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CASE REPORT

INTERMEDIATE

HEART CARE TEAM/MULTIDISCIPLINARY TEAM LIVE

Chest Pain

Who Needs Additional Testing Beyond ECG and Troponin?

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ABSTRACT

In the first case, we describe a 45-year-old man who presented to the emergency department for evaluation of chest pain. He reported having chest discomfort 5 days prior that lasted a few minutes after an altercation with his coworker. In the second case, we describe a 54-year-old woman with history of well-controlled diabetes mellitus, hypertension, and dyslipidemia who presented to the ED with a 10-day history of intermittent sharp and burning chest pain in the substernal region, 5/10 intensity, lasting 15-20 minutes, associated with exertion. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2021;3:1643-1648) © 2021 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

CASE 1

A 45-year-old man presents to the emergency department (ED) for evaluation of chest pain. He reports having chest discomfort 5 days prior that lasted a few minutes after an altercation with his coworker. He did not seek medical attention at that time because the discomfort subsided quickly. However, he had recurrence of the pain today an hour ago after another altercation with the same coworker, but the pain lasted longer this time. He describes chest pain as a substernal dull aching sensation, nonradiating, associated with shortness of breath, 8/10 in intensity, for ~10 minutes, which was relieved on his way to the ED. His medical history is notable for active tobacco use (20-pack-year smoking history). He does not take any medications. Family history is notable for coronary artery disease in mother at age 69 and hypertension in father and grandfather. At his last physical with his primary care physician a couple years ago, he had a normal blood pressure, HbA1c of 5.3, and lipid panel within normal limits. He exercises daily for about 30-40 minutes and has not noted any limitations or any chest discomfort with exercise.

In the ED, his blood pressure is 157/86 mm Hg, heart rate of 95 beats/min, saturation on room air 98%, and body mass index of 31 kg/m^2.

Physical examination reveals a well-nourished male, normal jugular venous pressure, and normal carotid pulse. Heart rate and rhythm were normal. On auscultation S4 is appreciated with no murmurs. Chest examination is clear, and the abdomen is soft and nontender. No pedal edema was evident.

LEARNING OBJECTIVES

- To identify low-risk patients with chest pain who do not need additional testing beyond ECG and hs-cTn.
- To identify patients with chest pain most likely to benefit from further testing.

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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ABBREVIATIONS AND ACRONYMS

ACS = acute coronary syndrome(s)

CAD = coronary artery disease

CCTA = coronary computed tomography angiography

CDP = clinical decision pathway

ECG = electrocardiogram

ED = emergency department

EDACS = Emergency Department Assessment of Chest Pain Score

FFR-CT = fractional flow reserve-computed tomography

HEART = History, ECG, Age, Risk factors and Troponin

hs-cTn = high sensitivity-troponin

MACE = major adverse cardiac events

mADAPT = Modified Accelerated Diagnostic protocol to Assess chest Pain using Troponins

A 12-lead electrocardiogram (ECG) demonstrated normal sinus rhythm with no ischemic changes. His initial blood results showed high sensitivity-troponin (hs-cTn) I level of 1 pg/mL (normal ≤12 pg/mL for men for this assay); hs-cTn I 1 hour later was 1.1 pg/mL.

QUESTION 1: WHAT IS THE LIKELIHOOD THAT THIS IS AN EPISODE OF ACUTE CORONARY SYNDROME? Answer 1. This is a physically active young male, with cardiac risk factors of smoking and perhaps essential hypertension that has not been diagnosed or treated, negative hs-cTn at 0, and 1 hour with the change in hs-cTn I level <6 pg/mL at 1 hour.

If we were to assess with use of clinical scores, his HEART (History, ECG, Age, Risk factors, and Troponin) score is 2, his EDACS (Emergency Department Assessment of Chest Pain Score) is 8, his mADAPT (modified Accelerated Diagnostic protocol to Assess chest Pain using Troponins) score is 0, then this patient represents a low-risk category for having an acute coronary syndrome (ACS) and adverse event of 0.9%-1.7%. Based on his data, it is highly unlikely this is an episode of ACS.

Classically ACS is a spectrum of conditions due to acute myocardial ischemia from an abrupt decrease in coronary blood flow and includes unstable angina pectoris without evidence of myocardial necrosis and myocardial infarction with or without concomitant ST-segment elevation (1,2). The hs-cTn assays are meant to complement clinical assessment and ECG analysis, and dynamic elevation >99th percentile usually within 1 hour of symptom onset is indicative of ACS. The higher sensitivity of hs-cTn allows for a rapid rule-in and rule-out strategy to decide on additional testing and hospital admission versus discharge with follow-up. Most importantly, by reducing the "troponin blind" interval due to higher sensitivity and earlier detection with hs-cTn, they have a high negative predictive value for ruling out ACS.

QUESTION 2: HOW WOULD YOU ASSESS HIS RISK? Answer 2. Based on his clinical presentation, negative hs-CTn, and low HEART, EDACS, mADAPT scores, he is at low risk and safe for discharge to early outpatient follow-up. Low risk designation means a 30-day risk of death or major adverse cardiac events (MACE) <1%.

Hs-cTn levels and clinical decision pathways (CDPs), such as HEART pathway, EDACS, and mADAPT scores, provide an integrated assessment combining clinical data such as age, ECG changes, symptom characteristics, and risk factors, to estimate an individual's probability of ACS and risk of 30-day MACE. Compared with a clinical assessment without structure, CDPs may decrease unnecessary testing and reduce admissions while maintaining high sensitivity for detection of ACS and 30-day MACE (**Central Illustration**) (3). Of note, when hs-cTn is used alone, absent risk scores, it also portends low risk and the hs-CTn 0/1 hour or the 0/2 hour protocol are CDPs that also portend low risk if negative. A 12-lead ECG within 10 minutes of arrival in the ED is critical. High-risk features on ECG are ST-segment depression, transient ST-segment elevation, and new T-wave inversion in comparison with a prior ECG. The dynamic rise and fall of cardiac troponins are sensitive and specific to cardiac myocyte injury. Appropriate interpretation of troponin results is dependent on time from onset of chest pain and the delta or actual difference between serial measurements than the actual levels. One exception to this if the levels are very low, and a single measurement may be sufficient if patient's chest pain began 3 hours prior. Of note, these numbers are assay specific; for the assay we use, the change in 1 hour ≥6 pg/mL is significant and clinicians need to be aware of cutoffs at their institution.

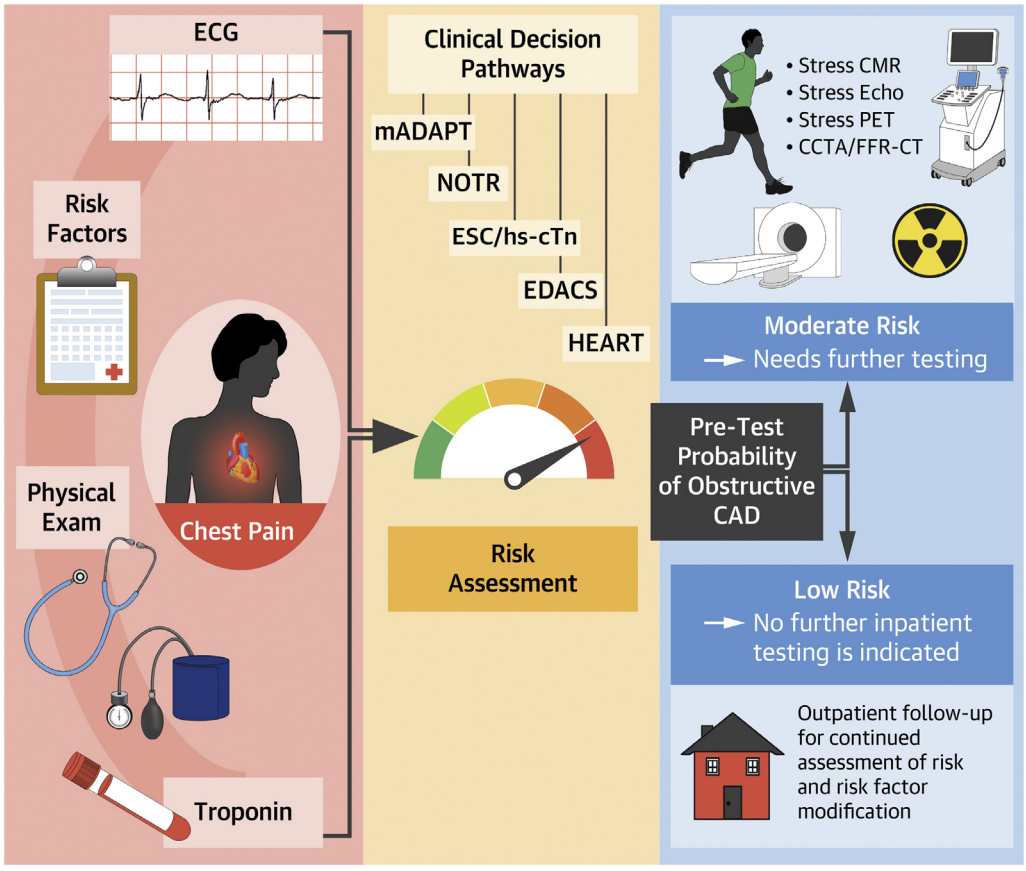
Clinical risk stratification tools or CDPs implemented at the institution level can help with appropriate risk stratification with optimal patient outcomes. If it is a low-risk patient, such as ours, no further cardiac testing is required and the patient can be safely discharged from the ED with appropriate follow-up. The importance of follow-up with primary care physician and further risk factor modification needs to be emphasized.

QUESTION 3: DOES THIS PATIENT NEED HOSPITAL ADMISSION? Answer 3. This patient is a low-risk patient and will not benefit from hospital admission. He can be safely discharged to early outpatient follow-up

QUESTION 4: DOES THIS PATIENT NEED FURTHER TESTING? Answer 4. This individual does not need additional testing beyond ECG and hs-cTn in the ED and does not need admission. For patients with acute or stable chest pain who are determined to be at low risk, urgent diagnostic testing for suspected coronary artery disease is not indicated.

The patient has risk factors that need further follow-up care with a primary care physician. Therefore, establishing good out-patient care and blood pressure monitoring will be of benefit. Furthermore,

CENTRAL ILLUSTRATION **Structured Approach to Evaluation for Patients Presenting With Chest Pain**



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CAD = coronary artery disease; CCTA = coronary computed tomography angiography; CMR = cardiac magnetic resonance; ECG = electrocardiogram; EDACS = Emergency Department Assessment of Chest Pain Score; ESC = European Society of Cardiology; FFR-CT = fractional flow reserve derived from coronary CT angiography; HEART = History, ECG, Age, Risk Factors, and Troponin; mADAPT = modified Accelerated Diagnostic Protocol to Assess Patients with Chest Pain Symptoms Using Contemporary Troponins; NOTR = no objective testing rule; PET = positron emission tomography.

education and discussion about smoking cessation is important. However, at this point, offering any type of additional cardiac testing is of little utility and would increase economic burden on the patient and the healthcare system. Discussion of low probability of MACE at 30 day should be done with the patient along with importance of risk factor modification and primary prevention strategies.

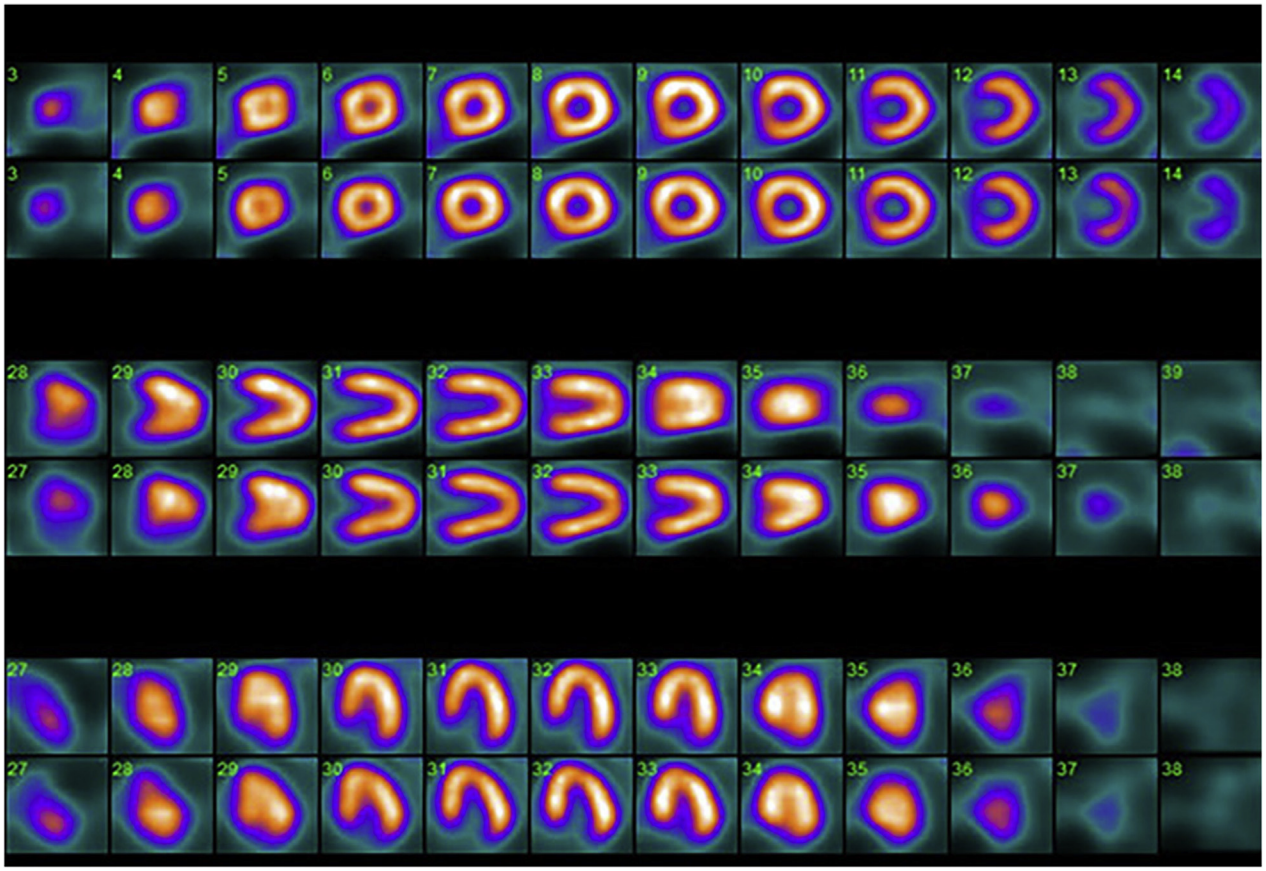
Pretest probability of having obstructive coronary artery disease is based on age, sex, and symptoms. If coronary artery calcium score is available, it may be used to estimate pretest probability of obstructive coronary artery disease (CAD) based on the coronary artery calcium score (4,5).

CASE 2

A 54-year-old woman with history of well-controlled diabetes mellitus, hypertension, and dyslipidemia presents to the ED with a 10-day history of intermittent sharp and burning chest pain in the substernal region, 5/10 intensity, lasting 15-20 minutes, associated with exertion. Her last episode was 3 hours ago but lasted longer so she decided to get an evaluation. Patient had a prior exercise nuclear stress imaging 2 years ago (**Figure 1**) when she exercised for 8 minutes, with metabolic equivalents of 7.1 and had normal myocardial perfusion. She is a lifetime nonsmoker, and walks 2 miles daily without change in exercise tolerance.

JACC: CASE REPORTS, VOL. 3, NO. 15, 2021
NOVEMBER 3, 2021:1643–1648

FIGURE 1 Myocardial Perfusion Study (Splash Views) Single-Photon Emission Computed Tomography Images



Myocardial perfusion study (Splash views) single-photon emission computed tomography images in short-axis, vertical long-axis, and horizontal long-axis views display normal left ventricular cavity and homogenous tracer distribution throughout the myocardium.

Family history is positive for diabetes in mother, and hypertension and atrial fibrillation in father.

Patient's body mass index is 28.8 kg/m2, blood pressure 134/80 mm Hg, heart rate 82 beats/min, saturation on room air of 96%, and temperature 36.7°C. Physical examination shows a well-nourished woman without distress, no jugular venous distension, normal heart rate with regular rhythm, and no obvious murmurs, rubs, or gallops. No reproducible chest or abdomen tenderness was elicited.

A 12-lead ECG shows normal sinus rhythm with nonspecific ST-T changes, initial blood results showed hs-cTn level of 6 pg/mL (Normal <10 pg/mL for women), and 1 hour later hs-cTn level is 10 pg/mL

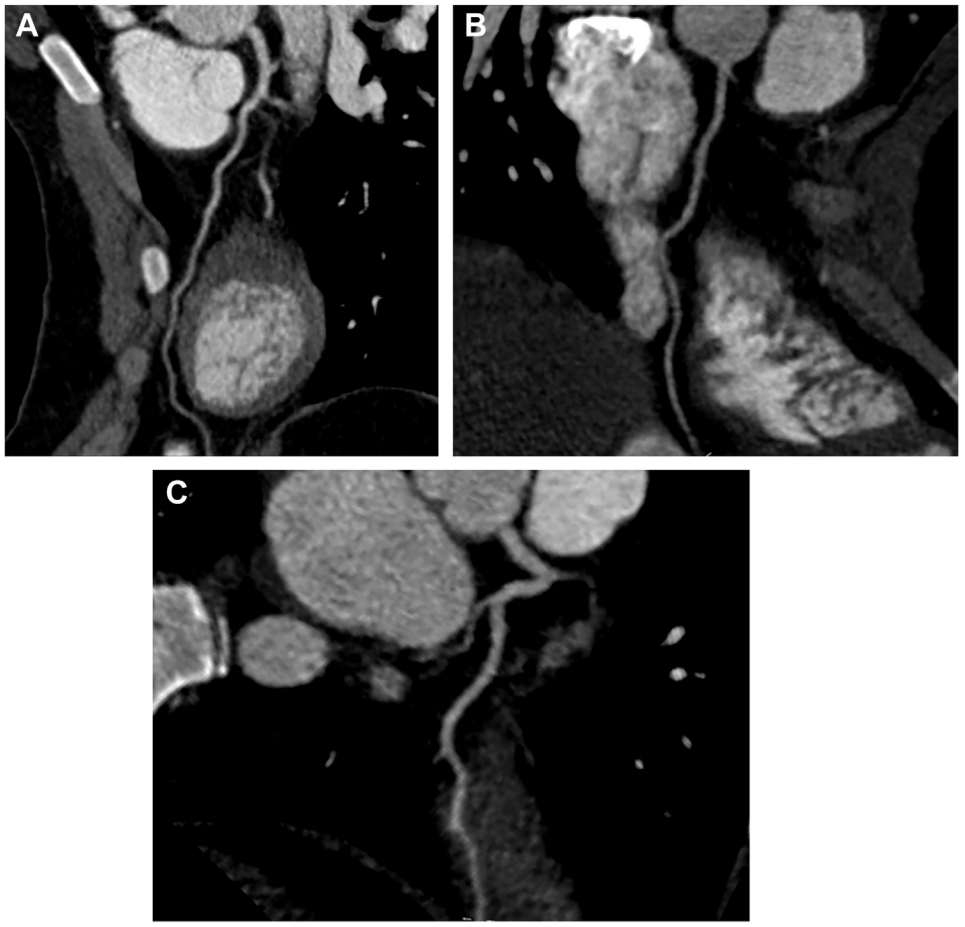
Her medical regimen on admission included aspirin, atorvastatin, and losartan.

QUESTION 5: WILL THIS PATIENT BENEFIT FROM FURTHER TESTING? Answer 5. Based on her data, she is at intermediate risk. Patients with acute or stable chest pain who are at intermediate risk or intermediate-to-high pretest risk of obstructive coronary artery disease, respectively, will benefit the most from cardiac imaging and testing.

If we follow one of the several CDPs and use the European Society of Cardiology 0/1 hour algorithm (6), the patient's last chest pain episode was 3 hours ago and at 0 hours her hs-cTn I is not very low. It is in the low normal range, therefore, additional testing at 1 hour was indicated and performed. The delta or change in the hs-cTn I level is not <2, therefore, this cannot be a rapid rule out. At the same time, it did not increase >6 pg/mL, therefore, she does not fall in the rapid rule-in category either. Based on her clinical and troponin data, she is at intermediate risk (6).

Patient had a prior cardiac testing with a normal nuclear stress imaging but this was 2 years ago and theoretically she has exceeded the warranty interval for that test (3). If a nuclear stress test within 1 year is of

FIGURE 2 Coronary Computed Tomography Angiography



Coronary computed tomography angiography showing no significant coronary artery stenosis. (Images courtesy of Dr Anoop Ayappan). **(A)** Curved multiplanar reformat coronary computed tomography angiography image of the normal left anterior descending artery. **(B)** normal right coronary artery. **(C)** Normal left circumflex artery.

good quality with normal left ventricular ejection fraction and symptoms have not changed, typically no further testing would be recommended. In our patient, because the previous test was of adequate quality, however, outside the warranty interval, and with change in symptoms, we have the option of repeating the stress test or performing an anatomic test with a coronary computed tomography angiography (CCTA). An informed decision about the options of testing should be discussed with the patient before performing the test. Other forms of stress testing may be considered, such as treadmill stress ECG testing (if baseline ECG is normal), stress cardiac magnetic resonance imaging, stress echocardiography, or stress positron emission tomography (PET). If the stress testing is inconclusive, CCTA may also be performed at that time. If stress test shows moderate to severe ischemia, invasive angiography should be performed.

If the CCTA shows no CAD or minimal stenosis, patients can be safely discharged. If it shows intermediate stenosis, further functional testing is warranted, with either a different form of stress imaging or fractional flow reserve-computed tomography (FFR-CT). If the FFR-CT is ≤0.8 or stress imaging shows moderate to severe ischemia, invasive coronary angiography would be appropriate.

After informed discussion with our patient, she underwent a CCTA that did not reveal any coronary artery stenosis (Figure 2) and was then discharged from the ED with follow-up after other causes of chest pain were ruled out.

JACC: CASE REPORTS, VOL. 3, NO. 15, 2021
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QUESTION 6: HOW WOULD THE DECISION BE AFFECTED IF PATIENT HAD A KNOWN PRIOR HISTORY OF CAD? **Answer 6.** For intermediate-risk patients with acute chest pain and known CAD, stress imaging (positron emission tomography/single-photon emission computed tomography myocardial perfusion imaging, cardiac magnetic resonance imaging, or stress echocardiography) is reasonable to guide decisions on optimizing medical management and/or need for coronary angiography and myocardial revascularization. Alternatively, CCTA can be useful to determine progression of atherosclerotic plaque and obstructive CAD.

Patients presenting with acute chest pain with known prior CAD, who fall under intermediate risk based on the described CDP do not need hospital admission as default. If they have a known non-obstructive CAD, with <50% stenosis, CCTA may be performed in the ED and, if no change from prior known coronary artery anatomy, can be safely discharged from the ED. If obstructive CAD is found or extensive plaque burden noted, functional stress imaging, FFR-CT, or invasive angiography may be performed. With known obstructive CAD, CCTA may not be beneficial and functional stress imaging is indicated.

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KEY WORDS acute coronary syndrome, chest pain, computed tomography, nuclear medicine

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