratio (95% CI)
Increased likelihood of AMI			
Radiation to right arm or shoulder	29	770	4.7 (1.9-12)
Radiation to both arms or shoulders	14	893	4.1 (2.5-6.5)
Associated with exertion	14	893	2.4 (1.5-3.8)
Radiation to left arm	24	278	2.3 (1.7-3.1)
Associated with diaphoresis	24	8426	2.0 (1.9-2.2)
Associated with nausea or vomiting	24	970	1.9 (1.7-2.3)
Worse than previous angina or similar to previous MI	29	7734	1.8 (1.6-2.0)
Described as pressure	29	11 504	1.3 (1.2-1.5)
Decreased likelihood of AMI			
Described as pleuritic	29	8822	0.2 (0.1-0.3)
Described as positional	29	8330	0.3 (0.2-0.5)
Described as sharp	29	1088	0.3 (0.2-0.5)
Reproducible with palpation	29	8822	0.3 (0.2-0.4)
Inframammary location	31	903	0.8 (0.7-0.9)
Not associated with exertion	14	893	0.8 (0.6-0.9)

Abbreviations: AMI, acute myocardial infarction; CI, confidence interval.

Features With Increased Probability of MI





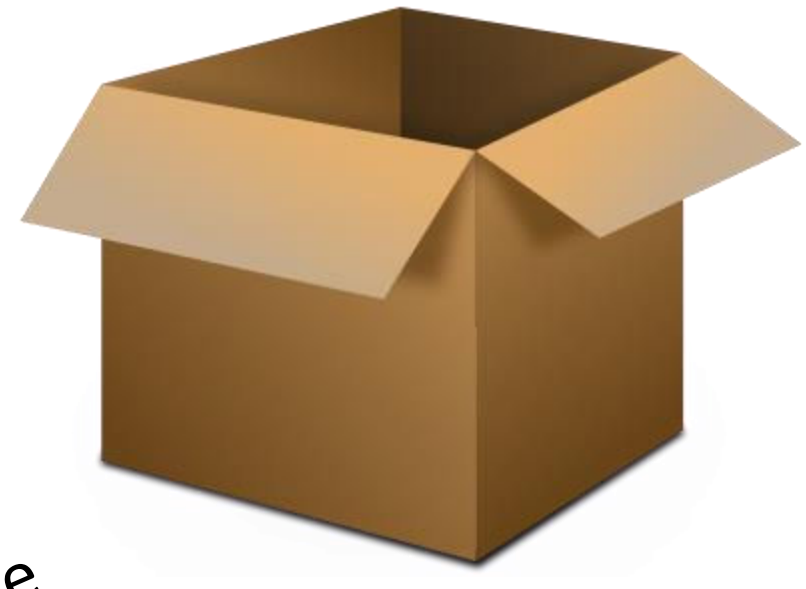
Differential Diagnosis

	Critical	*Less Critical*
Cardiac	*ACS, aortic dissection*	*Pericarditis, myocarditis*
Pulmonary	*PE, pneumothorax*	*Pneumonia, pleurisy, pleural effusion*
Gastrointestinal	*Esophageal rupture, perforated ulcer*	*GERD, esophageal spasm, esophagitis, PUD, cholecystitis*
Musculoskeletal	-	*Costrochondritis, rib fracture, cervical stenosis*
Dermatologic	-	*Herpes zoster*
Psychiatric	-	*Anxiety, panic attack*

Thinking Outside the Box…

Acute chest syndrome (sickle cell anemia)

Trauma



Referred pain

Precordial catch syndrome

Substance abuse

Collagen vascular disease

Herpes zoster

Diagnostic Approach

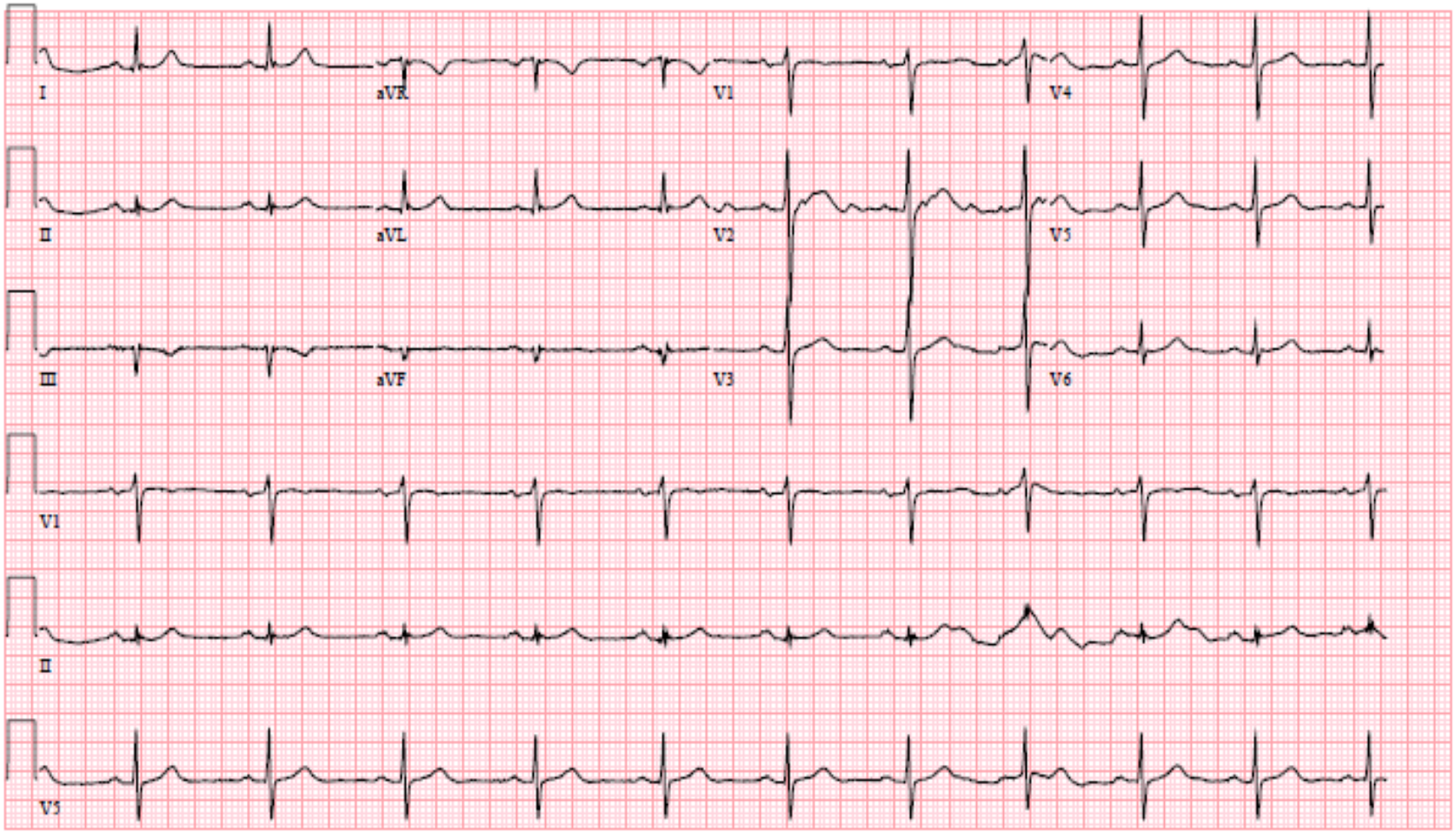
Step 1: Rule out critical conditions

- ACS → urgent ECG!
- Aortic dissection
- PE

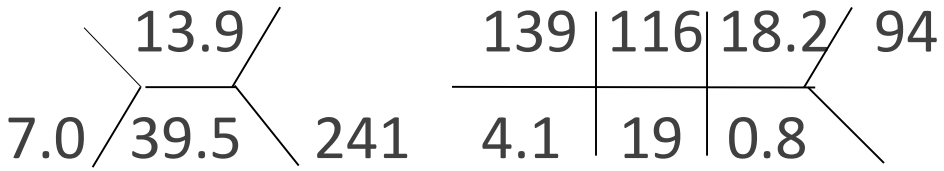
Step 2: Risk stratify patients for cardiac etiology

Step 3: Evaluate for less critical conditions

Mr. N



Mr. N's Labs



	Mr. Sullivan	Reference Range
High Sensitivity Troponin	<0.010	<0.010

- ECG, CXR, and one set of cardiac enzymes are normal.
- What do you do next?

Cardiac Enzymes

Test	Onset	Peak	Duration
CK (Isomers)	3-12 hours	18-24 hours	36-48 hours
Troponin T	3-12 hours	18-24 hours	Up to 10 days
Troponin High Sensitivity	2-3 hours	12- 48 hours	4-10 days

High-Sensitivity Troponin T (hs-cTnT)

5th generation

High-sensitivity assays for hs-cTnT can detect levels as low as 5ng/L.

hs-cTnT ≠ the current Troponin T

- The values should not be compared.
- hs-cTnT can detect lower levels.
- Shorter time intervals between repeat values
  - Possible intervals: 0, 2, and 6 hours

High-sensitivity troponin has greater early sensitivity and negative predictive value compared with conventional troponin

How to Interpret the Values (ng/L)

Whole numbers not decimals

Normal or elevated - not negative or positive

99th% upper limit normal

- Male: 15 ng/L
- Female: 10 ng/L

Deltas from Time 0	
2h Δ	≤3 = unchanged 4-9 = intermediate ≥10 = Changing
6h Δ	≥12+ = Changing

High-Sensitivity Troponin T (hs-cTnT)

What about the value of a single test?

In ED

- Initial results of <5 ng/l does as a clinical predictor does have some value in low- risk patients
  - Generally, not relied upon

In primary care

- Study in the Netherlands found reduction on non-ACS patient referral by about 7% using point of care hs-TnT
  - Generally, not relied upon in the US

Risk Stratification

Heart Score

Timi

TIMI Risk Score

Variables

- Age ≥65 years
- ≥ three risk factors for CHD
- Prior coronary stenosis of ≥50 percent
- ST segment deviation on admission ECG
- ≥ two anginal episodes in prior 24 hours
- ↑ serum cardiac biomarkers
- Aspirin use in prior seven days

TIMI Risk Score

↑ TIMI risk score =
↑ numbers of events at 14 days

All-cause mortality, new or recurrent MI, or severe recurrent ischemia requiring revascularization

Score	Risk %
0-1	4.7
2	8.3
3	13.2
4	19.9
5	26.2
6-7	40.9

HEART Score

- Useful to evaluate undifferentiated chest pain in the ED

	0 points	1 point	2 points
History	Incompatible with ACS	Potentially compatible with ACS	Strongly suggestive of ACS
ECG	Normal	Nonspecific repolarization abnormalities	ST depression or transient ST elevation
Age	<45	45-65	>65
Risk Factors	None	1-2 Risk Factors	3 Risk Factors or known CAD
Troponin Levels	Normal	1-3x upper limit of normal	>3x upper limit of normal

HEART Score

Predicts 6 week risk of major adverse cardiac event (MACE)

- Risk of missed ACS <1%

Score	Risk	Recommendation
0-3	Low Risk	Outpatient follow up
4-6	Moderate Risk	Admission to hospital
7	High Risk	Admission to hospital

Back to Mr. N

HEART score = **6**

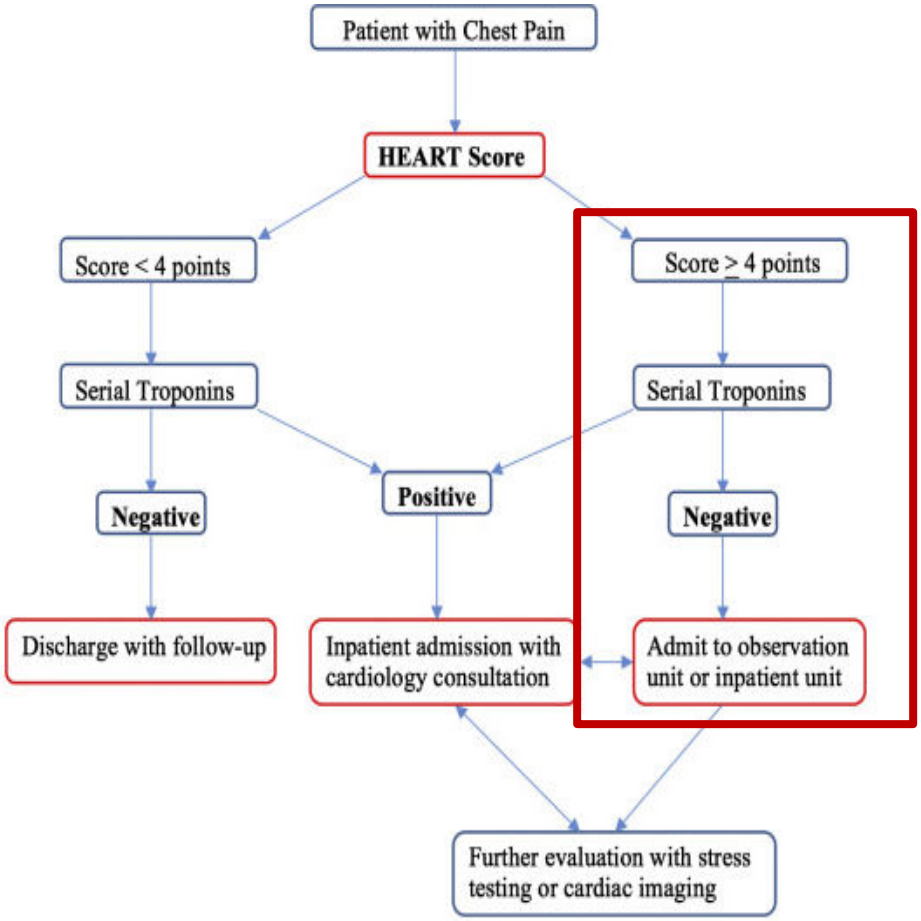
- History: potentially compatible with ACS **(1)**
- ECG: nonspecific repolarization abnormalities **(1)**
- Age: >65 **(2)**
- Risk Factors: at least three risk factors **(2)**

HEART Pathway

Combines the HEART score and serial cardiac troponins

Low risk score < 4

High Risk score ≥ 4



Mr. N

You admit Mr. N for observation and he is given ASA. He is monitored on cardiac telemetry overnight and has no recurrent chest pain.

A stress test is planned for the following morning…

Inpatient Stress Testing

Exercise or pharmacologic stress ↑ myocardial oxygen demand and reveals an inadequate oxygen supply (hypoperfusion) in diseased coronary arteries

Mixed data inpatient vs. outpatient

? low risk patients

Poor outpatient compliance

Modalities of Stress Testing

Exercise ECG: simple, widely available, low cost

- Many limitations, but may be appropriate initial test in some

Stress Echocardiography: localizes ischemia, provides structural information, fast results

- Limited utility with resting RWMA's

Stress Radionuclide Myocardial Perfusion Imaging (rMPI):

- Can quantify involved myocardium and assess viability, good for known CAD
- More expensive, radiation exposure, longer interpretation times; limited utility with balanced ischemia (3-vessel disease)

Coronary CT Angiography

Low to intermediate risk patients with normal ECG and negative troponins who have potential ACS

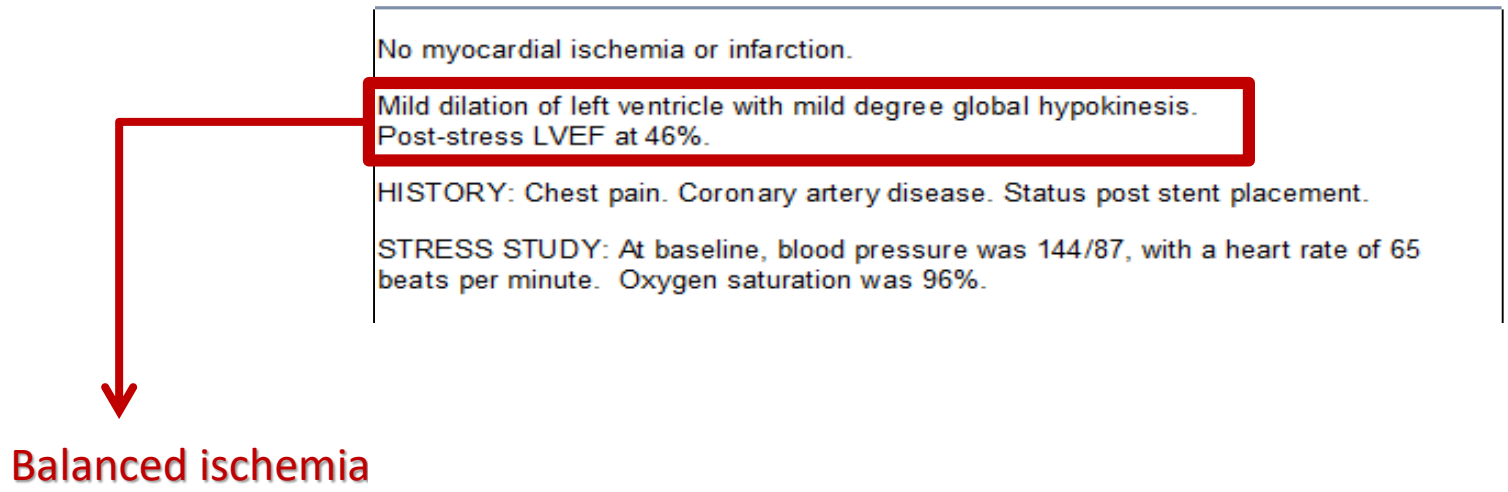
- **Sensitivity = 94%, Specificity = 83%**

  *for focal lesions of >70% stenosis when compared with invasive coronary angiography

Potential benefits: reduce unnecessary testing, decrease LOS, cost

Back to Mr. N

He underwent stress myocardial perfusion imaging.
Per his RN, he tolerated the procedure well. He is anxious to discharge .



ACS Treatment

- MONA is no more…

ACS Treatment

Step 1: Immediate therapy for ACS

- **OXYGEN**
  - Used for respiratory distress, oxygen saturation <90%
    - "Hyperoxia" has been shown to have a direct vasoconstrictor effect on coronary arteries
- **ASPIRIN**
  - 162-325mg for all patients suspected of ACS
- **NITRATES**
  - Screen for contra-indications (Phosphodiesterase- 5 inhibitors, R Ventricle MI)
  - Only use for patients with active pain
  - IV Nitroglycerin for persistent ischemic pain, HF, or HTN
- **ANALGESICS**
  - **Morphine** used only when other anti-anginals at maximum dose are not relieving CP
  - **NSAIDS** should be discontinued/not initiated because of risk of MACE

ACS Treatment

Step 2: Therapy for ACS

- **<u>P2Y12 INHIBITORS</u>**
  - **Clopidogrel** 300-600mg loading dose
  - **Ticagrelor** 180mg loading dose
  - ***Prasugrel** 60mg loading dose
- Load at time of presentation vs. PCI (risk vs. benefit)
  - Does your patient potentially need CABG?

ACS Treatment

Step 2: Therapy for ACS

- **PARENTERAL ANTICOAGULATION THERAPY:**
  - **Unfractionated Heparin (UFH):** continued for 48 hours or until PCI performed
  - **Enoxaparin (LMWH):** for duration of hospitalization or until PCI performed
  - **Fondaparinux (Factor Xa inhibitor):** for duration of hospitalization or until PCI performed
    - Not used as sole anticoagulant
  - **Bivalirudin (Direct thrombin inhibitor):** 0.10 mg/kg loading with 0.25 mg/kg per hour until PCI
    - Similar outcomes to UFH, but less cost effective

ACS Treatment

Step 3: Decide on a treatment strategy

- **STEMI**: FMC to device time expected to be ≤90 minutes
- **NSTE-ACS**: Ischemia guided vs. early invasive strategy

Ischemia-guided vs. Early Invasive Strategy

Ischemia-guided Strategy

- Only calls for an invasive evaluation if:
  - patient fails medical therapy (refractory angina)
  - objective evidence of ischemia (dynamic ECG changes, perfusion defect)
  - clinical indicators of very high prognostic risk (e.g. high TIMI or GRACE scores)

Early Invasive Strategy (within 24 hours)

- Triages patients to an invasive diagnostic evaluation (i.e. coronary angiogram)
  - Generally a high-risk patient, or with high-risk features (e.g. + troponin)

Irrespective of strategy chosen, a patient receives optimal anti-ischemic and anti-thrombotic medical therapy

ACS Treatment

Step 4: Institute routine medical therapy

- **Beta Blockers**: within 24 hours unless contraindicated
- **Statins:** high intensity, regardless of baseline LDL-C
- **ACE/ARB**: LVEF<40%, HTN, DM, stable CKD
- **Aldosterone Antagonist**: if already on therapeutic ACE, BB, and have an LVEF<40%
- **Calcium Channel Blockers**: no benefit; consider only if recurring ischemia, or BB and nitrates are contraindicated or maximized

Mrs. P

48 YO F with asthma, microcytic anemia 2/2 menorrhagia 2/2 uterine fibroids presents to the ED with DOE X 4 weeks and R shoulder and chest pain X 4 days.

Mrs. P

Vitals:

- T 36.5 C; HR 117 bpm; BP 150/94 mmHg; RR 24 br/min; SpO2 95% RA

Labs:

9.8	8.9	421
	30.9	

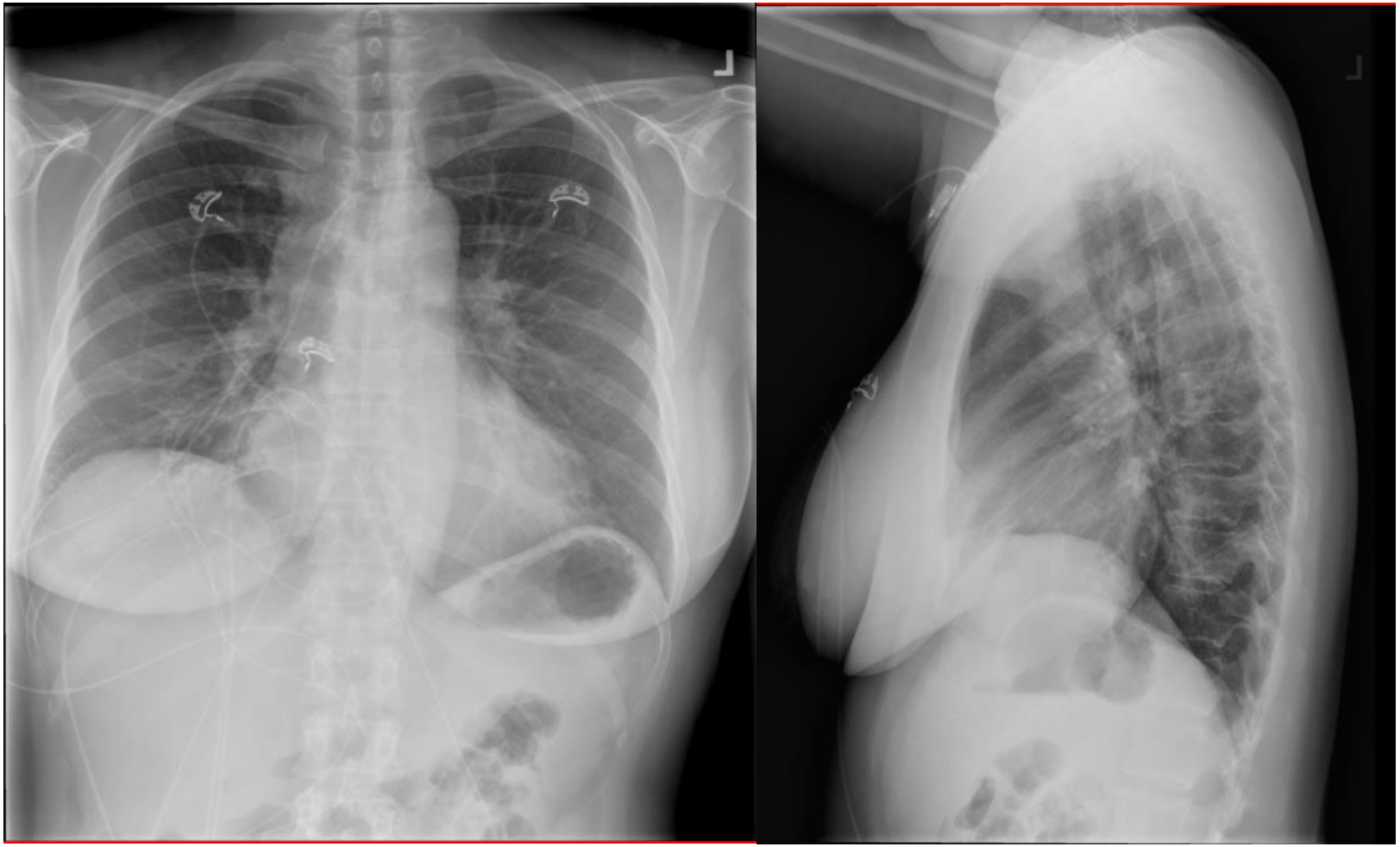
135	103	16.5	143
4.5	19	0.7	

hs-cTnT: 5 ng/L (female ≤ 10 ng/mL)

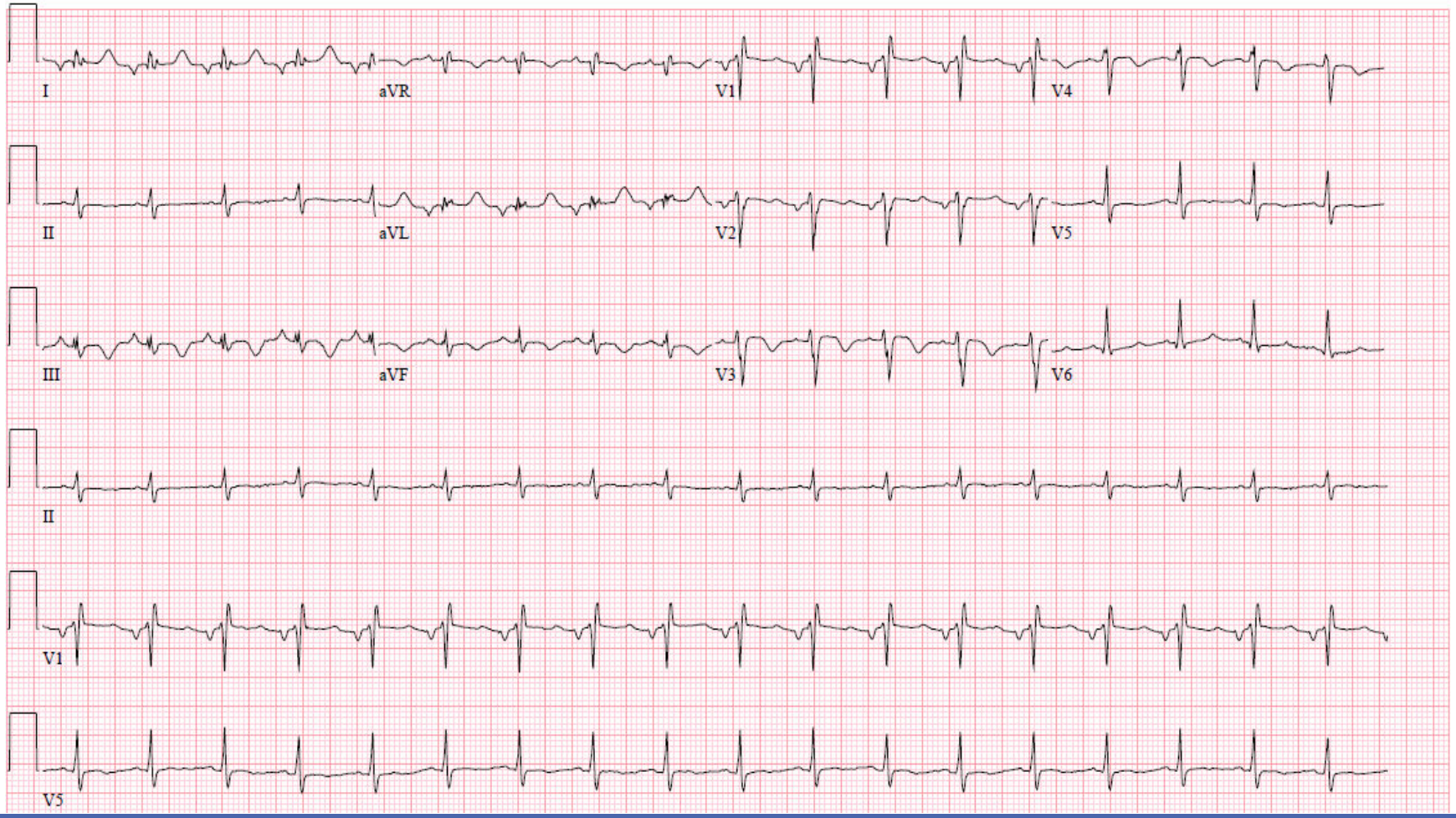
NT-Pro BNP: 6,204 pg/mL (<248 pg/mL)

D-Dimer: 5,924 ng/mL (< 500 ng/mL*)

Ms. P Chest X-ray



Admission ECG (no priors)



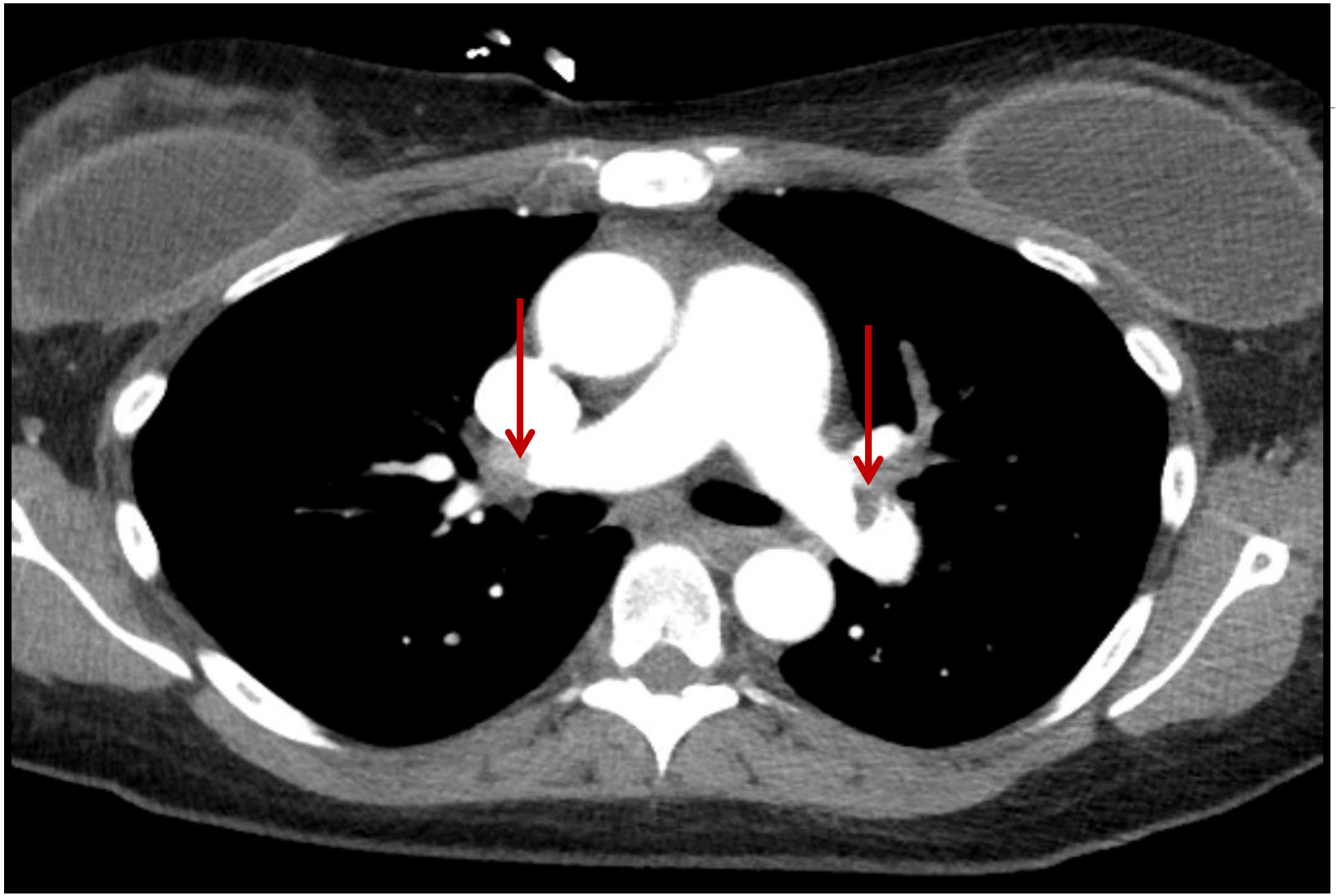
(Modified) Wells Score for PE

Criteria	Scoring
Clinical symptoms of DVT	3.0
Other diagnosis less likely than PE	3.0
HR >100	1.5
Immobilization ≥3 days or surgery in the previous 4 weeks	1.5
Previous DVT/PE	1.5
Hemoptysis	1.0
Malignancy	1.0

Wells Criteria	Score
High	>6.0
Moderate	2.0 to 6.0
Low	<2.0

Modified Wells Criteria	Score
PE likely	>4.0
PE unlikely	≤4.0

CTPA



PE Treatment

Step 1: If PE suspected, stabilize the patient while definitive diagnostic test is ongoing

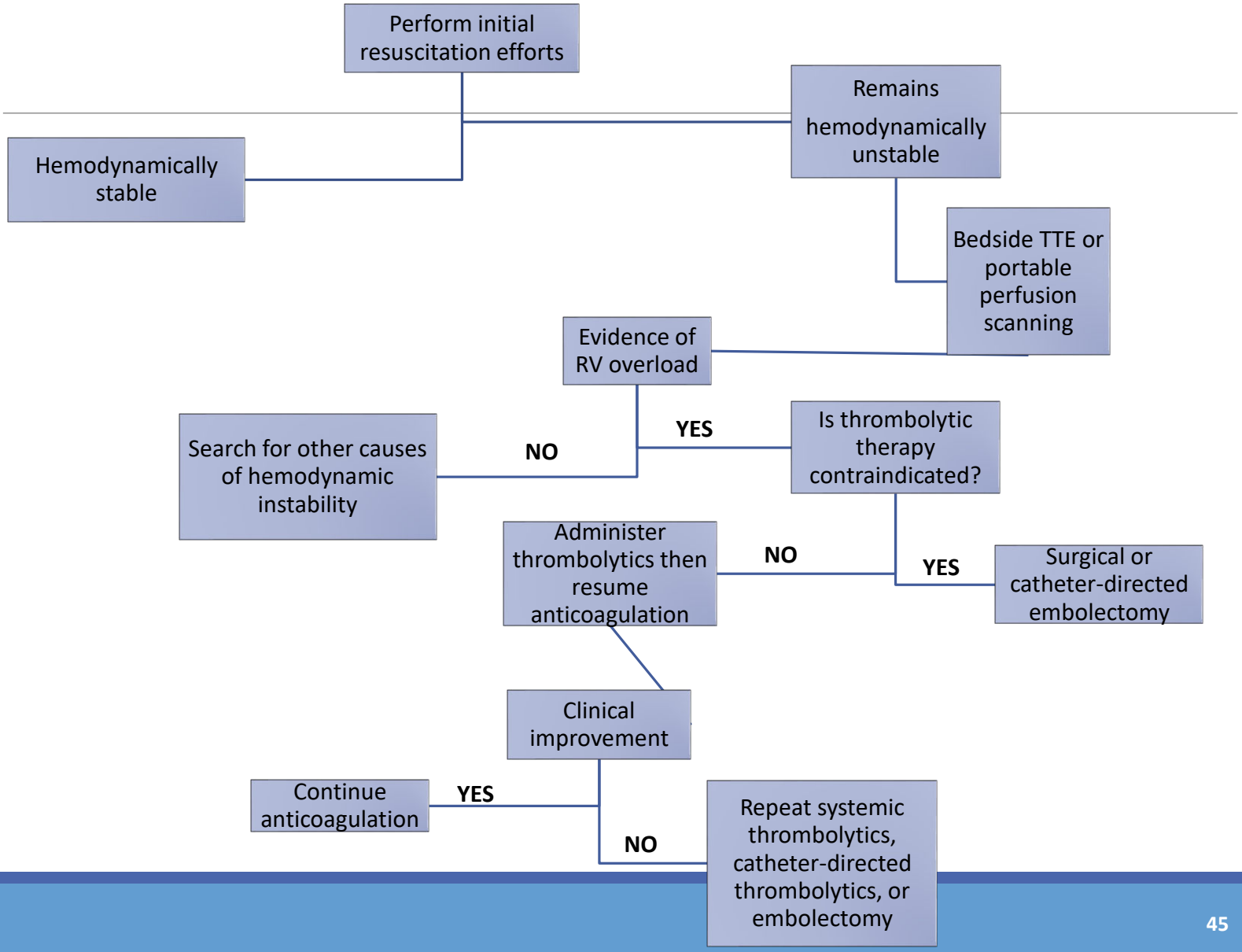
- IV Heparin v. Low Molecular Weight Heparin

Step 2: Risk stratification

- High-risk/massive
- Intermediate-risk/submassive
- Low-risk/small

Hemodynamic instability ("massive PE"): SBP<90 mmHg for >15 minutes, hypotension requiring vasopressors, or clear evidence of shock

Massive PE Treatment



Hemodynamically Stable PE

Treat with anticoagulation unless contraindicated:

- Consider IVC Filter
- Consider risk vs. benefit

Consider **thrombolysis** or **catheter-directed thrombolysis** on a case-by-case basis:

- Severe RV dysfunction
- Extensive DVT
- Presence of severe hypoxemia
- Patients who appear to be decompensating but not yet hypotensive
- Clot in transit (RA or RV clot)

Back to Mrs. P

Transthoracic Echocardiogram:

Final Impressions
1. Findings consistent with cor pulmonale - possibly acute.
2. Moderate right ventricular enlargement with moderate-severe systolic dysfunction (FAC 26%).
3. Estimated right ventricular systolic pressure 93 mmHg (systolic blood pressure 170 mmHg).
4. Tricuspid annulus dilatation with moderate-severe functional tricuspid regurgitation.
5. Severely dilated inferior vena cava with no inspiratory collapse and dilated hepatic veins.

Underwent emergent **catheter-directed thrombolysis**

Mrs. P

At 24 hours → catheter pulled and placed on heparin drip
- COMPLETE resolution of symptoms!

Transitioned to Xarelto upon discharge
- IUD placed for her vaginal bleeding

Mr. S

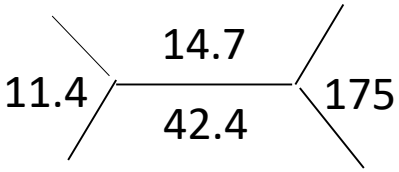
65 YO M with untreated HTN presents to the ED with acute onset of dizziness and severe chest pain with radiation to his back, of acute onset while he was in the shower. He also described bilateral 9/10 flank pain and nausea & emesis.

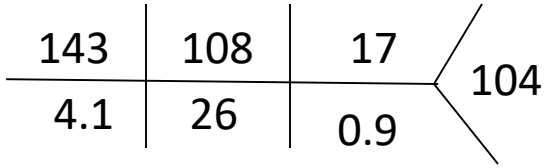
Mr. S

Vitals:

- T 37 C; HR 78; BP 189/99; RR 20 br/min; 96% RA

Labs:

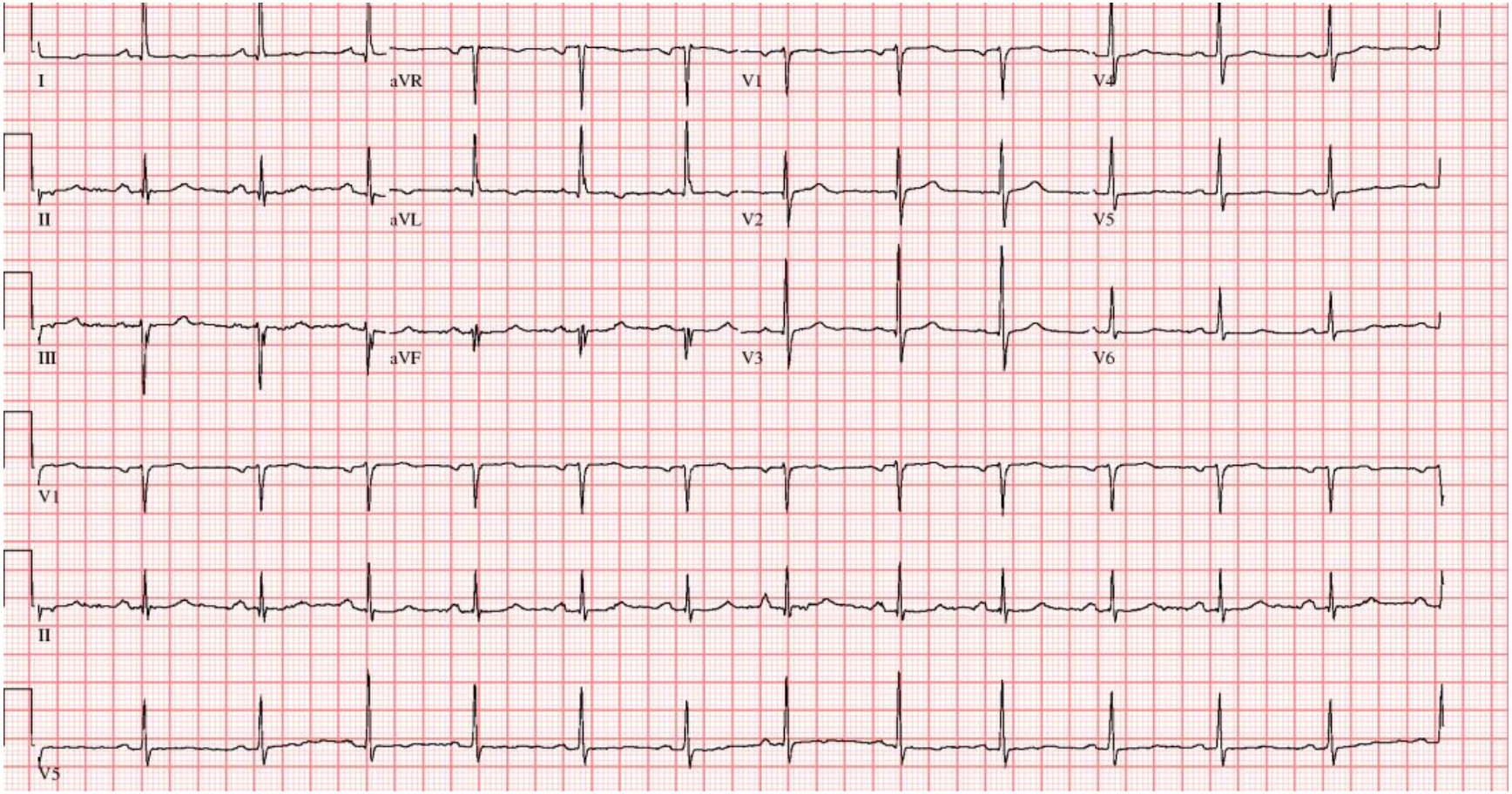




hs-cTnT: 8 ng/L (male ≤ 15 ng/L)

D-dimer: 1,208 ng/mL (< 500 ng/mL*)

Admission ECG



Chest X-Ray

Mr. S

You are called to see the patient in the ED, so you quickly review his records from when he was admitted to the hospital with atypical chest pain 1 month prior…

TTE (one month prior):

Final Impressions
1. Normal left ventricular chamber size. Hyperdynamic left ventricular systolic function.
2. Calculated 2-D monoplane volumetric left ventricular ejection fraction 73 %.
3. Mid left ventricular maximal instantaneous Doppler gradient rest 6 mm Hg; Valsalva 28 mm Hg.
4. Concentric remodeling (increased wall thickness to cavity ratio).
5. Findings consistent with normal left ventricular filling pressure.
6. Mild right ventricular enlargement with normal systolic function.
7. Normal left atrial size.
8. No hemodynamically significant valvular heart disease.
9. Normal inferior vena cava size with normal inspiratory collapse (>50%).
10. Mild ascending aorta dilatation (diameter 41 mm at proximal level).
11. No pericardial effusion.

ECG and CXR are unchanged.

ADD-RS

Aortic Dissection Detection Risk Score (ADD-RS):

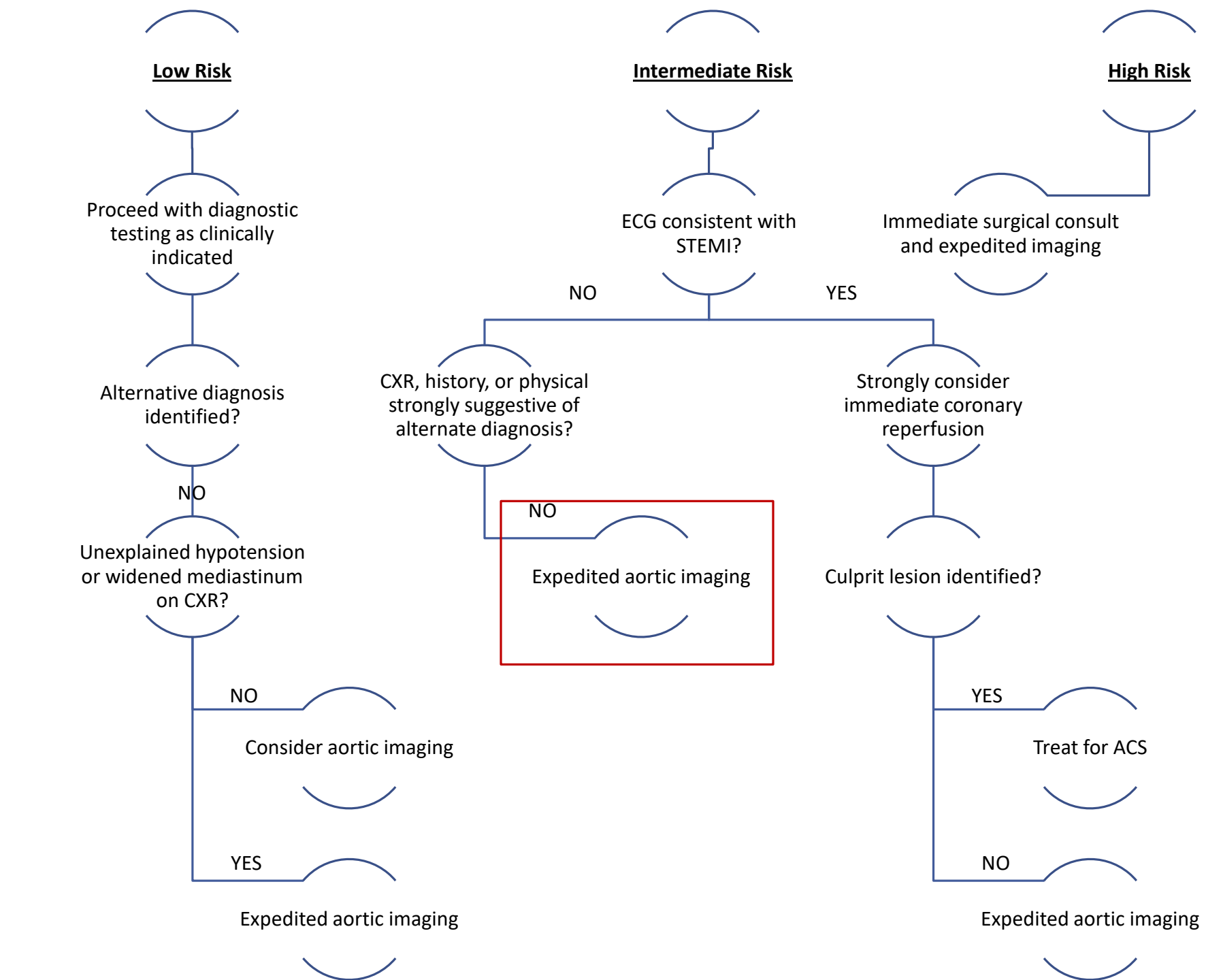
1. **High risk conditions**: Marfan syndrome or other CT disease, aortic valvular disease, family history/gene mutation, known thoracic aortic aneurysm, previous cardiac surgery or aortic manipulation

1. **High risk features:** pain in the chest back or abdomen that is abrupt, severe, or a ripping/tearing sensation

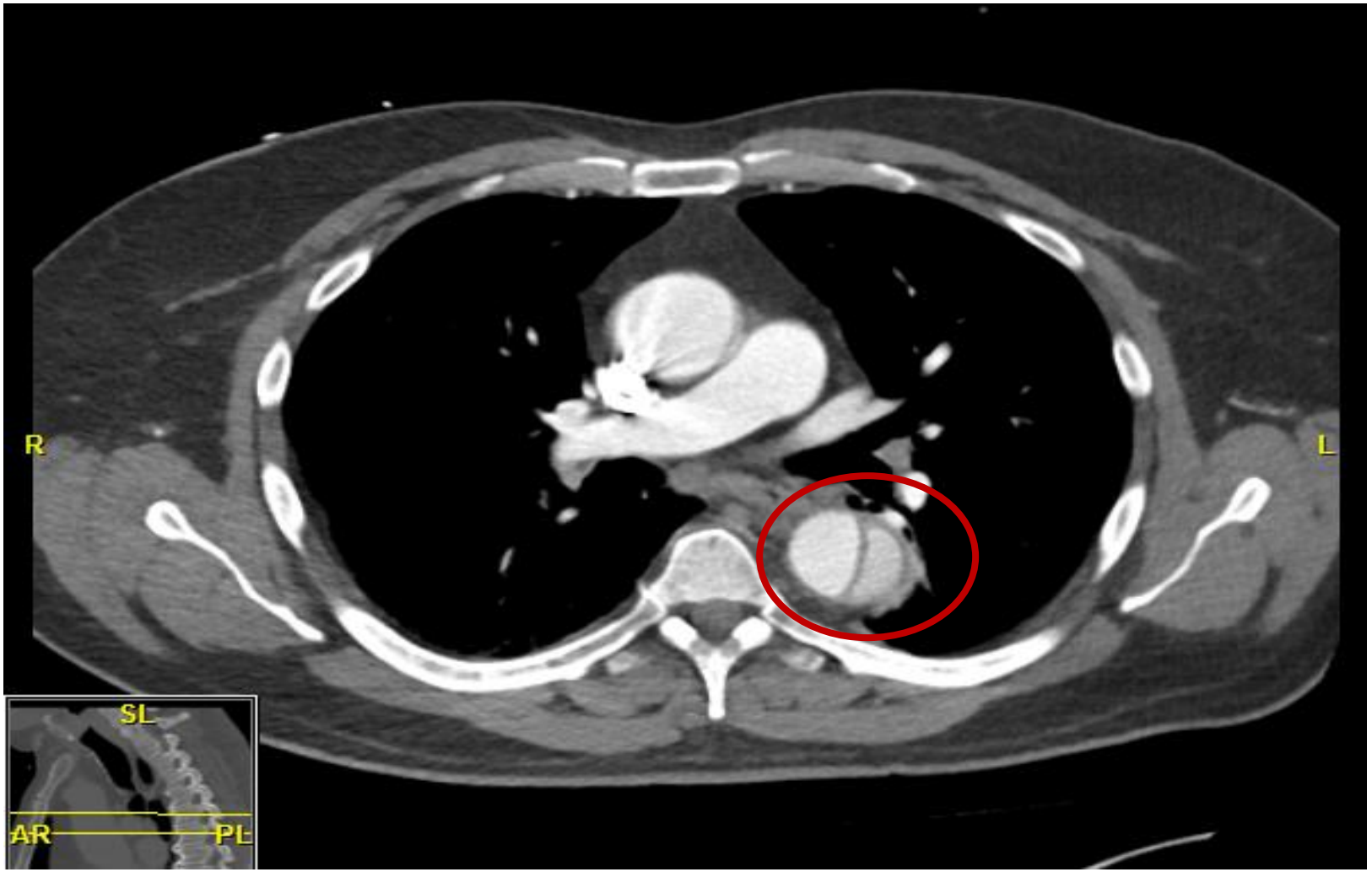
1. **High risk PE findings:** pulse deficit, SBP difference, focal neurologic deficit, aortic diastolic murmur, shock

Score 0-3 based on the presence of any positives in each of the categories

- low risk = 0
- intermediate risk = 1
- high risk = 2-3


Low Risk
Intermediate Risk
High Risk
Proceed with diagnostic testing as clinically indicated
ECG consistent with STEMI?
Immediate surgical consult and expedited imaging
NO
YES
Alternative diagnosis identified?
CXR, history, or physical strongly suggestive of alternate diagnosis?
Strongly consider immediate coronary reperfusion
NO
NO
Unexplained hypotension or widened mediastinum on CXR?
Expedited aortic imaging
Culprit lesion identified?
NO
Consider aortic imaging
YES
Treat for ACS
YES
NO
Expedited aortic imaging
Expedited aortic imaging

CT Angiography Chest



Mr. S

CT Angio Chest

CONCLUSION:

1. Type B aortic dissection in the mid descending thoracic aorta with slow flow in the false lumen and intramural hematoma extending into the abdominal aorta. Please see dedicated abdominal CT for detailed intra-abdominal findings.

Management of Aortic Dissection

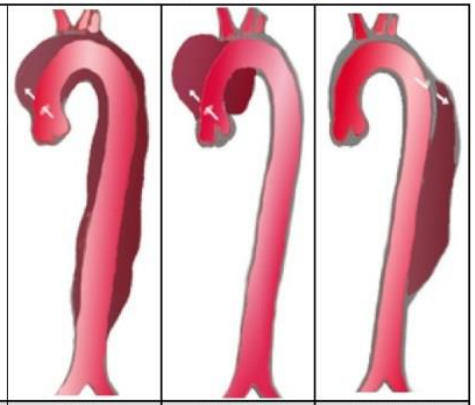
If hypotension or shock:
- IVF bolus +/- vasopressors
- Surgical consultation
- Review/additional imaging studies
  - Severe AR? Cardiac tamponade?

If stable, IV labetalol preferred
- Maintain HR <60, SBP <120 mmHg

Pain control is essential
- IV morphine reduces force of cardiac contraction

Dissections involving the **ascending thoracic aorta** should have urgent operative or interventional management if able

Classification of aortic dissection



Percentage	60%	10–15%	25–30%
Type	DeBakey I	DeBakey II	DeBakey III
	Stanford A (Proximal)		Stanford B (Distal)

Back to Mr. S

Admitted to the ICU, started on esmolol drip + nicardipine drip

Vascular Surgery consult: recommended conservative management and serial imaging studies

Complicated hospital course, eventually discharged hospital day 5 on the following regimen:

- labetalol 400mg TID
- lisinopril 40mg QD
- amlodipine 10mg QD
- chlorthalidone 25mg QD

Take Home Points

It is helpful to differentiate cardiac vs. non-cardiac chest pain.

Keep a wide differential…chest pain does not always mean ACS.

Use risk stratification tools, but despite these tools, your clinical judgement is most important!

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