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CASE REPORT

ADVANCED

HEART CARE TEAM/MULTIDISCIPLINARY TEAM LIVE

Triaging Down the 2021 Chest Pain Guidelines

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ABSTRACT

We applied the 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR chest pain guidelines to a case of a 76-year-old woman with no known coronary disease presenting to the emergency department with acute chest pain and an intermediate probability of acute coronary syndrome. Her workup per the guidelines involved rapid electrocardiogram, high-sensitivity troponins, nuclear stress testing, and eventually coronary invasive angiography. (**Level of Difficulty: Advanced.**)
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HISTORY OF PRESENTATION

A 76-year-old woman presented to the emergency department with chest pain. She described worsening substernal chest pain radiating to her left shoulder that started 2 weeks before presentation. The chest pain felt burning and had become more severe and frequent during this time. Her pain was associated with belching, so she assumed she was having acid reflux, thus delaying her presentation. Exertion worsened the chest pain and rest alleviated it.

Her past medical history was significant for prediabetes, obstructive sleep apnea, asthma, and osteoporosis. She denied history of smoking, substance use, obesity, hypertension, or hyperlipidemia. She was not taking any cardiovascular medications.

On arrival to the emergency room, she was chest pain free. Her vitals on admission were within normal limits except for a blood pressure of 168/71 mm Hg. Physical examination was also unrevealing.

LEARNING OBJECTIVES

- To stress the importance of early triaging with ECGs and preference for high-sensitivity troponins when assessing for ACS on arrival to the emergency room.
- To use clinical decision pathways appropriately for risk stratification of patients incorporating both risk scores and high-sensitivity troponins.
- To understand the options and incremental value for risk assessment and coronary disease diagnosis of noninvasive imaging in patients deemed intermediate risk presenting with chest pain.

QUESTION 1: WHAT IS THE DIFFERENTIAL AT THIS STAGE? The differential for chest pain includes cardiac etiologies including acute coronary syndrome (ACS), arrhythmias, stress-induced cardiomyopathy, severe aortic stenosis, and peri-myocarditis. The noncardiac causes of chest pain include aortic dissection, esophageal spasm or rupture, pulmonary embolism, and costochondritis.

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ABBREVIATIONS AND ACRONYMS

ACS = acute coronary syndrome

CCTA = coronary computed tomography angiography

ECG = electrocardiogram

GRACE = Global Registry of Acute Coronary Events

RCA = right coronary artery

SPECT = single-photon emission computed tomography

TIMI = Thrombolysis In Myocardial Infarction

QUESTION 2: WHAT INVESTIGATIONS FOR ACS ARE WARRANTED AT THIS STAGE? As the new 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR chest pain guidelines[1] recommend, a 12-lead electrocardiogram (ECG) should be performed for ST-segment elevation myocardial infarction within 10 minutes of arrival to the emergency department (Class 1, Level of Evidence [LOE]: C-LD) and troponins without delay (Class 1, LOE: C-LD) (**Figure 1, Central Illustration**). For our patient, an ECG was done on presentation within 10 minutes and showed normal sinus rhythm without significant ST-T changes (**Figure 2**). Repeat ECG showed nonspecific ST-T changes as seen on her initial ECG (**Figure 3**). Her initial high-sensitivity troponin on presentation and then repeated were 56, 52 and 50 ng/L (99th percentile upper reference limit that defines myocardial injury <12 ng/L). Conventional troponin T was 0.023 and then 0.039 ng/mL (99th percentile upper reference limit that defines myocardial injury <0.029 ng/mL). Her complete blood count and comprehensive metabolic panel were unrevealing, and her low-density lipoprotein was 105 mg/dL. Chest radiograph showed no significant abnormalities.

QUESTION 3: WHAT IS THE ROLE OF HIGH-SENSITIVITY TROPONINS IN PATIENTS PRESENTING WITH CHEST PAIN TO THE EMERGENCY ROOM? The new guidelines advocate for the primacy of high-sensitivity troponins because they can exclude or detect myocardial injury with better diagnostic accuracy.[1] High-sensitivity troponins below threshold and a nonsignificant change between serial high-sensitivity values have a 99.5% negative predictive value with regard to 30-day outcomes of myocardial infarction or death.[2] In addition, using high-sensitivity troponin shortens triage time, as high-sensitivity troponins are collected between 1 and 3 hours, whereas conventional troponins are collected over 3 to 6 hours.

Compared with men, women have lower high-sensitivity troponins, which may be linked to lower myocardial mass even when corrected for body surface area.[3] Although certain troponin assays have Food and Drug Administration approval for sex-specific cutoffs, having universal sex-specific cutoffs have not been proven to apply to all assays, although prospective studies are sparse.[4]

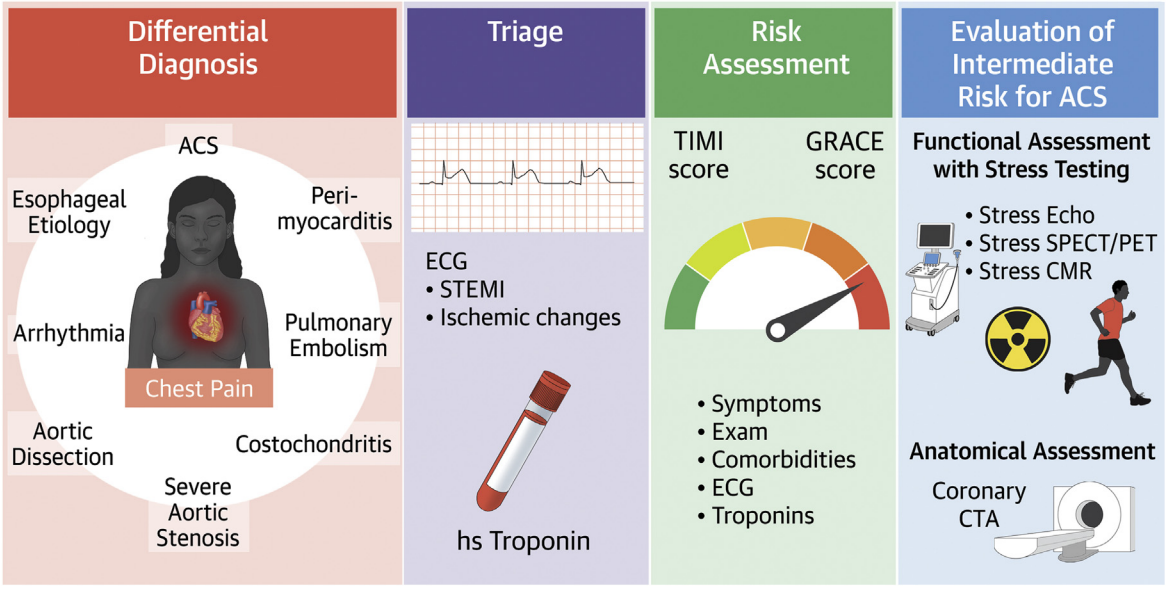
QUESTION 4: HOW DO YOU RISK STRATIFY ACS? Risk stratification in ACS remains crucial to further clinical decision making for early discharge or to

FIGURE 1 Recommendations Regarding Initial Triaging Testing on Presentation to the Emergency Department

Recommendations for Setting Considerations Referenced studies that support the recommendations are summarized in Online Data Supplement 5.		
COR	**LOE**	**Recommendations**
1	C-LD	3. In all patients who present with acute chest pain regardless of the setting, an ECG should be acquired and reviewed for STEMI within 10 minutes of arrival (1-3, 6, 7, 10).
1	C-LD	4. In all patients presenting to the ED with acute chest pain and suspected ACS, cTn should be measured as soon as possible after presentation (8, 9).

Adapted from the 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR chest pain guidelines, Section 2.3.1: Setting Considerations.[1]

CENTRAL ILLUSTRATION **Assessment of Acute Chest Pain in the Emergency Department**



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ACS = acute coronary syndrome; CMR = cardiac magnetic resonance; CTA = computed tomography angiography; ECG = electrocardiogram; GRACE = Global Registry of Acute Coronary Events; PET = positron emission tomography; SPECT = single-photon emission computed tomography; STEMI = ST-segment elevation myocardial infarction; TIMI = Thrombolysis In Myocardial Infarction.

FIGURE 2 **Initial Electrocardiogram**

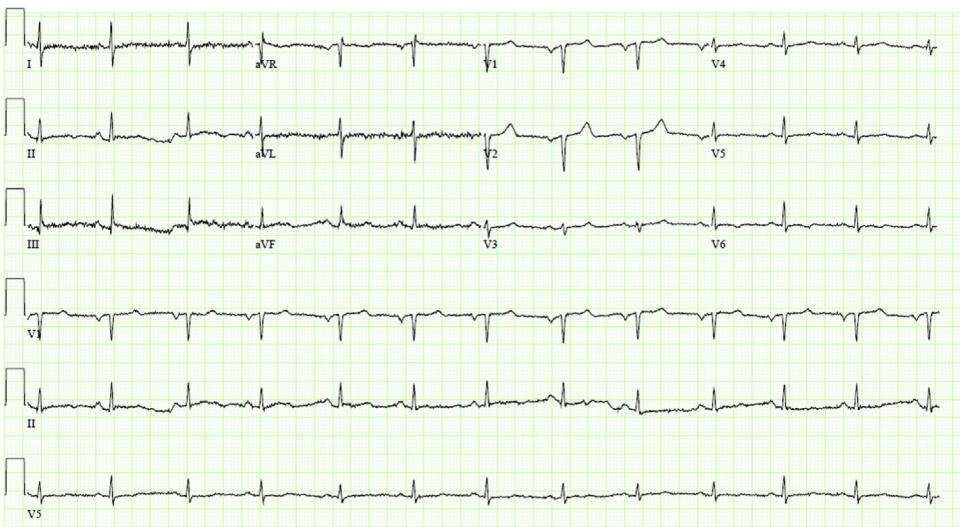
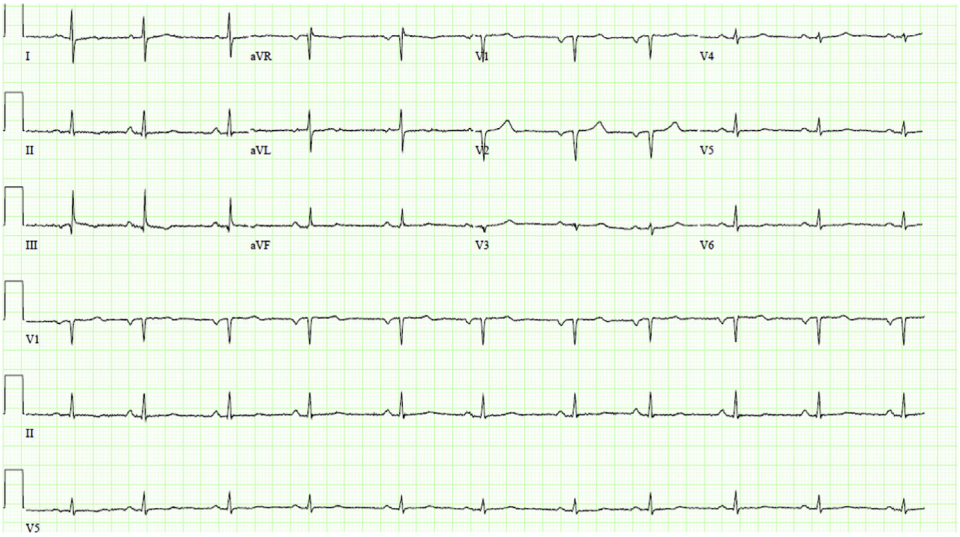


FIGURE 3 Repeat Electrocardiogram



pursue more downstream testing. Risk stratification incorporates the symptoms, examination, comorbidities, ECG, and troponins.[5] The description of typical angina can include chest and/or arm pain that is produced by exertion or stress and relieved with either rest or nitroglycerin. It is important to recognize that women, diabetic individuals, and elderly individuals may lack chest pain or have more vague symptoms, including only worsening dyspnea or epigastric pain. Moreover, comorbidities should be taken into account, including older age, history of coronary artery disease, strokes, peripheral vascular disease, hypertension, and diabetes, which all increase the probability of ACS. Objective data such as elevated and/or uptrending troponins as well as ECG changes, particularly new T-wave inversions and ST-segment depressions, also should increase the likelihood. Scoring systems, such as the GRACE (Global Registry of Acute Coronary Events) and TIMI (Thrombolysis In Myocardial Infarction), incorporate some of these factors to generate a prediction of major adverse cardiovascular events. A TIMI score of 3 or greater and GRACE score of 140 or greater indicates patients who would likely benefit from an early invasive strategy. Our patient's TIMI score was 3 and GRACE score was 103, which would be classified as intermediate risk and low risk alone, respectively (Table 1).

The new guidelines advocate for clinical decision pathways using a scoring system and high-sensitivity troponins to facilitate rapid risk stratification (Figure 4). Applying the presenting features of our patient to commonly used clinical pathways, as the guidelines recommend, her TIMI score classified her as intermediate risk, whereas her high-sensitivity troponin elevation and trend would place her at high risk. In the era of high-sensitivity troponins, scoring systems should still play a complementary

TABLE 1 TIMI and GRACE Calculations

TIMI Risk Score for Unstable Angina/NSTEMI	Points
Age ≥65 y	1
≥3 Coronary artery disease risk factors	0
Known coronary artery disease	0
Aspirin use in past 7 days	0
Severe angina ≥2 episodes in 24 hours	1
ST-segment changes ≥0.5 mm	0
Positive cardiac marker	1
Total	3

GRACE	Values	Points
Age (y)	76	75
Heart rate	65	3
Systolic blood pressure (mm Hg)	168	10
Creatinine (mg/dL)	0.76	4
Killip class	1	0
Cardiac arrest on admission	No	0
ST-segment deviation on electrocardiogram	No	0
Abnormal cardiac enzymes	Yes	14
Total		106

GRACE = Global Registry of Acute Coronary Events; NSTEMI = non-ST-segment elevation myocardial infarction; TIMI = Thrombolysis In Myocardial Infarction.

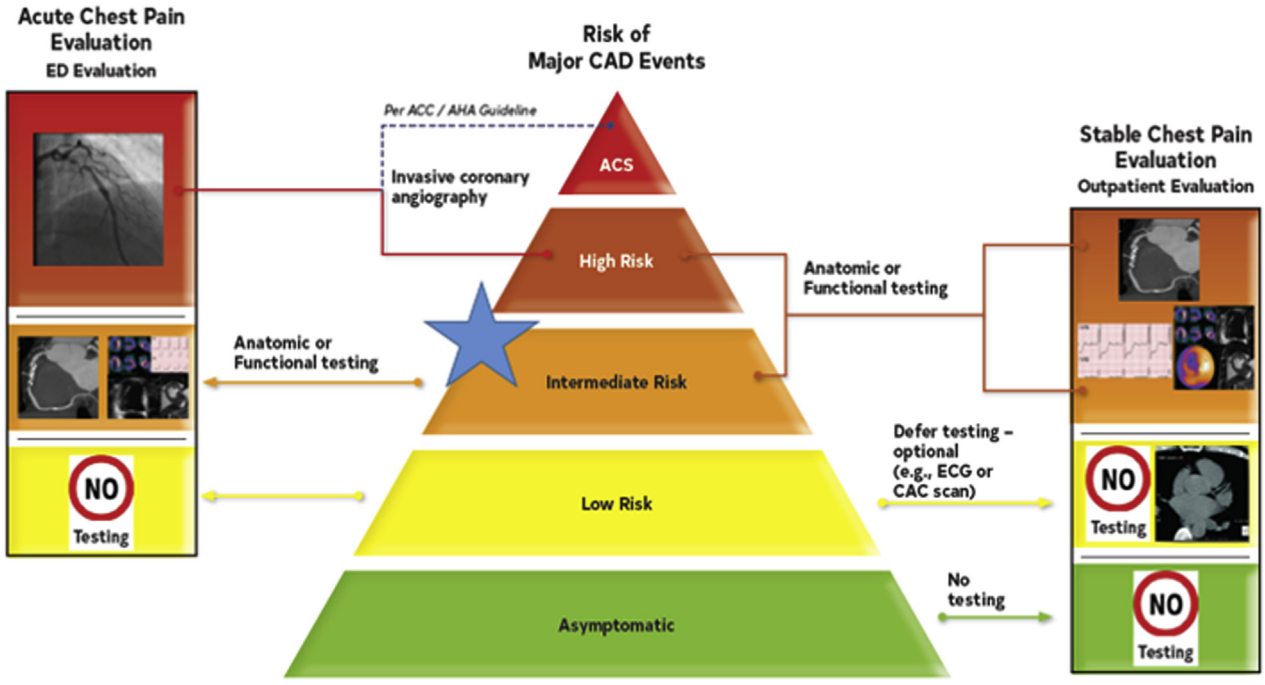
FIGURE 4 **Risk Stratification Based on Scoring System Along With Each Respective Scoring System That Incorporates History, Cardiovascular Risk Factors, ECG, and Troponins**

	HEART Pathway	TIMI Pathway	GRACE Pathway
Low Risk	Score <3 Negative 0, 3 hour hsTNT	Score 0-1 Negative 0, 2 hour hsTNT	Score <140 chest pain free symptom onset < 6 hour with negative hsTNT 0, 3 hours
Intermediate Risk	Score 4-6	Score 2-4	hsTNT 12-52 or 1h h Δ = 3–5 ng/L
High risk	Score 7-10	Score 5-7	Initial hsTNT >52 ng/L or 1h h Δ > 5 ng/L

Adapted from the 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR chest pain guidelines,[1] Table 6: Sample Clinical Decision Pathways Used to Define Risk.[1] The TIMI and GRACE Pathways were used in our patient. ECG = electrocardiogram; GRACE = Global Registry of Acute Coronary Events; TIMI = Thrombolysis In Myocardial Infarction.

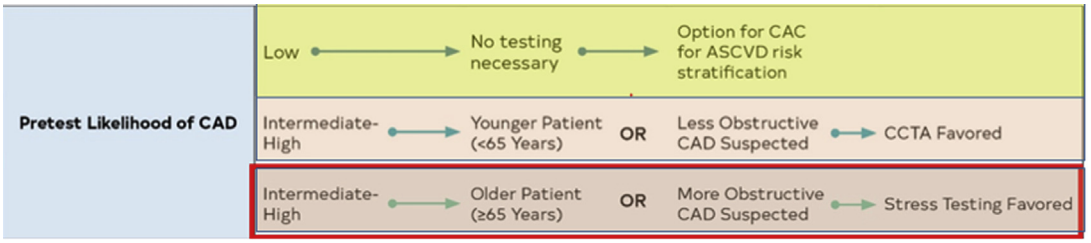
role to high-sensitivity troponins.[6] However, with the high sensitivity and specificity of these troponins for detecting myocardial injury, a prospective study showed that patients triaged to the High-Sensitivity Troponins in the Evaluation of Patients With Acute Coronary Syndrome pathway with serial high-sensitivity troponins, risk scores did not change outcomes.[7]

FIGURE 5 **Diagnostic Choice of Testing Based on the 2021 ACC/AHA Chest Pain Guidelines**



Reproduced from the 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR chest pain guidelines,[1] Figure 5: Chest Pain and Cardiac Testing Considerations.[1]

FIGURE 6 Choosing the Diagnostic Testing Depending on Pretest Likelihood

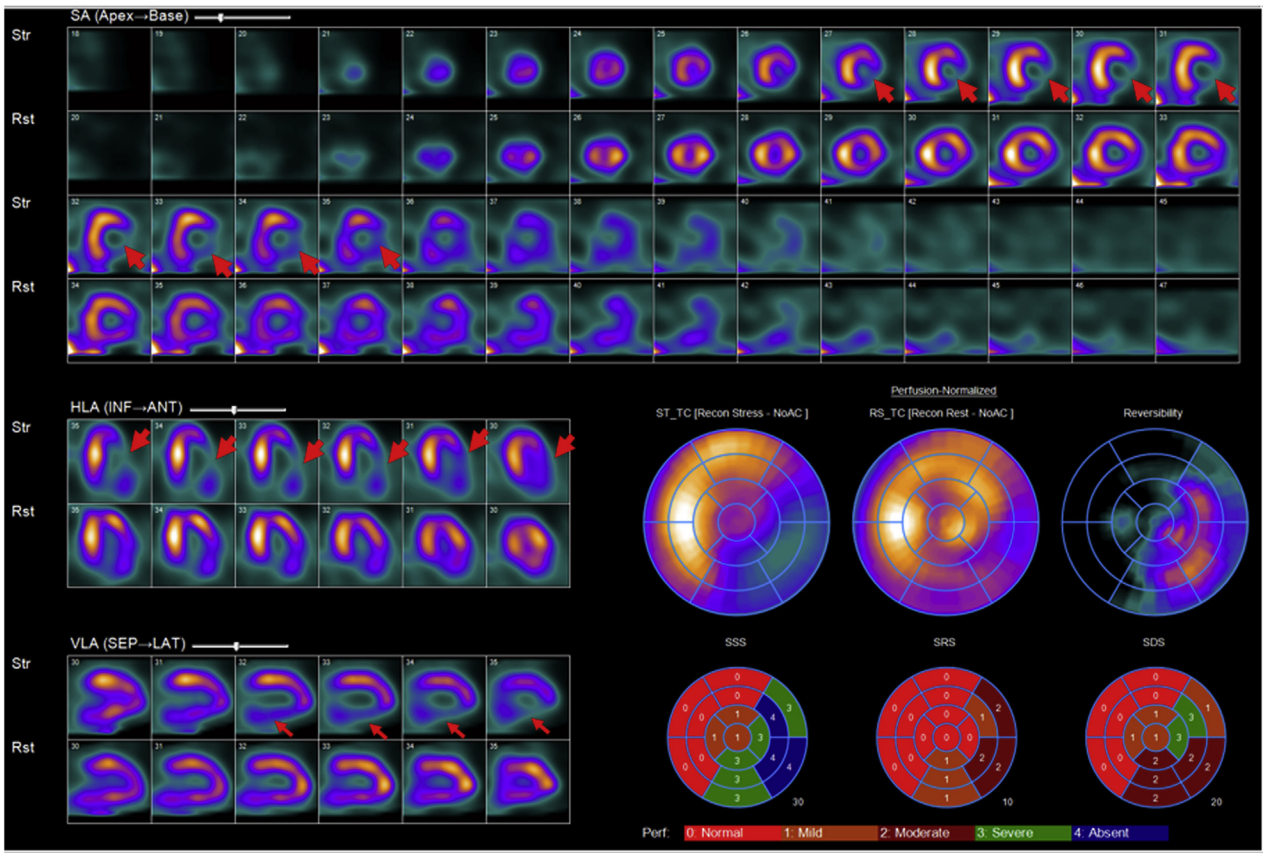


Adapted from the 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR chest pain guidelines,[1] Figure 6: Choosing the Right Diagnostic Test.[1]

QUESTION 5: WHICH NONINVASIVE IMAGING MODALITY WOULD BE APPROPRIATE TO EVALUATE FOR PATIENTS WITH INTERMEDIATE RISK OF ACS?

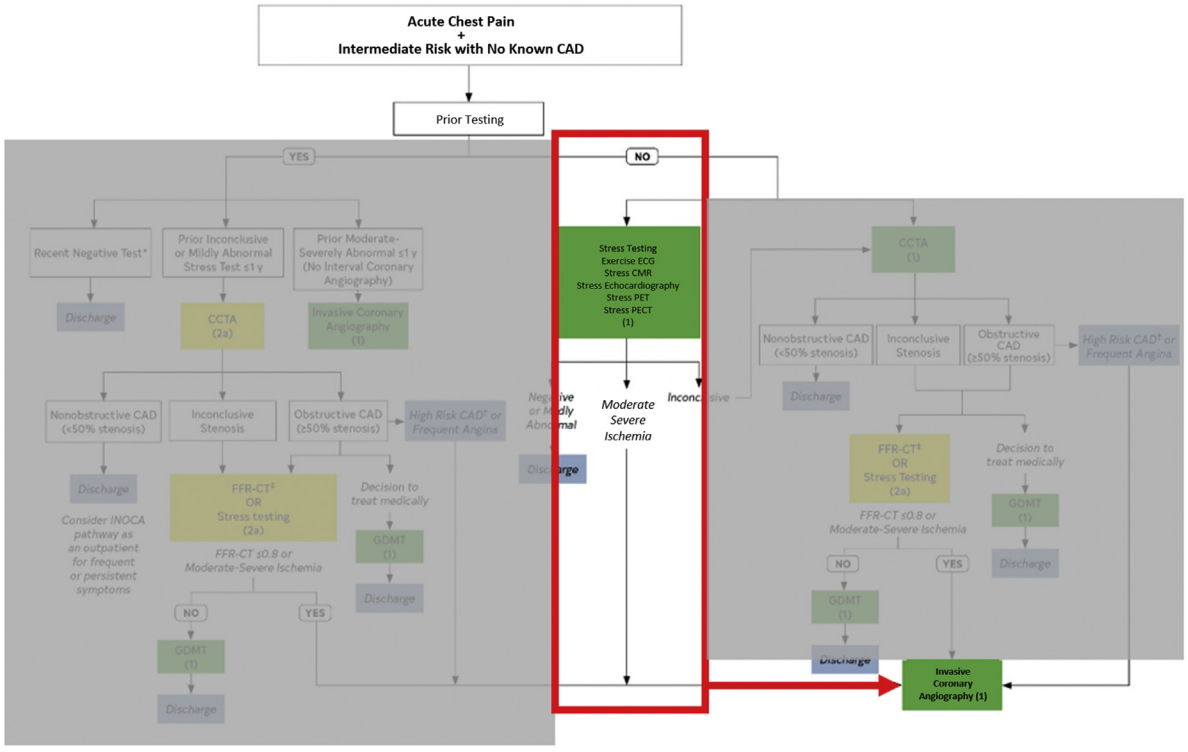
For intermediate-risk patients, the guidelines recommend functional or anatomic testing (Figure 5).[1] Given our patient's older age and to avoid confounding issues from coronary artery calcifications, she underwent stress testing. For younger patients

FIGURE 7 Single-Photon Emission Computed Tomography Imaging



Moderate ischemia seen in LCx territory **(arrows)** with mild ischemia in the RCA distribution **(arrows)**. LCx = left circumflex; RCA = right coronary artery

FIGURE 8 **Pathway per 2021 ACC/AHA Chest Pain Guidelines for Acute Chest Pain With Intermediate Probability**



Reproduced from the 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR chest pain guidelines,[1] Figure 9: Evaluation Algorithm for Patients With Suspected ACS at Intermediate Risk With No Known CAD.[1] ACS = acute coronary syndrome; CAD = coronary artery disease.

with also an intermediate risk probability of ACS and no history of coronary disease, a coronary computed tomography angiography (CCTA) also would be reasonable (**Figure 6**). Compared with functional testing, anatomic testing has similar major adverse coronary event outcomes with a follow-up of approximately 3.5 years.[8] For patients with prior CCTA and/or stress testing, these results can be extrapolated to 2 years and 1 year, respectively, if CCTA is without plaque or stenosis and stress testing is without ischemia.

Regarding choice of nuclear imaging, the latest recommendation gives a Class 2a (LOE: B) recommendation of positron emission tomography (PET) over single-photon emission computed tomography (SPECT) to increase testing accuracy with better spatial resolution and ability to perform myocardial blood flow assessment with PET. In a recent study of 475 patients with stable angina who underwent stress testing and angiography or stress testing was concerning, PET had higher sensitivity of 81% and specificity of 89% than SPECT, which had a specificity of 73% and sensitivity of 67%.[9]

HOSPITAL COURSE

The patient underwent a Tc-99m-tetrofosmin exercise gated SPECT with computed tomography and was able to achieve 4.7 metabolic equivalents with 95% predicted maximal heart rate before developing chest discomfort that resolved with rest. Her SPECT showed moderate ischemia in the circumflex territory, mild ischemia in the right coronary distribution, and small fixed perfusion defects in the circumflex and right (**Figure 7**). With moderate burden of ischemia seen on her SPECT, we pursued invasive angiography according to the algorithm for patients with acute chest pain and intermediate risk with no prior stress testing (Class 1) (**Figure 8**). She underwent left heart catheterization that showed a severe 90% stenosis in the proximal left circumflex (LCx), severe stenosis in the mid right coronary artery (RCA) that was significant on intravascular ultrasound, and a mid-left anterior descending artery stenosis of 50% (Videos 1 and 2).

She underwent percutaneous coronary intervention with drug-eluting stent to both the proximal LCx

TABLE 2 Adapted From the AHA/ACC Clinical Performance and Quality Measures for NSTEMI

Performance Measures for NSTEMI
Aspirin on arrival
Early cardiac troponin measurement (within 6 hours)
Evaluation of left ventricular ejection fraction
ACE inhibitor or ARB prescribed for systolic dysfunction
Cardiac rehabilitation referral
Medications prescribed on discharge
Aspirin
Beta blocker
High-intensity statin
P2Y12 receptor inhibitor

ACE = angiotensin-converting enzyme; AHA/ACC = American Heart Association/American College of Cardiology; ARB = angiotensin receptor blocker; NSTEMI = non-ST-segmentelevation myocardial infarction.

and the mid RCA with intravascular ultrasound guidance. She was started on atorvastatin 40 mg daily, metoprolol tartrate 12.5 mg twice a day, aspirin 81 mg daily, and clopidogrel 75 mg daily in accordance with the American Heart Association/American College of Cardiology Quality Measures for Non-ST-Elevation Myocardial Infarction[10] (Table 2). On discharge, she was referred to cardiac rehab.

FOLLOW-UP

The patient was seen in clinic a month later and reported no further episodes of chest pain.

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The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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KEY WORDS acute coronary syndrome, NSTEMI, nuclear imaging, stress testing, unstable angina

APPENDIX For supplemental videos, please see the online version of this paper.

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