European Heart Journal (2016) **37**, e15–e21
doi:10.1093/eurheartj/ehv409



# Questions and answers on diagnosis and risk assessment: a companion document of the 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation†

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**The disclosure forms of all experts involved in the development of these guidelines are available on the ESC website http://www.escardio.org/guidelines**

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*Online publish-ahead-of-print 29 August 2015*

**Keywords** Acute cardiac care • Acute coronary syndrome • Angioplasty • Anticoagulation • Antiplatelet • Atherothrombosis • Beta-blockers • Bypass surgery • Chest pain unit • Diabetes • Early invasive strategy • European Society of Cardiology • Guidelines • High-sensitivity troponin • Myocardial ischaemia • Nitrates • Non-ST-elevation myocardial infarction • Platelet inhibition • Recommendations • Revascularization • Rhythm monitoring • Stent • Unstable angina

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†Full text document: Roffi M, Patrono C, Collet J-P, Mueller C, Valgimigli M, Andreotti F, Bax JJ, Borger MA, Brotons C, Chew DP, Gencer B, Hasenfuss G, Kjeldsen K, Lancellotti P, Landmesser U, Mehilli J, Mukherjee D, Storey RF, Windecker S. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. *Eur Heart J*. doi: 10.1093/eurheartj/ehv320. Available at http://www.escardio.org/guidelines and http://eurheartj.oxfordjournals.org.

**Q1: You are a practicing cardiologist and receive a call from a 60-year-old patient with hypertension, diabetes mellitus and hypercholesterolemia as cardiovascular risk factors (CVRFs). His check-up 6 months earlier was unremarkable. He reports ongoing moderate to severe retrosternal chest pain with radiation to both shoulders and some sweating as well as nausea. The pain has lasted for approximately 30 min. What is your advice to him?**

*The patient should immediately call the ambulance. He should be brought to a hospital with a 24-h cardiac catheterization facility. The ambulance team should record a 12-lead electrocardiogram (ECG) at first contact. The cardiac rhythm of the patient should be continuously monitored during transport. The team should be trained and equipment available to manage cardiac arrest (section 4.4).*

**Q2: You are on rounds in an intermediate care unit and your intern asks you what is the main difference between non-ST-segment elevation myocardial infarction (NSTEMI) and unstable angina?**

*NSTEMI is characterised by myocardial injury, while ischaemic symptoms at rest in the absence of myocardial injury define unstable angina. This translates into an increased risk of death in NSTEMI patients, while unstable angina patients are at low risk of death or myocardial infarction (MI) (section 2.1.2.).*

**Q3: You are the cardiologist on call and your colleague from the emergency room (ER) asks you to admit a patient with NSTEMI. Although you would like to have more information to verify the diagnosis, he replies that there is no need, as 'any elevation in cardiac troponin above the 99th percentile of healthy individuals with a rise and/or fall represents a NSTEMI'. Is he right?**

*No. According to the universal definition of MI, at least one additional criterion is required to make the diagnosis of NSTEMI, including typical ischaemic symptoms or ischaemic ECG changes (section 2.1.1).*

**Q4: A 70-year-old patient with hypertension and hypercholesterolemia as CVRFs presents to the ER with typical chest pain, palpitations, ST depression on ECG and troponin rise. Is it correct to state that the underlying process is definitely a rupture, ulceration, fissuring or erosion of a coronary atherosclerotic plaque?**

*No. According to the universal definition of MI, two main subtypes of NSTEMI have to be differentiated: type 1 MI, characterized by any of the processes just described, and type 2 MI, in which an extra-coronary condition contributes to an imbalance between myocardial oxygen supply and demand (e.g. tachycardia, anaemia or hypotension). Type 2 MI also includes two coronary aetiologies not associated with plaque instability: coronary spasm and coronary embolism. The patient described may have, among other conditions, severe aortic stenosis or (intermittent) atrial fibrillation (section 2.1.1).*

**Q5: You are on call in the coronary care unit (CCU) with only one vacant bed left. Your colleague from the ER wishes to transfer two patients to the CCU: patient A, 78 years of age with NSTEMI, and patient B, 45 years of age with unstable angina. Which one would you admit to the CCU?**

*Patient A, because the short-term risk of death and of life-threatening rhythm disturbances is far higher in NSTEMI as compared with unstable angina (section 2.1.2). In the absence of recurrent symptoms, continuous rhythm monitoring is not mandatory for patient B (Table 7, section 4.2.2).*

**Q6: You plan to introduce the measurement of high-sensitivity cardiac troponin in your hospital. A fellow wonders what the impact will be on the diagnosis of NSTEMI and unstable angina in patients presenting to the ER with chest pain?**

*With the introduction of high-sensitivity troponin (vs. the use of a conventional cardiac troponin assay), an increase in NSTEMI diagnoses is to be expected (approximately 4% absolute and 20% relative increase), with a corresponding decrease in the diagnoses of unstable angina (Table 3, section 3.3.2).*

**Q7: Which are the three diagnostic cornerstones of the early diagnosis of non-ST-elevation acute coronary syndrome (NSTE-ACS) among the following: past clinical history including a detailed description of the chest pain characteristics, 12-lead ECG, chest X-ray, cardiac troponin, treadmill test, computed tomography (CT) angiography and myocardial perfusion scan?**

*Early diagnosis of NSTE-ACS relies on clinical assessment (i.e. past clinical history including a detailed description of the chest pain characteristics), 12-lead ECG and cardiac troponin (section 3.3 and Figure 1, section 3.3.2).*

**Q8: Which clinical features increase the likelihood of NSTE-ACS in patients presenting to the ER with acute chest pain?**

*Conditions include older age, male gender, family history of coronary artery disease (CAD), diabetes, hyperlipidaemia, hypertension, renal insufficiency, previous manifestation of CAD or other evidence of systemic atherosclerosis such as peripheral or carotid artery disease (section 3.1).*

**Q9: You are on duty in the cardiac catheterization laboratory on Friday afternoon. Because of staff availability, you are able to perform only one additional non-emergent case, with additional patients scheduled for Monday. The ER attending informs the cardiology fellow on call that an early invasive strategy is indicated in two of his patients: patient A, a 75-year-old woman with NSTEMI, and patient B, a 45-year-old man with unstable angina. Which one would you give priority?**

*Patient A, because the short-term risk of death and the benefit from an early invasive strategy are more pronounced in NSTEMI as compared with unstable angina. If patient B is admitted to the hospital, he may undergo non-invasive stress testing or coronary angiography on Monday (section 2.1.2).*

**Q10: The cardiology fellow is calling you because the ER attending has requested an immediate transthoracic echocardiography (TTE) for a haemodynamically stable and**

**currently asymptomatic patient with NSTEMI. She refused it because of other priorities, replying that the patient may be studied next day. The ER doctor disagrees and wants this decision to be signed-off by the cardiology staff. Is your fellow right?**

*Yes. While assessment of left ventricular (LV) function (e.g. using TTE) is recommended in all NSTE-ACS patients at some point during hospitalization, immediate TTE is mandatory only in patients presenting with haemodynamic instability, shock or cardiac arrest (section 3.3.4).*

**Q11: A 70-year-old patient with diabetes mellitus and suspected NSTE-ACS is admitted to the ER and the resident in charge of the patient informs you that D-dimers are positive. The cardiology fellow wonders whether this measurement was appropriate and whether the finding of positive D-dimers is of additional value to confirm/refute the diagnosis of NSTE-ACS on top of the standard assessment (i.e. clinical assessment, 12-lead ECG and cardiac troponin)?**

*No, it was not appropriate. D-dimers are not helpful for the diagnosis of NSTE-ACS. D-dimers may be helpful in the workup of patients presenting with chest pain if aortic dissection or pulmonary embolism are suspected (section 3.3.2).*

**Q12: Your fellow argues that clinical examination is useless in patients with suspected NSTE-ACS. Is he right?**

*He is right that uncomplicated NSTEMI is unlikely to cause obvious abnormalities on clinical examination. However, physical examination may help detect complications of MI such as mitral regurgitation, ventricular septal defect or heart failure. In addition, it may give hints to alternative causes of acute chest pain such as aortic stenosis or musculoskeletal pain. Finally, clinical findings such as xanthoma or the absence of peripheral pulses indicating peripheral artery disease increase the probability of NSTE-ACS (section 3.2).*

**Q13: A 65-year-old patient with long-standing, poorly controlled hypertension presents to the ER because of a 30-min episode of moderate to severe retrosternal chest pain. He is haemodynamically stable and the physical examination is unremarkable. The 12-lead ECG shows 0.5 mm ST-segment depression in V5 and V6. You question the cardiology fellow about the most helpful next step, comparing the ECG with the one from his prior admission or repeating an ECG 30 min later?**

*Since the patient may have ST-segment deviation related to LV hypertrophy, the most important step is to determine whether the ECG changes are new. Comparison with a previous ECG is very helpful (section 3.3.1).*

**Q14: A 55-year-old patient with multiple CVRFs (i.e. positive family history, smoking, hypertension) presents with persistent severe typical retrosternal chest pain lasting for 1 h at the time of ER admission. He is haemodynamically stable and the initial physical examination is unremarkable. The 12-lead ECG shows no ST deviation while chest pain persists. What are the most important next diagnostic steps: cardiac CT scan, CT scan to exclude aortic dissection or pulmonary embolism, D-dimers, troponin, recording of additional ECG leads (V7–V9 and V3R and V4R) or a second ECG recording shortly after (e.g. in 10 min)?**

*Recording additional leads (V7–V9 and V3R and V4R) and, if no ST elevations are detected, a second ECG recording in ~10 min are the most helpful steps in this patient with suspected ongoing myocardial ischaemia. The use of additional leads may help detect acute MI, as ~50% of acute occlusions of the left circumflex artery may not cause ST-segment elevation in the 12-lead ECG (section 3.3.1).*

**Q15: A 65-year-old patient with a history of CAD and stenting of the left anterior descending coronary artery 2 years earlier presents to the ER with persistent moderate left thoracic chest pain. The pain started 4 h prior to hospital admission. He is haemodynamically stable and the initial physical examination is unremarkable. The 12-lead ECG shows 0.5 mm ST-segment depression in V5 and V6. Additional ECG leads show no abnormality and a repeat ECG after 10 min is identical to the initial one. Can you make a definitive diagnosis based on these findings?**

*No. Cardiac troponin, measured at presentation and at 1–3 h, is the mandatory third tool (i.e. in addition to clinical assessment and 12-lead ECG) to make a definitive diagnosis (sections 3.3.2 and 4.1).*

**Q16: The measurement of which cardiac biomarker(s) among B-type natriuretic peptide (BNP), creatine kinase (CK), cardiac troponin, CK-MB, copeptin and D-dimers is mandatory in patients with suspected NSTE-ACS?**

*Cardiac troponin is the preferred biomarker to quantify cardiomyocyte injury and to diagnose or rule out acute MI. It is the only biomarker mandatory in all patients with suspected NSTE-ACS. BNP is a quantitative marker of haemodynamic stress and heart failure. It is a powerful and independent predictor of death in patients with established NSTE-ACS. It does not have a role in the diagnosis of NSTE-ACS. CK and CK-MB are the traditional markers of cardiomyocyte damage. They are less sensitive and less specific as compared with cardiac troponin. Accordingly, they are not mandatory. Serial CK levels may help to quantify the size of MI, while CK-MB helps to detect and rule out recurrent MI soon after revascularization (as it more rapidly returns to normal as compared with cardiac troponin). Copeptin is a quantitative marker of endogenous stress and nearly universally elevated in the first hours of MI. It provides substantial added value for early rule-out of MI when using conventional less sensitive cardiac troponin assays, but only a very small (if any) added value when using high-sensitivity cardiac troponin. Accordingly, it is recommended whenever high-sensitivity cardiac troponin is not available. D-dimers are a quantitative marker of fibrinolysis and used in ruling out suspected venous thromboembolism. They have no role in the diagnosis of NSTE-ACS (sections 3.3.2 and 4.1).*

**Q17: A 50-year-old patient with no relevant past medical history presents with persistent severe retrosternal chest pain radiating to both shoulders and arms (chest pain onset 2 h earlier) to the ER. He is haemodynamically stable and the initial physical examination is unremarkable. The 12-lead ECG is normal. The initial high-sensitivity cardiac troponin T level is elevated at 300 ng/L [upper limit of**

**normal (ULN) <14 ng/L]. With what delay would you make a second cardiac troponin measurement?**

*There is no need for a second troponin assessment. The diagnosis of NSTEMI is made and appropriate treatment should be initiated. The positive predictive value for NSTEMI of typical symptoms and a substantial (>20 times the 99$^{th}$ percentile) elevation in cardiac troponin is >90% (section 3.3.3).*

**Q18: A 60-year-old patient without prior history of CAD presents to the ER with intermittent recurrent moderate right thoracic chest pain without radiation and increasing cough over the last 2 days. The last chest pain episode started 2 h prior to hospital admission and lasted for 30 min. He is haemodynamically stable and the physical examination reveals mild end-inspiratory rales over the base of the right lung. The 12-lead ECG is normal. The initial high-sensitivity cardiac troponin T level is normal at 7 ng/L (ULN <14 ng/L). The intern in the ER asks you as a cardiology consultant if the patient can be discharged?**

*No. The intern should perform a chest X-ray and wait for the second cardiac troponin measurement at 1–3 h. If the second measurement is also within normal limits, NSTEMI can be reliably ruled out and the patient is to be considered at very low risk of cardiac events. From a cardiology perspective, he may then be discharged home. If no alternative explanation, such as pneumonia or bronchitis, is found to explain the symptoms of the patient, he may undergo non-invasive stress testing (preferably with imaging) on an outpatient basis (section 3.3.3).*

**Q19: A 60-year-old patient with no history of CAD presents to the ER with chest pain and cough lasting for 2 days. The chest pain is persistent, moderate in intensity, right thoracic, without radiation and increases in intensity during exercise and inspiration. The last episode of chest pain started 8 h prior to admission and the patient is still mildly symptomatic in the ER. He is haemodynamically stable and the physical examination is unremarkable. The 12-lead ECG is normal. The initial cardiac troponin I level (high sensitivity) is very low/undetectable at <2 ng/L (ULN <26 ng/L). The ER intern, a bright young physician who wants to become cardiologist, challenges you by saying that 'it is obvious that the chest pain does not represent acute MI and no additional investigations or blood tests in this respect are needed'. Is she right?**

*Yes. NSTEMI, based on the delay between symptom onset and blood test, can be reliably ruled out with a single undetectable level of high-sensitivity cardiac troponin I (or T). In addition, unstable angina is extremely unlikely since prolonged ischaemia is expected to lead to some degree of troponin elevation. An alternative diagnosis such as pneumonia/bronchitis should be considered (section 3.3.3).*

**Q20: You are supervising the ER/chest pain unit (CPU) and see an 80-year-old patient with a history of CAD and hypertensive heart disease presenting with persistent moderate right thoracic chest pain ongoing for 1 h that increases in intensity during exercise and during inspirations. In addition, he has mild fever and an increasing productive cough over the last 3 days. He is haemodynamically stable and the initial physical examination reveals rales over the base of the right lung. ECG is normal. Chest X-ray shows an infiltrate in the right lung suggestive of pneumonia. Your intern is about to order blood cultures (plus legionella and pneumococcus antigen in the urine) and prescribe antibiotics when the high-sensitivity cardiac troponin level is reported from the laboratory as elevated. Your intern now asks you if the patient needs treatment for pneumonia, NSTEMI or both?**

*This patient has a high likelihood for pneumonia and a low likelihood for NSTEMI. To answer the question whether he has concomitant NSTEMI, you need to know the exact value of high-sensitivity cardiac troponin at presentation as well as the dynamics after 1–3 h. If the cardiac troponin levels are only mildly elevated (e.g. according to the assay <25 ng/L if ULN is <14 ng/L, or <40 ng/L if ULN is <26 ng/L), then the mild elevation in cardiac troponin in this specific patient can be attributed to cardiac causes other than NSTEMI (e.g., pre-existing CAD or hypertensive heart disease) and no specific treatment is needed. A rise or fall in cardiac troponin is required for the diagnosis of NSTEMI in order to differentiate it from conditions resulting in chronic myocardial damage.*

**Q21: You are working in the ER/CPU and a representative of a laboratory company tells you that his new cardiac troponin point-of-care assays are high-sensitivity and have an even higher sensitivity as compared with automated high-sensitivity laboratory assays. Should you embrace this technology immediately?**

*No. Current cardiac troponin point-of-care assays, while having the advantage of delivering the results faster, have lower sensitivity and therefore lower diagnostic accuracy as compared with automated laboratory assays (section 3.3.2).*

**Q22: Which NSTEMI patients derive the greatest benefit from the higher sensitivity and higher diagnostic accuracy offered by the new generation of cardiac troponin assays: early vs. late presenters, patients with small vs. large MI, old vs. young individuals or patients with normal vs. impaired renal function?**

*Patients presenting early after chest pain onset and patients with small MIs have the greatest advantage of high-sensitivity troponin assays compared with the standard ones. In both settings, MI may have been missed at presentation with less sensitive assays. Some of the early presenters might have been detected by late (e.g. 6 h) sampling with conventional assays, while others might have remained undetected even with prolonged sampling with the conventional assays. High-sensitivity cardiac troponin may also help to diagnose MI in elderly patients with atypical symptoms. Renal function does not seem to affect the diagnostic benefit related to high-sensitivity cardiac troponin. However, slightly higher cut-off levels should be used in patients with impaired renal function.*

**Q23: You are introducing a high-sensitivity cardiac troponin assay in your hospital. The scientist in charge of the laboratory warns you that, compared with the standard troponin assays, the greatest relative increase in MI diagnoses is expected for type 2 MI. Is he right?**

*Yes. Compared with standard troponin assays, high-sensitivity cardiac troponin assays (section 3.3.2) have a higher negative predictive value for acute MI; reduce the troponin-blind interval, leading to earlier detection of acute MI; yield an ~20% increase in the detection of type 1 MI (i.e., related to acute plaque rupture/thrombus formation) and a corresponding decrease in the diagnosis of unstable angina and detect a marked increase (~100%) in type 2 MI (resulting from a mismatch of oxygen demand vs. supply; e.g. related to tachy-/bradyarrhythmias, anaemia, respiratory failure, hypotension or severe hypertension).*

**Q24: On rounds, your intern asks you which conditions other than plaque rupture/thrombus formation may be associated with troponin elevation?**

*Those conditions include, among others, tachyarrhythmias, heart failure, hypertensive emergencies, critical illnesses, perimyocarditis, Tako–Tsubo cardiomyopathy and structural heart disease such as aortic stenosis, aortic dissection and pulmonary embolism. In patients presenting to the ER with suspected NSTE-ACS, only a few disorders are associated with substantial elevations (e.g. >10 times the 99th percentile) in cardiac troponin. These include NSTEMI, Tako–Tsubo cardiomyopathy and myocarditis. Most other acute or chronic cardiac conditions are associated with mild elevations in cardiac troponin (section 3.3.2).*

**Q25: You are caring for a 70-year-old woman with NSTEMI on the cardiology ward who was successfully revascularized with a drug-eluting stent for a single high-grade proximal left anterior descending lesion 3 days earlier. Her initial hospital course was unremarkable and TTE documented mildly impaired systolic LV function (ejection fraction 50%) due to apical hypokinesia. Peak high-sensitivity cardiac troponin T was 2000 ng/L (ULN <14 ng/L) at 36 h and additional cardiac biomarkers were also measured at this time. The patient is rather anxious and only after specific questions reports a new chest pain episode on day 3. The retrosternal pain started 9 h earlier and lasted for 3 h; it was less severe than at the time of first presentation and somehow different in character (more like stabbing). The 12-lead ECG shows no changes compared with the ECG performed after revascularization. High-sensitivity cardiac troponin T is 1000 ng/L. Your intern asks you if this represents reinfarction and whether additional blood tests may be useful?**

*In acute MI, cardiac troponin remains elevated for several days and is of limited value to detect early reinfarction. CK-MB levels can be very helpful in this setting, as they fall much more rapidly after MI. Accordingly, normal levels of CK-MB in the case described above help rule out recurrent MI and avoid unnecessary invasive assessments. However, the probability of reinfarction in this patient, even if no biomarkers were available, is extremely low in the presence of prolonged chest pain, no ECG changes and a single proximal left anterior descending coronary artery lesion treated by a stent. If anything, one should fear stent thrombosis, which in this patient would likely be associated with ST elevation in the anterior leads (section 3.3.2).*

**Q26: Your hospital has recently introduced a high-sensitivity cardiac troponin assay in the ER/CPU to reduce the time needed for rule out or rule in NSTEMI. The head of the ER, anxious to discharge patients as early as possible, informs you that she plans to use an algorithm assessing high-sensitivity troponin at presentation and at 1 h. Would this be safe for the patients?**

*Yes, assuming she is using an assay with a validated 0 h/1 h algorithm. Accordingly, the diagnostic accuracy of the 0 h/1 h and 0 h/3 h algorithms appears to be comparable (sections 3.3.2 and 3.3.3).*

**Q27: You are the cardiology consultant responsible for the training of residents starting their rotation in the ER. When discussing patient pathways, a resident asks you whether the majority of patients presenting with acute chest pain to the ER ultimately require hospitalization to reliably rule out or rule in acute MI?**

*No. Using either a 0 h/3 h algorithm or a 0 h/1 h algorithm, the vast majority of patients (~75%) can be reliably ruled out or ruled in within the first hours after admission in the ER (sections 3.3.2 and 3.3.3).*

**Q28: You are supervising the ER/CPU. A resident questions you regarding the further management of a 60-year-old woman without a history of CAD but two CVRFs (hypertension and hypercholesterolemia) presenting with ongoing moderate left thoracic chest pain without radiation that started 3 h prior to admission and resolved spontaneously in the ER. She is haemodynamically stable and the physical examination and the 12-lead ECG are unremarkable. Levels of high-sensitivity cardiac troponin T assessed at presentation and 1 h were normal and identical at 8 ng/L (ULN <14 ng/L). Can NSTEMI be ruled out?**

*Yes, the negative predictive value for MI in patients classified as 'rule-out' by the high-sensitivity cardiac troponin T 0 h/1 h algorithm is 99–100%. Used in conjunction with clinical assessment and the 12-lead ECG as mandatory additional sources of information, the 0 h/1 h algorithm allows the early rule-out of MI and early detection of patients that are candidates for outpatient management (i.e. no further investigation or non-invasive imaging). It is important to highlight that prior to discharge, other life-threatening causes of acute chest pain, such as aortic dissection, pulmonary embolism and tension pneumothorax, need to be evaluated/excluded (sections 3.3.2 and 3.3.3).*

**Q29: You are supervising the ER/CPU. A resident asks you about the further management of a 64-year-old woman without CVRFs and without known CAD presenting with moderate retrosternal chest pain without radiation that started 3 h prior to admission and lasted for 1 h. She is haemodynamically stable, pain free and the physical examination as well as the 12-lead ECG are normal. Levels of high-sensitivity cardiac troponin T at presentation are 75 ng/L (ULN <14 ng/L). Your intern is using the novel assay-specific 0 h/1 h algorithm you just introduced in the hospital and he tells you that according to the algorithm the patient can be 'ruled in'. Now the intern wants to know what it means: does the patient have NSTEMI?**

*The positive predictive value for MI in patients classified as 'rule-in' by the high-sensitivity cardiac troponin T 0 h/1 h algorithm is 70–80%. Used in*

*conjunction with clinical assessment and the 12-lead ECG—mandatory additional sources of information—the 0 h/1 h algorithm allows the early detection of patients that are candidates for early coronary angiography, particularly as most of the rule-in patients with a diagnosis other than acute MI will have conditions that also usually require inpatient coronary angiography for accurate diagnosis, including Tako–Tsubo cardiomyopathy, myocarditis and unstable angina. This patient should undergo early coronary angiography (sections 3.3.2 and 3.3.3).*

**Q30: You are supervising the ER/CPU. A resident asks you how to manage a 64-year-old patient with known CAD presenting with moderate ongoing retrosternal chest pain without radiation (chest pain onset 1 h earlier). He is haemodynamically stable and the physical examination and 12-lead ECG are normal. The level of high-sensitivity cardiac troponin I (ULN <26 ng/L) is 20 ng/L at presentation and rises to 40 ng/L at 1 h. Using your novel assay-specific 0 h/1 h algorithm, the patient can be 'ruled in' due to the substantial absolute change within the first hour. What is the clinical consequence for patients being classified as 'rule-in' by the high-sensitivity cardiac troponin 0 h/1 h algorithm?**

*The positive predictive value for MI in patients classified as 'rule-in' by the high-sensitivity cardiac troponin 0 h/1 h algorithm is 70–80%. Used in conjunction with clinical assessment and the 12-lead ECG as mandatory additional sources of information, the 0 h/1 h algorithm will allow the early detection of patients that are candidates for early coronary angiography, particularly as most of the rule-in patients with a diagnosis other than acute MI will have conditions that also usually require inpatient coronary angiography for accurate diagnosis, including Tako–Tsubo cardiomyopathy, myocarditis and unstable angina. As, until proven otherwise, this patient has ongoing ischaemia, he should undergo immediate (<2 h) coronary angiography (sections 3.3.2 and 3.3.3).*

**Q31: You are supervising the ER/CPU. A resident asks you about the management of a 70-year-old patient with a history of hypertension and hypercholesterolemia presenting with moderate retrosternal chest pain without radiation (chest pain onset 5 h earlier). He is haemodynamically stable, the physical examination is normal and the 12-lead ECG is unremarkable except for pre-existing mild T-wave inversion in I and aVL. Levels of high-sensitivity cardiac troponin T are mildly elevated without a relevant change within 1 h (i.e. 18 ng/L at presentation and 20 ng/L at 1 h with a ULN of 14 ng/L). The intern in the ER is using the assay-specific 0 h/1 h algorithm you just introduced and tells you that the patient is assigned to the 'observe' zone. What's next?**

*About 25–30% of patients presenting to the ER with chest pain may be classified as 'observe'. This is a heterogeneous group of patients. A large proportion will require further measurement of cardiac troponin, e.g. at 3 h. Coronary angiography should be considered in patients for whom there is a high degree of clinical suspicion of NSTE-ACS, while in patients with a low to intermediate likelihood for this condition, a non-invasive anatomical (coronary CT angiography) or functional [stress echo, myocardial perfusion scintigraphy, cardiac magnetic resonance (CMR)] test should be considered. No further diagnostic testing in the ER is indicated when alternative conditions such as rapid ventricular rate response to atrial fibrillation or hypertensive emergency have been identified (sections 3.3.2, 3.3.3 and 3.3.4).*

**Q32: Which patients with suspected NSTE-ACS require immediate echocardiography?**

*Patients with haemodynamic instability, shock or cardiac arrest (section 3.3.4.1 and Figure 3).*

**Q33: During a cardiology meeting, you discuss with colleagues from other hospitals and are informed that different imaging modalities are used in patients discharged from the ER after rule-out of MI based on a normal/non-diagnostic 12-lead ECG and negative cardiac troponin levels. While stress echocardiography is preferred in your institution (in patients with adequate ultrasound windows), hospital B uses stress CMR in most patients and myocardial perfusion scintigraphy is the imaging modality of choice in hospital C. The colleague from hospital B argues that stress CMR has been shown to have higher sensitivity and specificity for exercise-induced myocardial ischaemia than the other imaging modalities. Is he right?**

*No. All three stress imaging modalities (stress echocardiography, CMR and myocardial perfusion scintigraphy) achieve similar diagnostic performance in this setting (section 3.3.4).*

**Q34: The ER doctor performed coronary CT angiography to exclude CAD in a 40-year-old patient without known CAD and without CVRFs who presented with acute chest pain suggestive of NSTE-ACS, negative cardiac troponins and no ischaemic ECG changes. Your fellow would like to know whether the management was in accordance with current guidelines?**

*Yes. Coronary CT angiography should be considered to exclude CAD in patients with acute chest pain suggestive of NSTE-ACS, negative troponins and no ischaemic ECG changes (section 3.3.4).*

**Q35: You are working as a resident in the ER. You are discussing with a senior interventional cardiologist a 50-year-old patient without CVRFs and no previous cardiac history presenting to the ER with a 3 h episode of acute left-sided chest pain (stabbing in character, worsening with inspiration and exercise) without radiation. The 12-lead ECG and serial measurements of cardiac troponin are normal. The senior cardiologist states that this patient very likely has unstable angina and should therefore undergo early coronary angiography. Is she right?**

*No. Among unselected patients presenting to the ER with acute chest pain, disease prevalence can be expected to be the following: 5–10% STEMI, 15–20% NSTEMI, 10% unstable angina, 15% other cardiac conditions and 50% non-cardiac diseases. Although this patient may have unstable angina, non-cardiac causes of acute chest pain are more likely. Non-invasive anatomical (CT angiography) or functional (stress echo, CMR, scintigraphy) imaging tests should be performed first, unless the pre-test probability for unstable angina is very high (which is not the case of the patient based on history, presentation and ECG) (Figure 1 and section 3.3.4).*

**Q36: You are discussing a patient with NSTEMI with a colleague in the ER. He states that the risk of death is rather similar in all patients with NSTEMI. Therefore routine risk stratification is not required. Is he right?**

*No. The risk of death varies widely among patients with NSTEMI. Short- and long-term ischaemic risk can be accurately and conveniently assessed using the Global registry of Acute Coronary Events (GRACE) 2.0 risk calculator (section 4.2).*

**Q37: Following your response, your colleague then asks you whether similar scores have been developed regarding the risk for major bleeding?**

*Yes, there are also bleeding risk scores. However, their clinical utility is challenged by the overlap between bleeding and ischaemic risk factors and the overall modest accuracy of the bleeding risk scores. However, these risk scores (e.g. CRUSADE) may still be useful to inform clinicians and patients (section 4.3).*

**Q38: At your hospital, a just-appointed radiologist challenges the current workup of acute chest pain patients by stating the following: 'Why bother with clinical evaluation, repeat troponin and ECG assessments in patients with suspected NSTE-ACS? All patients with expected good image quality based on cardiac rhythm and heart rate should undergo CT angiography as an initial test, now that the radiation doses have markedly decreased'. Is she right?**

*No. CT angiography is only helpful to exclude relevant CAD in patients presenting with chest pain to the ER who are haemodynamically stable patients without known CAD, a normal ECG and a normal initial standard cardiac troponin level in the presence of a slow and regular heart rate. In addition, despite the reduction in radiation doses achieved in recent years, acquisition of high-quality images with low radiation exposure, as well as appropriate interpretation of CT images, is not usually available on a 24/7 basis (see Figure 1 and section 3.3.4).*

**Q39: It is 2 A.M. and you are the cardiology fellow in charge of a 60-year-old patient with multiple CVRFs who has typical chest pain refractory to the administration of beta-blockers and nitrates. The pain started 1 h prior to admission, has lasted for a total of 2 h and is ongoing. The first high-sensitivity cardiac troponin was slightly elevated while the ECG showed no frank ST elevation. You contacted the interventionalist on call to proceed to immediate coronary angiography. She replied that there was no need to hurry based on the troponin and ECG findings. The interventional cardiologist stated she would perform coronary angiography as the first case in the morning and in the meantime morphine may be used to control pain if needed. Who is right?**

*You are. Until proven otherwise, based on patient as well as chest pain characteristics, the individual has ongoing ischaemia refractory to initial treatment. According to the guidelines, he needs to undergo immediate coronary angiography. He may have occlusion of a main coronary artery (i.e. the left circumflex coronary artery) or a branch, which may be silent on 12-lead ECG. As a consequence, he is at risk of life-threatening arrhythmias and of deterioration of cardiac function. Additional ECG leads (V7–V9 and V3R and V4R) may detect ST elevation. Visualization of regional wall motion abnormalities on TTE, while not mandatory, would reinforce your suspicion. If the interventional cardiologist on call will take responsibility for the decision, then repeat the troponin assessment at 1 h. This will likely show a clear rise, and the colleague on call will be unable to further refuse coronary angiography that night (section 3.3.4 and Figure 2, section 5.6).*

**Q40: A 50-year-old man, active smoker, seeks medical attention for atypical chest pain. The last episode occurred the day before and lasted for 3 h. ECG at presentation showed 0.5-mm ST depression in the lateral leads, unchanged after 2 h. The first high-sensitivity cardiac troponin is normal and the intern in the ER asks you if a second troponin measurement is necessary?**

*No. NSTEMI can be ruled out with a single measurement of high-sensitivity cardiac troponin in patients in whom chest pain onset can be reliably assessed. The cardiac prognosis of this patient is excellent. Although unstable angina cannot be formally ruled out, the fact that the patient had chest pain lasting 3 h and high-sensitivity troponin was negative make it unlikely. The patient may be discharged. He may be scheduled within the next days on an outpatient basis for an imaging test to assess myocardial ischaemia (e.g., stress echo or myocardial perfusion scintigraphy or CMR) or CT angiography (sections 3.3.2, 3.3.3 and 3.3.4).*

## Reference

Full text document: Roffi M, Patrono C, Collet J-P, Mueller C, Valgimigli M, Andreotti F, Bax JJ, Borger MA, Brotons C, Chew DP, Gencer B, Hasenfuss G, Kjeldsen K, Lancellotti P, Landmesser U, Mehilli J, Mukherjee D, Storey RF, Windecker S. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. *Eur Heart J*. doi: 10.1093/eurheartj/ehv320. Available at http://www.escardio.org/guidelines and http://eurheartj.oxfordjournals.org.