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ACUTE CORONARY SYNDROME

Study guide

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The study guide is recommended for students of medical institutions of higher education in the discipline of Internal Medicine, as well as for interns in the specialties of "Internal Medicine" and "General Practice – Family Medicine".

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Introduction

The information about the diagnosis and treatment of patients with acute coronary syndromes has recently been updated. Therefore, there is a need to publish a manual for the 5th and 6th year (medical) students, containing up-to-date information and materials relevant to the etiopathogenesis, diagnosis, and treatment of acute coronary syndrome. In order to provide a large amount of important in-depth information on this topic, the authors used materials developed by European Cardiologists, who were a part of the Working Group of the European Society of Cardiology on the management of patients with acute coronary syndrome without persistent ST-segment elevation (2015), set out in "2015 Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation" (European Heart Journal, 2015), and the Working Group of the European Society of Cardiology on the management of patients with acute coronary syndrome with ST-segment elevation (2017), set out in "2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation" (European Heart Journal, 2017).

The first part of this manual is devoted primarily to theoretical aspects on acute coronary syndrome, whereas the second part is a summary of ESC recommendations (2015, 2017): "Guidelines for management of acute coronary syndromes in patients presenting without persistent ST-segment elevation" and "2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation" (https://www.escardio.org/). The tests and coronary angiograms are presented at the end of the manual for student's self-assessment.

Acute Coronary Syndrome

Acute coronary syndrome (ACS) is characterized by acute chest pain due to complete or incomplete occlusion of a coronary artery resulting from an unstable (often ruptured) plaque in the setting of advanced coronary heart disease. There are three clinical pathologies grouped together under ACS: unstable angina pectoris, non-ST-segment elevation myocardial infarction (NSTEMI), and ST-segment elevation myocardial infarction (STEMI). Similar symptomatology often makes these conditions difficult to distinguish among them.

Pathophysiology

The formation of ACS occurs in several stages (Fig. 1):

- Stable angina pectoris: a stable, stenosing plaque slowly develops and manifests with symptoms only during exertion when there is an increased oxygen demand.
- Unstable angina pectoris: an unstable plaque rupture leads to the formation of a thrombus that partially occludes the coronary vessel and a decrease in blood supply leads to symptoms regardless of demand (thus, manifesting also in rest). Constant interaction between thrombus formation and endogenous thrombolysis (which prevents complete vessel occlusion) is developing. It can progress to myocardial infarction (by causing either microemboli (NSTEMI) or an occluding thrombus (STEMI).
- Thrombus formation, which may be episodic in nature, is the mechanism underlying the compromise in coronary blood flow.
- NSTEMI = inner wall infarction: small emboli from the unstable plaque are carried to smaller vessels before complete occlusion of small branches affecting the inner layer of the heart.
- STEMI = transmural infarction: complete occlusion of the main coronary artery develops from thrombus formation directly at the ruptured plaque or thromboembolus. Stenosis $\geq$ 90 % (mostly due to thrombus formation) $\rightarrow$ infarction followed by coagulation necrosis.

- Causes other than plaque rupture include dynamic obstruction of a coronary artery due to vasospasm (Prinzmetal angina) and cardiac inflammation or infection.

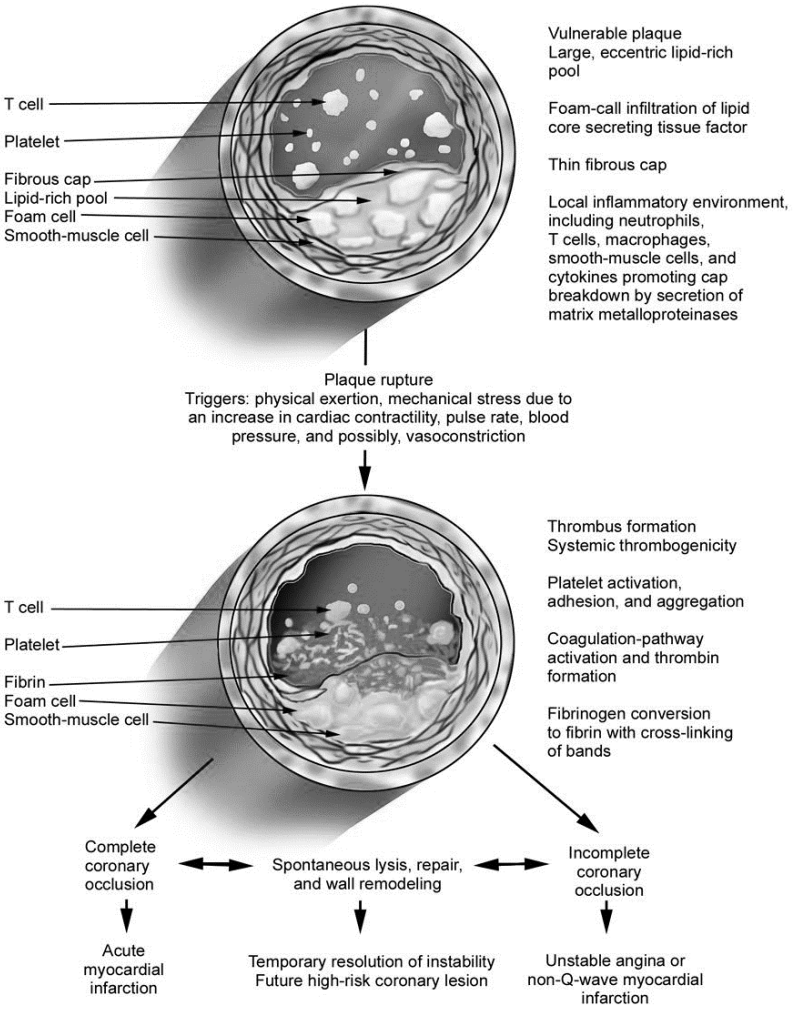


Figure 1 – Pathophysiology of acute coronary syndrome

Unstable angina is defined as:

1) prolonged rest angina (usually more than 20 min);
2) new-onset angina of at least class III severity (Canadian Cardiovascular Society (CCS) Classification);
3) increasing angina, i. e., previously diagnosed angina that has become distinctly more frequent, more severe, longer in duration, or lower in threshold (e. g., increased by ≥ 1 CCS class or reached at least CCS class III);
4) transient ECG changes, such as ST-segment depression, ST-segment elevation, or T-wave inversion, may occur during unstable angina;
5) cardiac markers, such as CPK, troponin I/T, are not elevated This group of patients is not supposed to be treated with thrombolysis.

Braunwald Classification of Unstable Angina Severity:

I – new onset of severe angina or increasing angina. No angina during rest;

II – angina during rest within the past month but not within the preceding 48 h;

III – angina during rest within 48 h.

Clinical situation:

A – develops secondary to an extracardiac condition that worsens myocardial ischemia;

B – develops when no contributory extracardiac condition is present;

C – develops within 2 weeks of acute MI.

Myocardial infarction

Universal definition of myocardial infarction: Acute myocardial infarction (MI) defines cardiomyocyte necrosis in a clinical setting consistent with acute myocardial ischemia.

A combination of criteria is required to meet the diagnosis of acute MI with at least one value above the 99th percentile of the upper reference limit and at least one of the following:

1) clinical symptoms of ischemia;

2) new or presumed new significant ST-T wave changes or left bundle branch block on 12-lead ECG;

3) appearance of pathological Q waves on ECG;

4) evidence of new or presumed new loss of viable myocardium or regional wall motion abnormality diagnosed with imaging methods;

5) intracoronary thrombus detected on angiography or at autopsy.

Non-ST-segment elevation myocardial infarction (NSTEMI):

1) symptoms typical for myocardial ischemia (persisting longer than 20 min);
2) on ECG: ST-segment depression, transient ST-segment elevation, or T-wave inversion;
3) troponin T positive (slightly increased).

ST-segment elevation myocardial infarction (STEMI):

1) symptoms typical for myocardial ischemia (persisting longer than 20 min);
2) ST segment elevation lasting longer than 20 min or a new-onset left bundle branch block;
3) troponin T positive (significantly increased);
4) this group of patients has to receive reperfusion therapy on presentation.

Classification of myocardial infarction (Fourth Universal Definition of Myocardial infarction (2018):

Type 1

Spontaneous myocardial infarction related to ischemia due to a primary coronary event (erosion and/or rupture of atherosclerotic plaque, fissuring, or dissection).

Type 2

Myocardial infarction secondary to ischemia due to either increased oxygen demand or decreased supply, spasm of a coronary artery, coronary embolism, anaemia, arrhythmias, hypertension or hypotension).

Type 3

Sudden unexpected cardiac death, including cardiac arrest, often with symptoms suggestive of myocardial ischemia, accompanied by presumably new ST elevation, or new LBBB, or evidence of fresh thrombus in a coronary artery by angiography and/or at autopsy, but death occurring before blood samples could be

obtained, or at a time before the appearance of cardiac biomarkers in the blood.

Type 4a

Myocardial infarction associated with percutaneous coronary intervention (PCI).

Type 4b

Myocardial infarction associated with stent thrombosis as documented by angiography or at autopsy.

Type 5

MI associated with coronary artery bypass graft (CABG).

Acute chest pain lasting more than 30 min can accompany various diseases (see **Table 1**)

Table 1 – Differential diagnosis of acute chest pain

Differential diagnosis of acute chest pain				
Disease	**Clinical features**			**Additional methods of diagnostics**
	Patient characteristics (age, previous condition)	**Characteristics of pain**	**Location**	
Cardiac				
Acute coronary syndrome	Usually in older patients (> 40 years)	Heavy, dull, pressure/squeezing sensation. In angina pectoris, pain may be relieved with nitroglycerin	Poorly localized/retrosternal. Radiation to the left shoulder	ECG: ST-segment elevation/depression, T-wave inversions, Q waves. Lab: troponin T/I elevation
Pericarditis	Usually in younger patients; sometimes follows a viral infection (usually a URI)	Sharp pain, exacerbated by lying down and improved by leaning forward	Retrosternal Radiation to the left shoulder	Auscultation: sometimes high-pitched pericardial "squeak". ECG: diffuse ST-segment elevation and/or PR-segment depression. ↑ ESR/CRP
Takotsubo cardio-myopathy	Particularly in older women	Heavy, dull, pressure/squeezing sensation	Retrosternal	ST-segment changes and elevated cardiac enzymes, but no evidence of coronary stenosis or occlusion on catheterization

Continuation of Table 1

Aortic dissection	Any age, coexisting hypertension	Tearing pain. Feeling of impending doom. Hypotension, asymmetrical blood pressure and pulse readings between limbs	Chest and/or interscapular	CT angiography of chest ± abdomen/pelvis. Chest and abdominal ultrasound/x-ray. Unstable patients: transesophageal echocardiography
Pulmonary				
Pulmonary embolism	History of DVT	Pleuritic pain. Associated acute onset dyspnea, coughing, sometimes hemoptysis	Unilateral	Elevated D-dimer (nonspecific). ECG: right ventricular strain. CT/MR angiography. V/Q scan
Pneumonia and/or pleurisy	Any age	Pleuritic pain. Associated fever, dyspnea, coughing	Unilateral	Leukocytosis (nonspecific). Infiltrate on chest x-ray. If pleurisy is present: pleural rub on auscultation. If effusion is present: diminished breath sounds and dullness to percussion over the effusion. Chest ultrasound/x-ray → pleural effusion
Pneumothorax	History of a lung disease or trauma	Pleuritic pain. Sudden onset of dyspnea. Hyperresonance to percussion and diminished breath sounds on the affected side. Acute hypotension, if tension pneumothorax develops	Unilateral, lateral to pneumothorax	Chest x-ray: increased lucency over pneumothorax, possibly pleural lines. Ultrasound: lack of lung sliding

Continuation of Table 1

Musculoskeletal				
Costochondritis	May have a history of recent exercise/ exertion/ chest wall trauma	Sharp, well-localized pain	Variable	Pain reproducible with palpation
Gastrointestinal				
Gastroesophageal reflux disease	Any age. May be associated with certain foods	Pressure/burning sensation. Increased severity in the supine position	Substernal	Endoscopy
Esophageal perforation	Iatrogenic esophageal perforation (most common cause): symptoms within 24h of upper endoscopy. Boerhaave syndrome: post-emesis. Other: trauma, foreign body ingestion	Mackler triad (chest pain, vomiting, subcutaneous emphysema)	Chest pain radiating to the back	Chest X-ray: shows widened mediastinum. If patient is stable: contrast esophagram with gastrografin. If patient is unstable: CT scan of the chest
Mallory-Weiss syndrome	Repeated episodes of severe vomiting	Hematemesis	Epigastric pain radiating to the back	Esophagogastroduodenoscopy
Peptic ulcer disease	NSAID intake. *Helicobacter pylori*-associated gastritis	Possible hematemesis and tarry stools. If duodenal: pain relieved with food.f gastric: pain worsens after meals	Epigastric	Anemia (hemorrhage). Endoscopy

Continuation of Table 1

Acute pancreatitis	History of alcoholism/ gallstones	Nausea/vomiting. Sometimes improved with leaning forward	Upper abdominal pain radiating straight to the back	↑ lipase and amylase. Hypocalcemia → poor prognosis. Abdominal ultrasound
Dermatological				
Shingles	High risk in immunocom promised individuals	Severe burning or throbbing pain	Dermatomal distribution	Maculopapular → vesicular rash in dermatomal distribution
Emotional/psychiatric condition				
E. g., anxiety	Recent stress exposure	Severe left chest pain (where the heart is located). Feelings of anxiety. Tachycardia	Retroster-nal, variable	Negative workup for possible lethal causes Diagnosis of exclusion

The working diagnosis of ACS and the initial management should be based on the following parameters:

Diagnostics

1. Electrocardiography

The ECG is the most important instrument in the initial evaluation and triage of patients with the suspected acute coronary syndrome (ACS), such as MI. It is confirmatory of the diagnosis in approximately 80 % of cases.

ECG criteria of acute myocardial ischemia are:

- new ST-elevation at the J-point in two contiguous leads with the cut-point ≥ 1 mm in all leads other than V2–V3, for which the following cut-points apply: ≥ 2 mm in men ≥40 years; ≥ 2.5 mm in men < 40 years, or ≥ 1.5 mm in women regardless of age;
- new horizontal or downsloping ST-depression ≥ 0.5 mm in two contiguous leads and/or T inversion in two contiguous leads with prominent R wave or R/S ratio > 1.

No specific ECG changes (ST depression, inverted T wave, a decrease of R wave) are observed in patients with unstable angina pectoris and NSTEMI.

STEMI: specific ECG changes depend on the stage (Fig. 2).

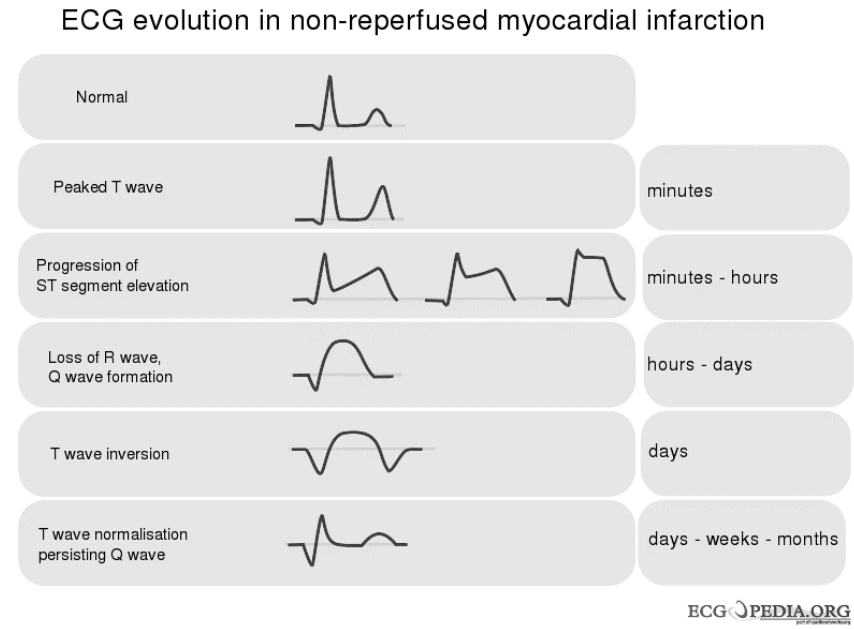


Figure 2 – ECG evolution in non-reperfused myocardial infarction

Evolving:

- hyperacute T wave ("peaked T wave");
- ST-elevation.

Acute stage:

- ST-elevation;
- R wave absent;
- Pathological Q-wave formation.

Healing stage:

- R wave absent;
- Q wave present;

- terminal T-wave inversion, ST-segment is essentially isoelectric.

Healed (after 28 days):

- Q wave present;
- ST-segment is essentially isoelectric;
- T-wave is inverted or positive.

ECG may show slight changes, if any, over the next several months (**healed**).

2. Laboratory tests

Laboratory tests used for the diagnosis of MI include the following:

- troponin levels: troponin is a contractile protein that normally is not found in serum; it is only detected when myocardial necrosis occurs. The American College of Cardiology/American Heart Association (ACC/AHA) and the European Society of Cardiology (ESC) guidelines recommend that cardiac biomarkers should be measured at presentation in patients with suspected MI, and that cardiac troponin is the only biomarker recommended for acute MI diagnosis at this time is due to its superior sensitivity and precision;
- complete blood cell count;
- comprehensive metabolic panel;
- lipid profile.

Cardiac troponin I (cTnI) and T (cTnT) are components of the contractile apparatus of myocardial cells and expressed almost exclusively in the heart. Cardiac TnI and cTnT are the preferred biomarkers for the evaluation of myocardial injury. High-sensitivity cTn assays are recommended for routine clinical use.

Other biomarkers, e. g., creatinine kinase MB isoform (CK-MB), are less sensitive and less specific (Table 2). Myocardial injury is defined to be present when blood levels of cTn are increased above the 99th percentile upper reference limit (URL). The injury may be acute, as evidenced by a dynamic rising and/or falling pattern of cTn values above the 99th percentile URL, or chronic, in the setting of persistently elevated cTn levels.

Table 2 – Myocardial enzymes

Enzyme		Elevation	Maximum	Normalization
Troponin T/I (cardiac-specific type)		~ 3 h	12–96 h	6–14 days
Myoglobin (non-cardiac-specific type)		~ 2–4 h	6–12 h	24 h
Creatine kinase (creatine phosphokinase) (important to evaluate reinfarction)	**Total CK**	~ 3–12 h	12–24 h	2–6 days
	CK-MB	~ 3–12 h	12–24 h	2–3 days
SGOT (AST) (non-cardiac-specific type)		~ 6–12 h	18–36 h	3–6 days

Instrumental diagnostic procedures:

3. Echocardiography:

It is performed immediately after ECG. EchoCG:

1) helps to visualize localization/size of wall motion abnormalities;
2) determines LV function → important for risk assessment;
3) assessment of complications (e. g., aneurysms, valve insufficiency, pericardial effusion, rupture).

4. Cardiac CT

Coronary computed tomography angiography (CCTA) involves an injection of iodine-containing contrast material and CT scanning to examine the arteries supplying blood to the heart and determine whether they have been narrowed. CCTA examinations have tended to help determine a lack of significant narrowing and calcium deposits in the coronary arteries, as well as the presence of

fatty deposits. Particularly, this has been found to exclude coronary artery disease.

5. Coronary angiography

During coronary angiography, a small catheter (a thin hollow tube with a diameter of 2−3 mm) is inserted through the skin into an artery in the groin or the arm. Being guided with the assistance of a fluoroscope (a special x-ray viewing instrument), the catheter is then advanced to the opening of the coronary arteries, the blood vessels supplying blood to the heart. Next, a small amount of radiographic contrast (a solution containing iodine, which is easily visualized with x-ray images) is injected into each coronary artery. The images that are produced are called angiograms. Angiographic images accurately reveal the extent and severity of all coronary arterial blockages. For individuals with suspected or confirmed acute MI, coronary angiography can be used to diagnose or rule out coronary artery disease definitively.

Management

Prehospital care

For patients with chest pain, prehospital care includes the following:

- intravenous access, supplemental oxygen, if SaO_2 is less than 90%, pulse oximetry;
- immediate administration of non-enteric-coated chewable aspirin;
- nitroglycerin for acute chest pain given sublingually or by spray;
- telemetry and prehospital ECG, if available.

Emergency department and inpatient care

- Initial stabilization of patients with suspected MI and ongoing acute chest pain should include administration of sublingual nitroglycerin if patients have no contraindications to it.

- The American Heart Association (AHA) recommends the initiation of beta-blockers to all patients with STEMI (unless beta-blockers are contraindicated).
- If STEMI is present and the patient is within 90 minutes of a PCI-capable facility, the patient should undergo emergent coronary angiography and primary PCI. If the patient is more than 120 minutes from a PCI-capable facility, fibrinolysis should be considered.
- Although patients presenting without ST-segment elevation (non-STE-ACS) are not candidates for immediate administration of thrombolytic agents, they should receive anti-ischemic therapy and may be candidates for PCI urgently or during admission.

Prehospital integration of ECG interpretation has been shown to decrease "door-to-balloon time," allow paramedics to bypass non-percutaneous coronary intervention (PCI)-capable hospitals in favor of PCI-capable facilities, and to expedite care by allowing an emergency department physician to activate the catheterization laboratory before the patient's arrival.

Additional objectives of prehospital care by paramedical and emergency personnel include adequate analgesia (generally achieved with morphine); pharmacologic reduction of excessive sympathoadrenal and vagal stimulation; treatment of hemodynamically significant or symptomatic ventricular arrhythmias (generally with amiodarone and lidocaine); and support of cardiac output, systemic blood pressure, and respiration.

Prehospital fibrinolytic therapy by administering tissue-type plasminogen activator (tPA), aspirin, and heparin may be given to patients with bona fide MI by paramedics, as guided by electrocardiographic findings, within 90 minutes of the onset of symptoms. This treatment improves outcomes, as compared with thrombolysis started after the patient's arrival at the hospital.

Emergency department care and in-hospital management

Triage and evaluation

Because ACS is a spectrum of conditions, initial evaluation to establish a working diagnosis is crucial, as this will dictate the

management owing to some differences in management steps and timelines for each component of the ACS spectrum.

All patients admitted to the emergency department with symptoms suggestive of acute myocardial infarction (MI) should be evaluated with a targeted history and focused physical examination. A 12-lead ECG interpreted by an experienced physician should be completed within 10 minutes of arrival, in addition to establishing intravenous (IV) access.

Initial management

The initial management of the overall management plan for patients with acute MI has the following goals:

- restoration of the balance between oxygen supply and demand to prevent further ischemia;
- pain relief;
- prevention and treatment of complications.

Oxygen

Continuous oxygen saturation monitoring by pulse oximetry is needed for all patients. Supplemental oxygen by a face mask or nasal cannula is indicated only for patients who are hypoxic (oxygen saturation < 90% or PaO_2< 60 mm Hg), or who present with heart failure.

Aspirin

All patients presenting with ACS should receive non-enteric-coated chewable aspirin in a dose of at least 162 to 325 mg unless there is a clear history of aspirin allergy. Patients with aspirin intolerance still should receive aspirin at presentation. Chewable aspirin is preferred, as this promotes rapid absorption into the bloodstream to achieve faster therapeutic levels.

Reduction of cardiac pain:

1) Nitrates

Nitrates are potent vasodilators, and they act mainly to relax the venous system. Systemic venodilation results in a reduction of venous blood return to the heart (i. e., reducing the ventricular preload); this will lead to decreased workload of the heart, less oxygen demand, and ischemic pain reduction. Nitrates are also most commonly used to relieve cardiac chest pain related to ischemia via

coronary vasodilation; however, their use is not associated with a decrease in ACS-associated mortality.

Nitrates are usually given as a 0.4 mg dose in a sublingual tablet, followed by close observation of the effect on chest pain and the hemodynamic response. If the initial dose is well tolerated, nitrates can be further administered. The most common side effects of nitrates are hypotension and headache.

If chest pain persists or recurs, IV nitrates are indicated, usually started at a dose of 5 to 10 μg/min and gradually increased until relief of chest pain is achieved. Nitrates should not be used in patients presenting with marked hypotension or bradycardia, or if there is suspicion of right ventricular infarction.

2) Analgesia

Pain control is essential for quality patient care. Analgesics ensure patient's comfort, promote pulmonary toilet, and have sedating properties, which are beneficial for patients who experience pain.

Morphine sulfate is the drug of choice for narcotic analgesia due to its reliable and predictable effects, safety profile, and easy reversibility with naloxone. Morphine sulfate is administered intravenously, may be dosed in a number of ways, and is commonly titrated until the desired effect is achieved.

The initial dose of morphine of 2 to 4 mg as an IV bolus can be given, with increments of 2 to 4 mg repeated every 5 to 10 minutes until the pain is relieved or intolerance is manifested by hypotension, vomiting, or depressed respiration. Should toxicity occur, a morphine antagonist such as naloxone is used for reversal. The patient's blood pressure and pulse should be monitored; the systolic blood pressure should be maintained above 100 mm Hg and, optimally, below 140 mm Hg.

The use of other analgesic agents, such as nonsteroidal anti-inflammatory drugs (NSAIDs) should be strictly avoided since the use of these agents has been associated with adverse cardiovascular events.

ST-elevation myocardial infarction

Management of ST-elevation myocardial infarction (MI) (STEMI) relies on two essential components: rapid detection and timely reperfusion.

Reperfusion

Early mechanical intervention (primary PCI) or pharmacologic reperfusion should be performed as soon as possible for patients with the clinical presentation of STEMI within 12 hours of symptom onset and for those having persistent ST-segment elevation or new or presumed new left bundle branch block (LBBB).

For patients admitted to a PCI-capable hospital, emergent coronary angiography and primary PCI should be accomplished within 90 minutes. For patients admitted to a non-PCI-capable hospital, if they cannot be transferred to a PCI-capable hospital within 120 minutes, it is very important to assess the following rapidly in order to decide on administration of fibrinolytic therapy.

Primary percutaneous intervention

PCI is defined as an emergent percutaneous coronary intervention in the setting of STEMI, without previous fibrinolytic treatment. Current guidelines strongly recommend performing primary PCI in patients presenting with symptoms of less than 12 hours' duration, or those who present with cardiogenic shock or develop acute severe heart failure, irrespective of the time of delay from onset of symptoms. Guidelines also recommend considering primary PCI for patients who present between 12 and 24 hours after onset of symptoms, provided there is ongoing clinical or ECG evidence of myocardial ischemia.

This method of reperfusion entails performing emergent coronary angiography after establishing arterial access, which can be achieved via the radial or femoral artery. After identifying the anatomy of the coronary circulation and determining the culprit vessel, coronary stents are placed to establish reperfusion.

Coronary artery bypass grafting (CABG)

Despite the great improvement of intraoperative myocardial preservation, CABG has a limited role in the acute management of STEMI. However, CABG remains an indication for cardiogenic

shock, failed PCI, high-risk anatomy, surgical repair of a mechanical complication of STEMI (e. g., ventricular septal rupture, free-wall rupture, or severe mitral regurgitation from papillary muscle dysfunction or rupture). CABG is also the preferred revascularization strategy for patients with unprotected left main coronary artery disease, but PCI with DES is a reasonable alternative treatment option in those with favorable anatomy and high surgical risk.

Fibrinolysis

Fibrinolysis is an important reperfusion strategy, particularly in case primary PCI cannot be offered to a STEMI patient within the recommended timelines. The benefit of fibrinolytic therapy in patients with STEMI is well established, with the best benefit being observed when administered early (within 12 hours after symptoms onset) and in patients with the highest cardiovascular risk, including patients older than 75 years. Fibrinolytic therapy may not be beneficial in patients who present later than 12 hours after symptoms onset.

The main objective of thrombolysis is to restore circulation through a previously occluded vessel by the rapid and complete removal of a pathologic intraluminal thrombus or embolus that has not been dissolved by endogenous fibrinolytic system.

The first generation of fibrinolytic drugs (e. g., streptokinase, urokinase, acetylated plasminogen streptokinase activator complexes (APSACs), reteplase, and novel plasminogen activator (nPA)) indiscriminately induced activation of circulating plasminogen and clot-associated plasminogen. First-generation drugs invariably elicited a systemic lytic state characterized by depletion of circulating fibrinogen, plasminogen, and hemostatic proteins and by marked elevation of concentrations of fibrinogen degradation products in plasma.

Second-generation drugs (e. g., alteplase (tPA), single-chain urokinase plasminogen activator), such as tenecteplase, preferentially activate plasminogen in the fibrin domain, rather than in the circulation, as with free plasminogen. Therefore, they have clot selectivity. Tenecteplase should be initiated as soon as possible in patients with STEMI; tenecteplase is administered as a single bolus, exhibiting a biphasic disposition from the plasma.

Anticoagulation

Anticoagulant agents are an important adjunctive therapy for reperfusion therapy regardless of the strategy chosen (i. e., whether it is a primary PCI or fibrinolysis therapy). Different anticoagulation agents are available; the utility of each agent depends on the clinical context and takes into account the method of reperfusion.

For primary PCI, unfractionated heparin (UFH), bivalirudin, and low molecular weight heparin (LMWH) (e. g., enoxaparin) are available options.

In patients receiving fibrinolytic therapy, anticoagulation should be given until revascularization is performed; if reperfusion is not feasible, anticoagulants should be given for at least 48 hours or for the duration of hospital stay up to 8 days. UFH or LMWH may be used, with LMWH (enoxaparin) being preferred. Caution should be used with the administration of enoxaparin in patients older than 75 years as well as in those with impaired renal function, because the use of enoxaparin is associated with a higher risk of intracranial bleeding. Bivalirudin may be used in patients who develop or have a history of heparin-induced thrombocytopenia (HIT) and require anticoagulation.

Unfractionated heparin (UFH)

Heparin augments the activity of antithrombin III and prevents the conversion of fibrinogen to fibrin. Heparin does not actively lyse, but it is able to inhibit further thrombus formation and prevents reaccumulation of a clot after spontaneous fibrinolysis.

An initial loading dose of 60 IU/kg (maximum 4 000 IU) with an initial infusion of 12 IU/kg per hour (maximum 1 000 IU/h) adjusted per activated partial thromboplastin time (PTT) is recommended to maintain therapeutic anticoagulation according to the specific hospital protocol. This regimen is continued for 48 hours or until PCI is performed.

A major disadvantage of the use of unfractionated heparin is the large interindividual variability and narrow therapeutic window.

Low molecular weight heparin (LMWH)

Enoxaparin enhances the inhibition of factor Xa and thrombin by increasing antithrombin III activity. In addition, it

preferentially increases the inhibition of factor Xa. Enoxaparin is indicated for the treatment of acute STEMI managed medically or with subsequent PCI. It is also indicated for prophylaxis of ischemic complications caused by unstable angina and non-Q-wave myocardial infarction.

Enoxaparin is given at a dose of 1 mg/kg subcutaneously (SC) every 12 hours. It should be continued for the duration of hospitalization or until PCI is performed. A dose reduction is required for patients with impaired kidney function.

Enoxaparin results in more predictable and efficient anticoagulation than unfractionated heparin, leading to a reduction in recurrent MI events; however, there is possibly a higher bleeding risk in patients undergoing PCI.

Anticoagulant agents are recommended for all patients with NSTE-ACS, regardless of the initial treatment strategy, in addition to antiplatelet therapy. The following agents may be considered as treatment options from this group of medications.

Bivalirudin binds directly to thrombin and thereby inhibits the thrombin-induced conversion of fibrinogen to fibrin. It inactivates fibrin-bound as well as fluid-phase thrombin. Since the drug does not bind to plasma proteins, its anticoagulant effect is more predictable than that of UFH. Bivalirudin is a direct thrombin inhibitor that is given at a loading dose of 0.1 mg/kg, followed by 0.25 mg/kg per hour only in patients managed with an early invasive strategy. This regimen is continued until diagnostic angiography or PCI is performed.

Fondaparinux is a synthetic pentasaccharide that binds reversibly and non-covalently to antithrombin with high affinity, thereby preventing thrombin generation. This agent is given as a once-daily subcutaneous (SC) injection of 2.5 mg, which is continued for the duration of hospitalization or until PCI is performed. Fondaparinux is considered a parenteral anticoagulant with the most favourable efficacy-safety profile and is recommended regardless of the management strategy unless the patient is scheduled for immediate coronary angiography.

Note that fondaparinux is contraindicated in patients with impaired kidney function. In addition, in patients undergoing PCI,

another anticoagulant agent (e. g., unfractionated heparin or bivalirudin) should be administered, since fondaparinux is associated with a higher risk of catheter thrombosis.

Except in overdoses, no utility exists in checking PT or aPTT, because aPTT does not correlate with the anticoagulant effect of fractionated LMWH.

Antiplatelet agents

Aspirin is a cyclo-oxygenize (COX) inhibitor preventing the production of thromboxane A2 and thereby reducing platelet aggregation and thrombus formation. Aspirin should be given to all patients with suspected ACS unless contraindicated.

All patients with STEMI should receive an empiric loading dose of aspirin (150.5 to 325 mg) as early as possible and prior to reperfusion, regardless of the reperfusion method. A lifelong maintenance dose of 75 to 81 mg daily should be prescribed to all patients after STEMI.

Other antiplatelet agents used for dual antiplatelet therapy include $P2Y_{12}$ receptor inhibitors (e. g., clopidogrel, ticagrelor, prasugrel); a loading dose of these agents is given before or at the time of reperfusion and an extended duration maintenance dose is administered after that, depending on the method of reperfusion.

Clopidogrel selectively inhibits adenosine diphosphate (ADP) binding to platelet receptors and subsequent ADP-mediated activation of glycoprotein GPIIb/IIIa complex, thereby inhibiting platelet aggregation.

For patients undergoing primary PCI, a loading dose of 600 mg of clopidogrel, 180 mg of ticagrelor, or 60 mg of prasugrel should be given as early as possible or at the time of primary PCI. A maintenance dose of $P2Y_{12}$ receptor inhibitors should be continued for at least 1 year for patients who receive a stent, either a BMS or a DES. A daily dose of 75 mg clopidogrel, 90 mg ticagrelor (twice daily), or 10 mg prasugrel is recommended. It is reasonable to discontinue $P2Y_{12}$ receptor inhibitor agents in less than 1 year in patients who receive a BMS if there is evidence of increased bleeding.

Beta-blockers

Beta-blockers reduce oxygen consumption of the myocardium by lowering the heart rate, blood pressure, and myocardial contractility. They also play an important role in the reduction of reinfarction and complex ventricular arrhythmias. These agents are recommended for oral use within the first 24 hours, preferably using one of the three drugs proven to reduce mortality in heart failure patients: metoprolol, carvedilol, or bisoprolol. During IV administration, blood pressure, heart rate, and ECG should be carefully monitored. Also, these agents should not be given to patients who have a contraindication to beta-blockers.

Beta-blockers are contraindicated in:

- bradycardia <60 bpm;
- 2nd or 3rd degree AV block;
- systolic BP <100 mmHg;
- severe heart failure;
- bronchospasm or asthma;
- significant peripheral vascular disease;
- concomitant use of verapamil.

Calcium channel blockers

Non-dihydropyridine calcium channel blockers (e. g., verapamil or diltiazem) should be given for recurrent myocardial ischemia only if there are contraindications to beta-blockers.

Avoid short-acting nifedipine in patients who are not receiving beta-blockers, as this may result in increased mortality in patients with ACS.

Non-ST-elevation (NSTE) ACS

The key points in the management of patients with non-ST-elevation acute coronary syndrome (NSTE-ACS) (unstable angina and NSTEMI) are early evaluation and assessment of hemodynamic and electrical stability, estimation of the overall risk in these patients, and guidance of therapy.

There are two alternative management strategies: an early invasive strategy with angiography aimed at revascularization with percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG); or a conservative strategy with initial medical

therapy and noninvasive cardiovascular imaging. Regardless of the strategy, aggressive utility of medications such as anticoagulants, antiplatelet agents, beta-blockers, statins is entailed, as well as possible use of angiotensin-converting enzyme (ACE) inhibitors for appropriate patient populations.

In patients with refractory angina, clinical evidence of heart failure, or hemodynamic or electrical instability, who do not have serious comorbidities or contraindications to angiography/PCI, an early invasive strategy is recommended.

An immediate early invasive strategy is also recommended for patients who are stable but at a high risk of clinical events. It is reasonable to consider an early invasive strategy within 24 hours of admission in patients with intermediate/high risk. For patients who fall out of this category, a delayed invasive strategy within 25 to 72 hours of admission versus a conservative (ischemia-guided) strategy may be considered.

Additional aspects of management and late hospital care

After the initial management and stabilization of the patient in the early and critical phase of acute myocardial infarction (MI), the goal of care for these patients is to restore normal activities and prevent long-term complications, as well as aggressively modify lifestyle and risk factors.

Cardioprotective medications

Inhibitors of the renin-angiotensin-aldosterone (RAA) system

ACE inhibitors may prevent the conversion of angiotensin I to angiotensin II, a potent vasoconstrictor, resulting in lower aldosterone secretion. ACE inhibitors reduce mortality rates after myocardial infarction. ACE inhibitors should be administered as soon as possible and as long as the patient has no contraindications and remains in stable condition. ACE inhibitors have the greatest benefit in patients with ventricular dysfunction.

Angiotensin-converting enzyme (ACE) inhibitors should be initiated and continued indefinitely in all patients with a left ventricular ejection fraction that is less than 40 % and in those with hypertension, diabetes mellitus, or stable chronic kidney disease unless contraindicated.

Angiotensin-receptor blockers may be used as an alternative to ACE inhibitors in patients who develop adverse effects, such as a persistent cough, although initial trials need to be confirmed.

Aldosterone blockers are recommended in addition to beta-blockers and ACE inhibitors in patients who have had MI with a reduced left ventricular ejection fraction of less than 40 %, provided they have no renal impairment and have normal blood potassium levels (< 5 mEq/L).

Statins

All patients with acute MI should be started on high-potency statin therapy and continued indefinitely. According to clinical practice guidelines, high potency statins such as atorvastatin 40 mg or 80 mg, or rosuvastatin 20 mg are recommended.

Complications of MI

Complications of myocardial infarction (MI) include arrhythmic complications, mechanical complications (ventricular free wall rupture, ventricular septal defect, left ventricular aneurysm formation, ventricular septal rupture), associated right ventricular infarction, ventricular pseudoaneurysm, post-MI pericarditis (Dressler syndrome).

In order to provide appropriate diagnostic and treatment strategy, Clinical Practice Guidelines should be used in day-to-day practice. Clinical Practice Guidelines are the statements that include recommendations intended to optimize patient care and involve a systematic review of evidence and an assessment of the benefits and harms of alternative care options.

Acute Coronary Syndrome

The guidelines summarize and evaluate available evidence in order to assist health professionals in selecting the best management strategies for a patient with a given condition. The guidelines and their recommendations should facilitate decision making for health professionals in their daily practice.

Updates on the management of patients presenting with ST-segment elevation myocardial infarction (STEMI) and non-ST-segment elevation myocardial infarction (NSTEMI) should be based

on sound evidence derived from well-conducted clinical trials whenever possible, or motivated expert opinion when needed. It must be recognized that, even when excellent clinical trials took place, the results are open to interpretation and treatments may need to be adapted to take account of clinical circumstances and resources.

Tables 3 and 4 should be used to evaluate the levels of evidence and classes of recommendations.

Table 3 – ESC levels of evidence

Level of evidence A	Data derived from multiple randomized clinical trials or meta-analyses
Level of evidence B	Data derived from a single randomized clinical trial or large non-randomized studies
Level of evidence C	Consensus of opinion of the experts and/or small studies, retrospective studies, registries

Table 4 – ESC classes of recommendations

Classes of recommendation	Definition	Suggested wording to use
Class I	Evidence and/or general agreement that the given treatment or procedure is beneficial, useful, and effective	**Is recommended/ is indicated**
Class II	Conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of the given treatment or procedure	
Class IIa	Weight of evidence/opinion is in favor of usefulness/efficacy	**Should be considered**
Class IIb	Usefulness/efficacy is less well established by evidence/opinion	**May be considered**
Class III	Evidence or general agreement that the given treatment or procedure is not useful/effective, and in some cases may be harmful	**Is not recommended**

Acute coronary syndrome (ACS) is an operational term used to describe a constellation of symptoms resulting from acute

myocardial ischemia. An ACS injury resulting in myocardial injury is termed myocardial infarction (MI). ACS includes the diagnosis of unstable angina (UA), non-ST-segment elevation myocardial infarction (NSTEMI), and ST-segment elevation myocardial infarction (STEMI).

Definition

The current nomenclature divided ACS into two major groups on the basis of delivered treatment modalities:

- STEMI-ACS where a patient presents with chest discomfort and ST-segment elevation on ECG. This group of patients is indicated to undergo reperfusion therapy on presentation;
- NSTEMI and unstable angina-ACS, where patients present with ischemic chest discomfort associated with transient or permanent NSTEMI on ECG. In case of biochemical evidence of myocardial injury, the condition is termed NSTEMI, while if no biochemical evidence of myocardial injury is present, the condition is termed unstable angina. Thrombolysis is not recommended for this group of patients.

The working diagnosis of ACS and the initial management should be based on the following parameters:

1) chest pain characteristics, duration and persistence as well as a symptom-oriented physical examination (e.g., systolic blood pressure, heart rate, cardiopulmonary auscultation, Killip classification);
2) assessment of CAD risk based on the chest pain characteristics, age, gender, CV risk factors, known CAD and noncardiac manifestations of atherosclerosis;
3) 12-lead ECG (to detect ST deviation or other abnormalities suggestive of myocardial ischemia or necrosis).

Based on these findings, a patient can be diagnosed with one of the four **working diagnoses**:

- ✓ STEMI;
- ✓ NSTE-ACS with ongoing ischemia or haemodynamic instability;
- ✓ NSTE-ACS without ongoing ischemia or haemodynamic instability;
- ✓ NSTE-ACS is unlikely.

2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation

Step 1: Initial evaluation and patient pathway

Chest pain or other atypical symptoms prompt the patient to seek medical attention. All patients with suspected NSTE-ACS are admitted to an emergency department and evaluated rapidly by a qualified physician. The delay between first medical contact and ECG should be ≤ 10 min. The cardiac rhythm of the patient should be monitored (Table 5).

Table 5 – Recommended unit and duration of monitoring according to clinical presentation after NSTE-ACS diagnosis established [1]

Clinical presentation	Unit	Rhythm monitoring
Unstable angina	Regular ward or discharge	None
NSTEMI at low risk for cardiac arrhythmias[a]	Intermediate care unit or coronary care unit	≤ 24 h
NSTEMI at intermediate to high risk for cardiac arrhythmias[b]	Intensive/coronary unit or intermediate care unit	> 24 h

[a]If none of the following criteria is present: haemodynamically unstable, major arrhythmias, left ventricular ejection fraction ≤ 40 %, failed reperfusion, additional critical coronary stenosis of major vessels or complications related to percutaneous revascularization.

[b]If one or more of the above criteria are present

The initial treatment should include nitrates (sublingual every 5 min for 15 min, then IV administration), if there is persisting chest pain, hypertension or heart failure. Oxygen therapy should be applied in case of blood oxygen saturation < 90 % or respiratory distress. Morphine (IV or SC) or alternative opiates are reserved for patients with persisting severe chest pain. In patients with ongoing chest pain and inconclusive ECG, immediate echocardiography should be considered to exclude alternative diagnoses (if appropriate in conjunction with CT angiography), such as pulmonary embolism,

pericarditis or aortic dissection and at the same time to reinforce the suspicion of NSTE-ACS (i. e., by identifying a focal wall motion abnormality). In the setting of ongoing myocardial ischemia or haemodynamic compromise (the clinical suspicion should be corroborated by the echocardiographic finding of regional wall motion abnormality), the patient should undergo immediate coronary angiography irrespective of ECG or biomarker findings to prevent life-threatening ventricular arrhythmias and limit myocardial necrosis. Blood work on admission should include at least cardiac troponin T or I (preferably high-sensitivity), serum creatinine, haemoglobin, haematocrit, platelet count, blood glucose and INR in patients on VKA. The results of the troponin measurements should be available within 60 min and troponin measurement should be repeated at 1–3 h, if high-sensitivity troponin assays are used. Vital signs should be assessed on a regular basis. In the case of hospital admission, guidance in the choice of the unit is described in Table 5. Patients with suspected NSTE-ACS should be observed at interdisciplinary emergency departments or chest pain units until the diagnosis of MI is confirmed or ruled out. If the diagnosis of NSTE-ACS is confirmed, the lipid profile should be tested in the early phase of admission. In the case of ongoing ischemia, defibrillator patches should be placed until urgent revascularization is performed.

Diagnosis of NSTE-ACS

1. Clinical presentation

Anginal pain in NSTE-ACS patients can have the following presentations:

- prolonged (20 min) anginal pain at rest;
- new-onset (de novo) angina (class II or III of the Canadian Cardiovascular Society classification);
- recent destabilization of previously stable angina with at least class III angina by Canadian Cardiovascular Society classification (crescendo angina); or
- post-MI angina.

Typical chest pain is characterized by a retrosternal sensation of pressure or heaviness (‘angina’) radiating to the left arm (less frequently to both arms or to the right arm), neck or jaw, which may

be intermittent (usually lasting for several minutes) or persistent. Additional symptoms such as sweating, nausea, abdominal pain, dyspnoea and syncope may be present. Atypical presentations include epigastric pain, indigestion-like symptoms and isolated dyspnoea. Atypical complaints are more often observed in the elderly, in women and in patients with diabetes, chronic renal disease or dementia.

2. Physical examination

Physical examination is frequently unremarkable in patients with suspected NSTE-ACS. Signs of heart failure or haemodynamic or electrical instability mandate a quick diagnosis and treatment. Cardiac auscultation may reveal a systolic murmur due to ischaemic mitral regurgitation, which is associated with poor prognosis, or aortic stenosis. Physical examination may identify signs of non-coronary causes of chest pain (e. g., pulmonary embolism, acute aortic syndromes, myopericarditis, aortic stenosis) or extracardiac pathologies (e. g., pneumothorax, pneumonia or musculoskeletal diseases).

3. Electrocardiogram

The resting 12-lead ECG is the first-line diagnostic tool in the assessment of patients with suspected ACS. While the ECG findings in the setting of NSTE-ACS may be normal in more than one-third of patients, characteristic abnormalities include ST depression, transient ST elevation and T-wave changes. If the standard leads findings are inconclusive and a patient has signs or symptoms suggestive of ongoing myocardial ischemia, additional leads should be recorded; left circumflex artery occlusion or right ventricular MI may be detected only in V_7–V_9 and V_{3R} and V_{4R}, respectively.

4. Biomarkers

Measurement of a biomarker of cardiomyocyte injury, preferably high-sensitivity cardiac troponin, is mandatory in all patients with suspected NSTE-ACS. Cardiac troponins are more sensitive and specific markers of cardiomyocyte injury than creatine kinase (CK), its MB isoenzyme (CK-MB) and myoglobin. If the clinical presentation is compatible with myocardial ischemia, then a dynamic elevation of cardiac troponin above the 99th percentile of healthy individuals indicates MI. In patients with MI, levels of cardiac

troponin rise rapidly (i. e., usually within 1 h, if high-sensitivity assays are used) after symptom onset and remain elevated for a variable period of time (usually several days).

5. Non-invasive imaging

Transthoracic echocardiography should be routinely available in emergency rooms and chest pain units and performed/interpreted by trained physicians in all patients during hospitalization for NSTE-ACS. This imaging modality is useful to identify abnormalities suggestive of myocardial ischemia or necrosis (i. e., segmental hypokinesia or akinesia). In the absence of significant wall motion abnormalities, impaired myocardial perfusion detected by contrast echocardiography or reduced regional function using strain and strain rate imaging might improve the diagnostic and prognostic value of conventional echocardiography.

Cardiac magnetic resonance (CMR) can assess both perfusion and wall motion abnormalities; CMR also permits detection of scar tissue (using late gadolinium enhancement) and can differentiate it from recent infarction (using T2-weighted imaging to delineate myocardial edema), and can facilitate the differential diagnosis between infarction and myocarditis or Takotsubo cardiomyopathy.

Multidetector computed tomography (MDCT) allows for visualization of the coronary arteries and a normal scan excludes CAD. Importantly, CT imaging can effectively exclude other causes of acute chest pain that, if untreated, are associated with high mortality, namely pulmonary embolism, aortic dissection and tension pneumothorax.

Chest X-ray is recommended in all patients in whom NSTE-ACS is considered unlikely in order to detect pneumonia, pneumothorax, rib fractures or other thoracic disorders.

Rhythm monitoring for up to 24 hours or PCI (whichever comes first) should be considered in NSTEMI patients at low risk for cardiac arrhythmias (i. e., with none of the following criteria: haemodynamically unstable, major arrhythmias, LVEF < 40 %, failed reperfusion, additional critical coronary stenoses or complications related to PCI). Rhythm monitoring for > 24 hours should be considered in NSTEMI patients at intermediate to high-

risk for cardiac arrhythmias (i. e., if one or more of the above criteria are present).

Step 2: Diagnosis validation, risk assessment, and rhythm monitoring

Once the initial clinical assessment complemented by the 12-lead ECG and the first cardiac troponin measurement has substantiated the diagnosis of NSTE-ACS, antithrombotic treatment (as described in step 3) as well as anti-anginal treatment (i. e., beta-blockers and nitrates – Table 6, 8) should be started. Further management of the patient is based on responsiveness to anti-anginal treatment and risk assessment, as quantified by the GRACE 2.0 risk score
(http://www.gracescore.org/WebSite/default.aspx?ReturnUrl=% 2f), as well as on results of the subsequent troponin measurement (at 1–3 h, if high-sensitivity assays are used) (Fig. 2). Echocardiography is useful to identify abnormalities suggestive of myocardial ischemia or necrosis (i. e., segmental hypokinesia or akinesia) and should be performed immediately in patients with haemodynamic instability of suspected CV origin. If aortic dissection or pulmonary embolism is suspected, echocardiography, D-dimer assessment, and CT angiography should be implemented according to the respective ESC guidelines.

Step 3: Treatment

Pharmacological treatment of ischemia

The goal of pharmacological anti-ischemic therapy is to decrease myocardial oxygen demand (secondary to a decrease in heart rate, blood pressure, preload or myocardial contractility) or to increase myocardial oxygen supply (by administration of oxygen or through coronary vasodilation). Oxygen should be administered when blood oxygen saturation is < 90 % or if the patient is in respiratory distress.

Nitrates

Intravenous nitrates are more effective than sublingual nitrates with regard to symptom relief and regression of ST depression (Table 4, 6). Under careful blood pressure monitoring, the dose should be

titrated upwards until symptoms are relieved, and in hypertensive patients – until blood pressure is normalized unless side effects (notably headache or hypotension) occur. Beyond symptom control, there is no indication for nitrate treatment. In patients with recent intake of a phosphodiesterase type 5 inhibitor (i. e., within 24 h for sildenafil or vardenafil and within 48 h for tadalafil), nitrates should not be administered due to the risk of severe hypotension.

Table 6 –Recommended doses of nitrates

Compound	**Route**	**Dosage**	**Time of onset**
Nitroglycerine, GTN	IV	5–200 μg/minute*	1 minute
	Sublingual	0.3–0.6 mg, can be repeated up to 3 times at 5 minute's intervals	2 minutes
	GTN spray	0.4–0.8 mg per metered dose, no more than 3 sprays at 5-minute intervals	2 minutes
	Transdermal patch	0.2–0.8 mg over 12 hours on, then 12 hours off	1–2 hours
Isosorbide dinitrate	IV	1.25–5 mg/hour	1 minute
	Transdermal patch	2.5–10 mg	3–4 minutes
	Oral	10–20 mg, bd/tds	30–60 minutes
Extended-release isosorbide mononitrate	Oral	30–60 mg, od	60 minutes
*The dose of IV nitrates should be titrated every 5–10 minutes until symptoms and/or ischemia is relieved and the desired haemodynamic response is obtained.			

Beta-blockers

This category of drugs has the potential to suppress ventricular ectopy due to ischemia or excess catecholamines. In the setting of myocardial ischemia, beta-blockers have antiarrhythmic properties and reduce myocardial oxygen demand secondary to elevations in heart rate and inotropy. Dosages of beta-blockers are provided in Table 7.

Table 7 – Recommended dosages of beta-blockers in STEMI

Type	Initiation dose	Target dose
Metoprolol	25 mg bd	100 mg bd
Atenolol	25 mg od	100 mg od
Propranolol	5 mg tds	80 mg tds
Carvedilol	3.125 mg bd	25 mg bd
Bisoprolol	1.25 mg od	10 mg od

In patients whose ischaemic symptoms are not relieved by nitrates and beta-blockers, opiate administration is reasonable while waiting for immediate coronary angiography, with the caveat that morphine may slow intestinal absorption of oral platelet inhibitors.

Antithrombotic treatment

Antiplatelet agents

All patients with NSTEMI should receive an empiric loading dose of aspirin (325 mg) as early as possible and prior to reperfusion, regardless of the reperfusion method. A lifelong maintenance dose of 75 to 81 mg daily should be prescribed to all patients after MI.

$P2Y_{12}$ (ADP) receptor inhibitors (clopidogrel, prasugrel, ticagrelor): $P2Y_{12}$ (ADP) receptor antagonists further reduce platelet aggregation and should be used in conjunction with aspirin (dual antiplatelet therapy). Clopidogrel can be used when ticagrelor or prasugrel are not available or are contraindicated, including those with prior intracranial bleeding or indication for oral anticoagulants.

Table 8 – Recommendations for anti-ischemic drugs use in the acute phase of non-ST-elevation acute coronary syndromes [1]

Recommendations	Class	Level
Early initiation of beta-blocker treatment is recommended in patients with ongoing ischemic symptoms and without contraindications	I	B
It is recommended to continue chronic beta-blocker therapy, unless the patient is in Killip class III or higher	I	B
Sublingual or IV nitrates are recommended to relieve angina; IV treatment is recommended in patients with recurrent angina, uncontrolled hypertension or signs of heart failure	I	C
In patients with suspected/confirmed vasospastic angina, calcium channel blockers and nitrates should be considered, while beta-blockers avoided.	IIa	B

The choice of the antithrombotic regimen in NSTE-ACS should be based on the selected management strategy (i. e., conservative vs. invasive) as well as the chosen revascularization modality (PCI vs. CABG). Dosing of antithrombotic agents (Tables 9, 10) should take into account the patient's age and renal function. Aspirin and parenteral anticoagulation are recommended. In patients intended for conservative treatment and not at high bleeding risk, ticagrelor (preferred over clopidogrel) is recommended once the NSTEMI diagnosis is established. In patients intended for an invasive strategy, the optimal timing of the administration of ticagrelor (preferred over clopidogrel) has not been adequately investigated, while prasugrel is recommended only after coronary angiography before PCI.

Duration of dual antiplatelet therapy (DAPT)

In patients with NSTE-ACS, DAPT with aspirin and clopidogrel has been recommended for 1 year over aspirin alone, irrespective of revascularization strategy and stent type. While a 1-year duration of DAPT in NSTE-ACS patients is recommended, based on individual patient ischaemic and bleeding risk profiles, DAPT duration may be shortened (i. e., 3–6 months) or extended (i. e., up to 30 months) in selected patients if required.

Table 9 – Dosing of antiplatelets in patients with normal and impaired renal function [1]

	Clopidogrel	**Prasugrel**	**Ticagrelor**	**Prasugrel**
Chemical class	Thienopyridine	Thienopyridine	Cyclopentiltiazolopyrimidine	Stabilized ATP analogue
Administration	Oral	Oral	Oral	Intravenous
Dose	300–600 mg orally, then 75 mg	60 mg orally, then 10 mg	180 mg orally, then 90 mg twice a day	30 μg/kg bolus, 4 μg/kg/min infusion
Dose in stage 3–4 CKD	No dose adjustment	No dose adjustment	No dose adjustment	No dose adjustment
Dosed in stage 5 CKD	Use only for selected indications	Not recommended	Not recommended	No dose adjustment

A proton pump inhibitor (PPI) in combination with DAPT is recommended in patients at higher-than-average risk of GI bleedings (i. e., history of GI ulcer or hemorrhage, anticoagulant therapy, chronic NSAID/corticosteroid use, or two or more of the following: age > 65 years, dyspepsia, gastro-eosophageal reflux disease, Helicobacter pylori infection, chronic alcohol use). More recently, more liberal use of PPI for all patients on DAPT has been recommended.

Anticoagulant agents

Anticoagulants should be administered to all patients with ACS. Anticoagulants are used to inhibit thrombin generation and/or activity, thereby reducing thrombus-related events. During PCI, if UFH is given, activated clotting time (ACT) is maintained between 250 and 300 sec.

Unfractionated heparin (UFH) should be stopped after PCI unless there is an established indication related to the procedure or to the patient's condition. Low-molecular-weight heparin (LMWH) has a more predictable dose-effect relationship than UFH and causes

heparin-induced thrombocytopenia less frequently. The most widely used agent in NSTE-ACS is enoxaparin (see Table 10 for dosing). Fondaparinux and bivalirudin are considered to be parenteral anticoagulants (see Table 10 for dosing).

Table 10 – Dosing of anticoagulants in patients with normal and impaired renal function [1]

Drug	**Normal renal function or stage 1–3 CKD**	**Stage 4 CKD**	**Stage 5 CKD**
Unfractionated heparin	Prior to coronary angiography: 60–70 IU/kg IV (max 5 000 IU) and infusion (12–15 IU/kg/h) (max 100 IU/h), target aPTT 1.5–2.5 times control During PCI: 70–100 IU/kg IV (50–70 IU/kg if concomitant with GPIIb/IIIa inhibitors)	No dose adjustment	No dose adjustment
Enoxaparin	1 mg/kg SC twice a day	1 mg/kg SC twice a day	Not recommended
Fondaparinux	2.5 mg SC once a day	2.5 mg SC once a day	Not recommended
Bivalirudin	Bolus 0.75 mg/kg IV, infusion 1.75 mg/kg/h	No adjustment of a bolus, reduce infusion rate to 1 mg/kg/h	On dialysis, no adjustment of a bolus, reduce infusion rate to 0.25 mg/kg/h

Step 4: Invasive strategy

Invasive coronary angiography

Invasive coronary angiography maintains its central role in the management of patients with NSTE-ACS. In the vast majority of cases, it allows clinicians to:

- confirm the diagnosis of ACS related to obstructive epicardial CAD (or to rule out a coronary origin of chest pain) and, as a consequence, to guide antithrombotic treatment and avoid unnecessary exposure to antithrombotic agents;
- identify the culprit lesion(s);
- establish the indication for coronary revascularization and assess the suitability of coronary anatomy for PCI and CABG and stratify the patient's short- and long-term risks.

The timing of angiography (calculated from the time of the first medical contact) can be classified into four categories based on the risk profile of a patient according to GRACE score (Table 11, 12, Fig. 3)

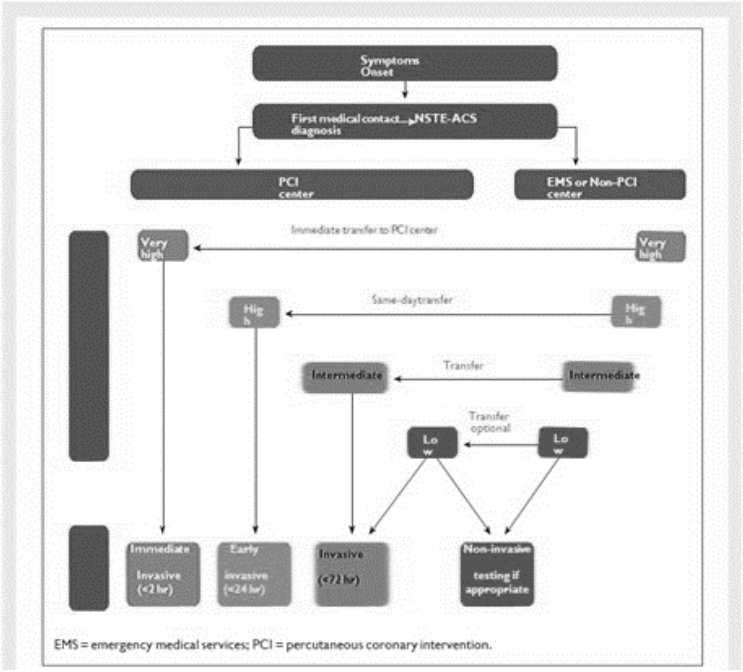


Figure 3 – Selection of non-ST-elevation acute coronary syndrome (NST-ACS) treatment strategy and timing according to initial risk stratification

Immediate invasive strategy (< 2 h). Paralleling the STEMI pathway, this strategy should be undertaken for patients with

ongoing ischemia, characterized by at least one very-high-risk criterion. The centers without ongoing STEMI programs should transfer the patient immediately.

- ✓ Early invasive strategy (< 24 h). Most patients in this category respond to the initial pharmacological treatment but are at increased risk and need early angiography followed by revascularization. Patients qualify if they have at least one high-risk criterion. It implies timely transfer for patients admitted to hospitals without onsite catheterization facilities.
- ✓ Invasive strategy (< 72 h). It is the recommended maximal delay for coronary angiography in patients without recurrence of symptoms but with at least one intermediate-risk criterion. Urgent transfer to a hospital with onsite catheterization facilities is unnecessary, but the 72 h window for coronary angiography should be complied with.

Table 11 – Calculation of GRACE risk score for in-hospital mortality

Age (years)	**Score**	**Heat rate (bpm)**	**Score**	**Killip class**	**Score**
40 ≥	0	70 ≥	0	Class I	0
49–40	18	89–70	7	Class II	21
59–50	36	109–90	13	Class III	43
69–60	55	149–110	23	Class IV	64
79–70	73	199–150	36	Cardiac arrest at admission	43
80 ≤	91	200 ≤	46	Elevated cardiac markers	15
Systolic BP	**Score**	**Creatinine (mg/dL)**	**Score**	ST-segment deviation	30
80 ≥	63	0.0–0.39	2		
99–80	58	0.4–0.79	5		
119–100	47	0.8–1.19	8		
139–120	37	1.2–1.59	11		
159–140	26	1.6–1.99	14		
199–160	11	0.2–3.99	23		
200 ≤	0	≥ 4	31		

Selective invasive strategy. Patients with no recurrence of chest pain, no signs of heart failure, no abnormalities in the initial or subsequent ECG and no increase in (preferably high-sensitivity) cardiac troponin level are at low risk of subsequent CV events. In this setting, a non-invasive stress test (preferably with imaging) for inducible ischemia is recommended before deciding on the invasive strategy.

Table 12 – Risk criteria mandating invasive strategy in NSTE-ACS

Very-high-risk criteria
– hemodynamic instability or cardiogenic shock;
– recurrent or ongoing chest pain refractory to medical treatment;
– life-threatening arrhythmias or cardiac arrest;
– acute heart failure;
– recurrent dynamic ST-T wave changes, particularly with intermittent ST-elevation.
High-risk criteria
– rise or fall in cardiac troponin consistent with MI;
– dynamic ST- or T-wave change (symptomatic or silent);
– GRACE score ≥ 40.
Intermidiate-risk criteria
– diabetes mellitus;
– renal insufficiency (eGFR ≤ 60 mL/min/1.73 m^2);
– LVEF ≤ 40 % or congestive heart failure;
– early post-infarction angina;
– prior PCI;
– prior CABG;
– GRACE risk score ≥ 109 and ≤ 140.
Low-risk criteria
– any characteristics not mentioned above.

Step 5: Revascularization modalities

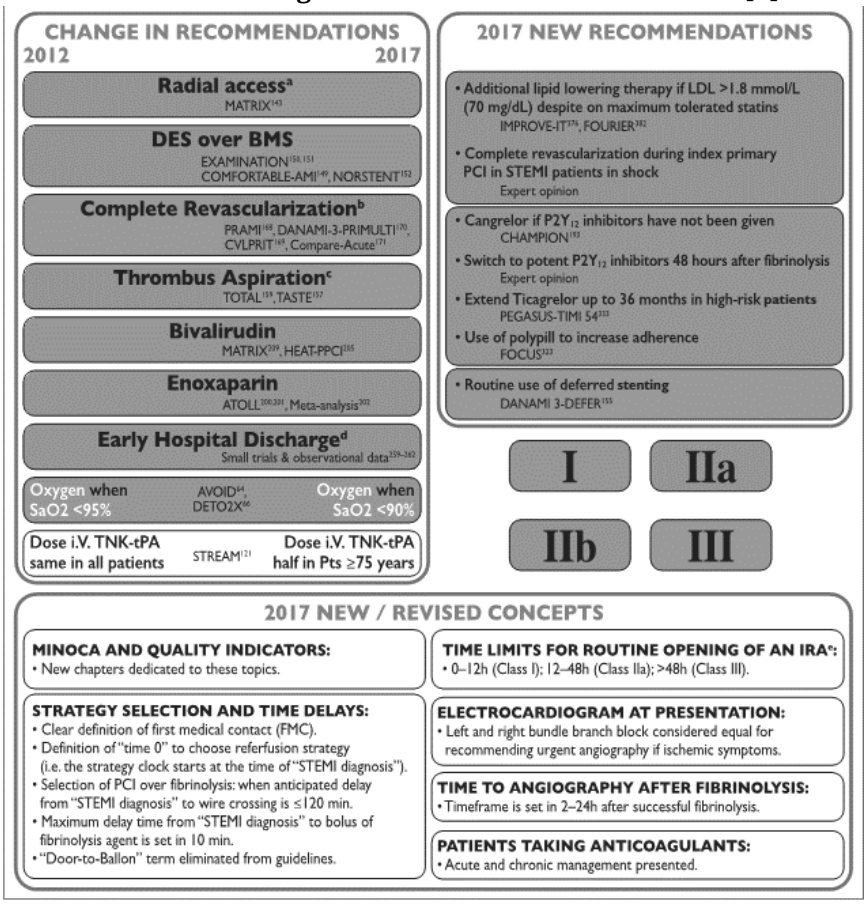
In patients with a single-vessel disease, PCI with stenting of the culprit lesion is the first choice. In patients with multivessel disease,

the decision for PCI or CABG should be individualized through consultation with the Heart Team.

2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation

Currently, 2017 ESC recommendations are used for the management of patients with STEMI. There are several changes that were approved in 2012 (Table 13).

Table 13 – Changes in recommendations 2012–2017 [2]



Initial diagnosis

Management (including diagnosis and treatment) of STEMI starts from the point of first medical contact (FMC, defined in Fig. 3). It is recommended that a regional reperfusion strategy should be established to maximize efficiency. A working diagnosis of STEMI (called the 'STEMI diagnosis' throughout this document) has to be made first. This is usually based on symptoms consistent with myocardial ischemia (i. e., persistent chest pain) and signs [i. e., 12-lead electrocardiogram (ECG)]. Important clues are a history of CAD and radiation of pain to the neck, lower jaw, or left arm. Some patients present with less-typical symptoms such as shortness of breath, nausea/vomiting, fatigue, palpitations, or syncope. A reduction in chest pain after nitroglycerin (glyceryl trinitrate) administration may be misleading and is not recommended as a diagnostic manoeuver. In the case of symptom relief after nitroglycerin administration, another 12-lead ECG should be obtained. Complete normalization of ST-segment elevation after nitroglycerin administration, along with complete relief of symptoms, is suggestive of a coronary spasm, with or without associated MI. In these cases, an early coronary angiography (within 24 h) is recommended. In case of a recurrent episode of ST-segment elevation or chest pain, immediate angiography is required.

It is recommended to initiate ECG monitoring as soon as possible in all patients with suspected STEMI in order to detect life-threatening arrhythmias and allow prompt defibrillation if indicated. When a STEMI is suspected, a 12-lead ECG should be obtained and interpreted as soon as possible at the time of FMC to facilitate early STEMI diagnosis and triage. In patients with a clinical suspicion of myocardial ischemia and ST-segment elevation, reperfusion therapy needs to be initiated as soon as possible. If the ECG findings are equivocal or do not show evidence to support the clinical suspicion of MI, ECGs should be repeated and, when possible, compared with previous recordings. If interpretation of pre-hospital ECG is not possible on-site, field transmission of the ECG is recommended.

In the proper clinical context, ST-segment elevation (measured at the J-point) is considered suggestive of ongoing acute occlusion of a coronary artery in the following cases: at least two

contiguous leads with ST-segment elevation ≥ 2.5 mm in men < 40 years, ≥ 2 mm in men > 40 years, or ≥ 1.5 mm in women in leads V2–V3 and/or ≥ 1 mm in the other leads (in the absence of left ventricular (LV) hypertrophy or left bundle branch block LBBB).

Table 14 – Indications for imaging and stress testing in STEMI patients [2]

Summary of indications for imaging and stress testing in ST-elevation myocardial infarction patients		
Recommendations	Class	Level
At presentation		
Emergency echocardiography is indicated in patients with cardiogenic shock and/or haemodynamic instability or suspected mechanical complications without postponing angiography.	I	C
Emergency echocardiography before coronary angiography should be considered if the diagnosis is uncertain.	IIa	C
Routine echocardiography that postpones emergency angiography is not recommended.	III	C
Coronary CT angiography is not recommended.	III	C
During hospital stay (after primary PCI)		
Routine echocardiography to assess resting LV and RV function, to detect early post-MI mechanical complications, and to exclude LV thrombus is recommended in all patients.	I	B
Emergency echocardiography is indicated in haemodynamically unstable patients.	I	C
When echocardiography is suboptimal/inconclusive, an alternative imaging method (CMR preferably) should be considered.	IIa	C
Either stress echocardiography, CMR, SPECT, or PET may be used to assess myocardial ischemia and viability, including in multivessel CAD.	IIb	C

In patients with inferior MI, it is recommended to record right precordial leads (V3R and V4R) seeking ST-segment elevation to identify concomitant right ventricular (RV) infarction. Likewise, ST-segment depression in leads V1–V3 suggests myocardial ischemia, especially when the terminal T-wave is positive (ST-segment elevation equivalent), and confirmation by concomitant

ST-segment elevation ≥ 0.5 mm recorded in leads V7–V9 should be considered as a means to identify posterior MI.

The presence of a Q-wave on the ECG should not necessarily change the reperfusion strategy decision.

The necessity for other visualization tests is shown in Table 14.

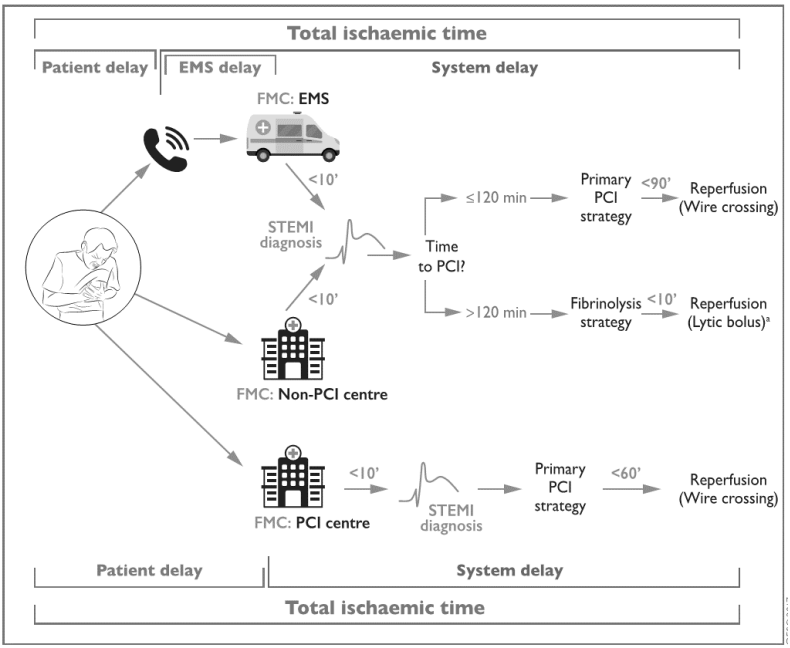


Figure 4 – Modes of patient presentation, components of ischemia time and flowchart for reperfusion strategy selection

Relief of pain, breathlessness, and anxiety:

- Oxygen is indicated in patients with hypoxemia (SaO2 < 90 % or PaO2 < 60 mmHg).
- Routine oxygen is not recommended in patients with SaO2 > 90 %.
- Titrated IV opioids should be considered to relieve pain.
- In patients following cardiac arrest and ST-segment elevation on the ECG, primary PCI is the strategy of choice.

Pre-hospital logistic of care

Components of the ischemia time, delays of initial management, and selection of reperfusion strategy are shown in Figure 4.

To shorten time to treatment, fibrinolysis should be administered in the pre-hospital setting, if possible. If the reperfusion strategy is fibrinolysis, the goal is to inject the bolus of fibrinolytics within 10 min after STEMI is diagnosed. STEMI diagnosis should be established within 10 min after the first medical contact (FMC) (Fig. 4).

Recommendations for reperfusion therapy:

1) reperfusion therapy is indicated for all patients with symptoms of ischemia of < 12 h duration and persistent ST-segment elevation; (IA)
2) a primary PCI strategy is recommended over fibrinolysis within indicated timeframes; (IA)
3) if timely primary PCI cannot be performed after STEMI diagnosis, fibrinolytic therapy is recommended within 12 h of symptom onset in patients without contraindications; (IA)
4) in the absence of ST-segment elevation, a primary PCI strategy is indicated in patients with suspected ongoing ischaemic symptoms suggestive of MI and at least one of the following criteria present:
   – haemodynamic instability or cardiogenic shock;
   – recurrent or ongoing chest pain refractory to medical treatment;
   – life-threatening arrhythmias or cardiac arrest;
   – mechanical complications of MI;
   – acute heart failure;
   – recurrent dynamic ST-segment or T-wave changes, particularly with intermittent ST-segment elevation. (IC)
5) early angiography (within 24 h) is recommended, if symptoms are completely relieved and ST-segment elevation is completely normalized spontaneously or after nitroglycerin administration (provided there is no recurrence of symptoms or ST-segment elevation); (IC)
6) in patients with >12 h after symptom onset, a primary PCI strategy is indicated in the presence of ongoing symptoms suggestive of ischemia, haemodynamic instability, or life-threatening arrhythmias; (IC)

7) a routine primary PCI strategy should be considered in patients presenting late (12–48 h) after symptom onset; (II a)
8) in asymptomatic patients, routine PCI of an occluded IRA > 48 h after onset of STEMI is not indicated. (III A)

Reperfusion therapy

Primary PCI is the preferred reperfusion strategy in patients with STEMI within 12 h of symptom onset, provided it can be performed expeditiously (i. e.,within 120 min after STEMI diagnosis, Figures 3) by an experienced team. An experienced team includes not only interventional cardiologists, but also skilled support.

The main terms related to reperfusion therapy are listed in Table 15, 16.

Table 15 – Definitions of terms related to reperfusion therapy [2]

Term	Definition
FMC	The time point when a patient is initially assessed by a physician, paramedic, nurse, or other trained personnel who can obtain and interpret the ECG results and deliver initial interventions (e. g., defibrillation). FMC can be either in the prehospital setting or upon the patient's arrival at the hospital (e. g., emergency department)
STEMI diagnosis	The time at which the ECG of a patient with ischaemic symptoms is interpreted as presenting ST-segment elevation or equivalent
Primary PCI	Emergent coronary angiography and PCI of the IRA if indicated. Emergent PCI with balloon, stent, or other approved device, performed on the IRA without previous fibrinolytic treatment
	Emergent coronary angiography and PCI of the IRA if indicated
Rescue PCI	Emergent PCI performed as soon as possible in the case of failed fibrinolytic treatment
Routine early PCI strategy after fibrinolysis	Coronary angiography, with PCI of the IRA, if indicated, performed between 2 and 24 hours after successful fibrinolysis
Pharmacoinvasive strategy	Fibrinolysis combined with rescue PCI (in case of failed fibrinolysis) or routine early PCI strategy (in case of successful fibrinolysis).

Primary percutaneous coronary intervention and adjunctive therapy

Radial access was associated with lower risks of access site bleeding, vascular complications, and need for transfusion.

Compared with balloon angioplasty alone, stenting with a bare-metal stent (BMS) is associated with a lower risk of reinfarction and target vessel revascularization but is not associated with a reduction in the mortality rate. In primary PCI, drug-eluting stents (DES) reduce the risk of repeated target vessel revascularization compared with BMS. New-generation DES have shown superior safety and preserved or even improved efficacy compared with first-generation DES, in particular with respect to lower risks of stent thrombosis and recurrent MI.

Table 16 – Summary of important time targets [2]

Intervals	Time strategy
Maximum time from FMC to ECG and diagnosis	≤ 10 min
Maximum expected delay from STEMI diagnosis to primary PCI (wire crossing) for choosing primary PCI strategy over fibrinolysis (if this target time cannot be met, fibrinolysis is considered)	≤ 120 min
Maximum time from STEMI diagnosis to wire crossing in the patient presenting at primary PCI hospitals	≤ 60 min
Maximum time from STEMI diagnosis to wire crossing in transferred patients	≤ 90 min
Maximum time from STEMI diagnosis to bolus or infusion start of fibrinolysis in patients unable to meet primary PCI target times	≤ 10 min
The time delay from the start of fibrinolysis to the evaluation of its efficacy (success or failure)	60–90 min
The time delay from the start of fibrinolysis to angiography (if fibrinolysis is successful).	2–24 hours

Routine thrombus aspiration is not recommended, but in cases of large residual thrombus burden after opening the vessel with a guidewire or a balloon, thrombus aspiration may be considered.

Routine revascularization of non-infarct-related artery (non-IRA) lesions should be considered in STEMI patients with multivessel disease before hospital discharge.

Non-IRA PCI during the index procedure should be considered in patients with cardiogenic shock.

CABG should be considered in patients with ongoing ischemia and large areas of jeopardized myocardium if PCI of the IRA cannot be performed.

Periprocedural pharmacotherapy includes:

Antiplatelet therapy

Patients undergoing primary PCI should receive DAPT, a combination of aspirin and a P2Y12 inhibitor, and a parenteral anticoagulant.

Anticoagulation

Anticoagulation is recommended in patients treated with thrombolytics until revascularization (if performed) or for the duration of the hospital stay up to 8 days.

Doses of anticoagulants are provided in Table 17, 18.

Table 17 – Doses of antiplatelet and parenteral anticoagulant co-therapies in primary percutaneous coronary intervention [2]

Aspirin	Loading dose 150–300 mg orally or 75–250 mg IV if oral administration is not possible, followed by a maintenance dose of 75–100 mg/day
Clopidogrel	Loading dose 600 mg orally, followed by a maintenance dose of 75–100 mg/day
Prasugrel	Loading dose 60 mg orally, followed by a maintenance dose of 10 mg/day
Ticagrelor	Loading dose 180 mg orally, followed by a maintenance dose of 90 mg twice a day
Bivalirudin	0.75 mg/kg IV bolus followed by infusion of 1.75 mg/kg/h for up to 4 hours after procedure
Enoxaparin	0.5 mg/kg IV bolus.

Recommendations:

1) anticoagulation is recommended for all patients in addition to antiplatelet therapy during primary PCI; (IC)
2) routine use of UFH is recommended; (IC)
3) in patients with heparin-induced thrombocytopenia, bivalirudin is recommended as an anticoagulant agent during primary PCI; (IC)
4) routine use of enoxaparin IV should be considered; (IIA)
5) routine use of bivalirudin should be considered; (IIa)
6) fondaparinux is not recommended for primary PCI. (III)

Table 18 – Doses of antiplatelet and parenteral anticoagulants in patients not receiving reperfusion therapy [2]

Aspirin	Loading dose 150–300 mg orally, followed by a maintenance dose of 75–100 mg/day
Clopidogrel	Loading dose 300 mg orally, followed by a maintenance dose of 75 mg/day
UFH	Same dose as with fibrinolytic therapy (See Table 19)
Enoxaparin	Same dose as with fibrinolytic therapy (See Table 19)
Fondaparinux	Same dose as with fibrinolytic therapy (See Table 19).

Fibrinolysis and pharmacoinvasive strategy

Fibrinolytic therapy is recommended within 12 h of symptom onset if primary PCI cannot be performed within 120 min from STEMI diagnosis, and if there are no contraindications (Table 19).

This is a valid treatment option in patients with STEMI only.

Time plays an important role regarding the benefit of thrombolysis. The greatest benefit of fibrinolytic treatment is achieved within the first 2 h. Fibrinolysis is not recommended later than twelve hours after the onset of chest pain and is associated with an increased incidence of serious complications such as cardiac rupture.

Recommendations:

1) when fibrinolysis is the reperfusion strategy, it is recommended to initiate this treatment as soon as possible

after STEMI diagnosis, preferably in the pre-hospital setting. (IA).

2) a fibrin-specific agent (i.e.,tenecteplase, alteplase, or reteplase) is recommended. (IB).

3) a half-dose of tenecteplase should be considered in patients older than 75 years of age.(IIa)

Antiplatelet co-therapy with fibrinolysis:

4) oral or IV aspirin is indicated. (IB)

5) clopidogrel is indicated in addition to aspirin. (IA)

6) DAPT (in the form of aspirin plus a P2Y12 inhibitor) is indicated for up to 1 year in patients undergoing fibrinolysis and subsequent PCI. (I)

7) anticoagulation co-therapy with fibrinolysis.

Anticoagulation is recommended in patients treated with thrombolytics until revascularization (if available) or for the duration of the hospital stay up to 8 days. The anticoagulants include:

– enoxaparin IV, followed by SC administration (preferred over UFH);

– UFH given as a weight-adjusted IV bolus followed by infusion;

– in patients treated with streptokinase: fondaparinux IV bolus followed by SC dose 24 h later. (IA)

Interventions following fibrinolysis.

9) emergency angiography and PCI, if indicated, are recommended in patients with heart failure/shock; (IA)

10) rescue PCI is indicated immediately if fibrinolysis has failed (<50% ST-segment resolution at 60–90 min) or at any time in the presence of haemodynamic or electrical instability, or worsening ischemia; (IA)

11) angiography and PCI of the IRA, if indicated, is recommended between 2 and 24 h after successful fibrinolysis; (IA)

12) emergency angiography and PCI, if needed, is indicated in the case of recurrent ischemia or evidence of reocclusion after initial successful fibrinolysis. (IB)

Table 19 – Drugs for fibrinolysis therapy and co-therapy in patients with STEMI [2]

Drug	Initial treatment
Streptokinase	1.5 million units over 30–60 min IV
Alteplase (tPA)	15 mg IV bolus 0.75 mg/kg IV over 30 min (up to 50 mg), then 0.5 mg/kg IV over 60 min (up to 35 mg)
Reteplase (rPA)	10 units + 10 units IV bolus given 30 min apart
Tenecteplase (TNK-tPA)	Single IV bolus: 30 mg (6 000 IU) if < 60 kg; 35 mg (7 000 IU) if 60 to < 70 kg 40 mg (8 000 IU) if 70 to < 80 kg; 45 mg (9 000 IU) if 80 to < 90 kg; 50 mg (10 000 IU) if ⩾ 90 kg It is recommended to reduce to half-dose in patients ⩾ 75 years
Aspirin	Starting dose of 150–300 mg orally (or 75–250 mg intravenously if oral administration is not possible), followed by a maintenance dose of 75–100 mg/day
Clopidogrel	Loading dose of 300 mg orally, followed by a maintenance dose of 75 mg/day. In patients ⩾ 75 years of age: loading dose of 75 mg, followed by a maintenance dose of 75 mg/day
Enoxaparin	In patients < 75 years of age: 30 mg IV bolus, followed 15 min later by 1 mg/kg SC every 12 hours until revascularization or hospital discharge for a maximum of 8 days. The first two SC doses should not exceed 100 mg per injection. In patients ⩾ 75 years of age: no IV bolus; start with the first SC dose of 75 mg/day with a maximum of 75 mg per injection for the first two SC doses. In patients with eGFR < 30mL/min/1.73 m^2, regardless of age: SC dose is given once every 24 hours
UFN	60 IU/kg IV bolus with a maximum of 4000 IU, followed by an IV infusion of 12 IU/kg with a maximum of 1000 IU/hour for 24–48 hours. Target aPTT: 50–70 s or 1.5 to 2.0 times the control value – to be monitored at 3, 6, 12 and 24 hours
Fondaparinux (only with streptokinase)	2.5 mg IV bolus, followed by SC dose of 2.5 mg once daily up to 8 days or until hospital discharge.

aPTT = activated partial thromboplastin time; eGFR = estimated glomerular filtration rate; IV = intravenous; IU = international units; rPA = recombinant plasminogen activator; SC = subcutaneous; tPA = tissue plasminogen activator; UFN = unfractionated heparin.

Contraindications to fibrinolytic therapy:

Absolute contraindications to thrombolysis:

- gastrointestinal bleeding within the past month;
- aortic dissection;
- central nervous system injury and/or intracranial neoplasm or arteriovenous malformation;
- previous haemorrhagic stroke;
- previous ischaemic stroke within the past 6 months;
- recent trauma and/or surgery within the preceding month;
- known bleeding disorders;
- non-compressible punctures in the past 24 hours.

Relative contraindications to thrombolysis:

- transient ischemic attack in the preceding 6 months;
- oral anticoagulant therapy;
- refractory hypertension (SBP >180 and/or DBP > 110);
- advanced liver disease;
- prolonged (> 10 min) cardiopulmonary resuscitation;
- pregnancy or within 1 week postpartum;
- active peptic ulcer;
- infective endocarditis.

Coronary artery bypass graft surgery

Emergent coronary artery bypass graft surgery (CABG) should be considered for patients with a patent IRA but with unsuitable anatomy for PCI, and either a large myocardial area at jeopardy or with cardiogenic shock. In patients with MI-related mechanical complications who require coronary revascularization, CABG is recommended at the time of repair. In STEMI patients with failed PCI or coronary occlusion not amenable to PCI, emergent CABG is infrequently performed because the benefits of surgical revascularization in this setting are uncertain.

Patients with haemodynamic deterioration or who are at high risk of recurrent ischaemic events (i. e., patients with a large area of myocardium at jeopardy due to critical coronary stenoses or recurrent ischemia) should be operated on as soon as possible without waiting for the full recovery of platelet function following

discontinuation of DAPT. For all other patients, a waiting period of 3–7 days may be the best compromise (at least 3 days following interruption of ticagrelor, 5 days for clopidogrel, and 7 days for prasugrel), while it is recommended that aspirin is continued. The first aspirin administration post-CABG is recommended 6–24 h after surgery in the absence of ongoing bleeding events.

Other co- therapies in acute, subacute, and long-term phases are described in Table 20.

Table 20 – Other co-therapies in acute, subacute, and long-term phases of STEMI [2]

Routine therapies in the acute, subacute, and long-term phases: beta-blockers, angiotensin-converting enzyme inhibitors, angiotensin II receptor blockers, mineralocorticoid receptor antagonist, and lipid-lowering treatments after ST-elevation myocardial infarction		
Recommendations	Class	Level
Beta-blockers		
Oral treatment with beta-blockers is indicated in patients with heart failure and/or LVEF ≤ 40 %, unless contraindicated	I	A
Intravenous beta-blockers should be considered at the time of presentation in patients undergoing primary PCI without contraindications, with no signs of acute heart failure, and with an SBP > 120 mmHg	IIa	A
Routine oral treatment with beta-blockers should be considered during hospital stay and continued thereafter in all patients without contraindications	IIa	B
Intravenous beta-blockers should be avoided in patients with hypotension, acute heart failure or AV block, or severe bradycardia	III	B
Lipid lowering therapies		
It is recommended to start high-intensity statin therapy as early as possible, unless contraindicated, and maintain it long-term	I	A
An LDL-C goal of < 1.4 mmol/L (55mg/dL) or a reduction of at least 50 %, if the baseline LDL-C is between 1.8–3.5 mmol/L (70–135 mg/dL), is recommended	I	B
It is recommended to obtain a lipid profile in all STEMI patients as soon as possible after presentation	I	C
In patients with LDL-C ≥ 1.4 mmol/L (≥ 55 mg/dL) despite a maximally tolerated statin dose who remain at high risk, further therapy to reduce LDL-C should be considered	IIa	A

Continuation of table 20

ACE inhibitors/ARBs		
ACE inhibitors are recommended, starting within the first 24 h of STEMI in patients with evidence of heart failure, LV systolic dysfunction, diabetes, or an anterior infarct	I	A
An ARB, preferably valsartan, is an alternative to ACE inhibitors in patients with heart failure and/or LV systolic dysfunction, particularly those who are intolerant of ACE inhibitors	I	B
ACE inhibitors should be considered in all patients in the absence of contraindications	IIa	A
MRAs		
MRAs are recommended in patients with LVEF ≤ 40 % and heart failure or diabetes, who are already receiving an ACE inhibitor and a beta-blocker, provided there is no renal failure or hyperkalemia.	I	B

High-intensity statins are atorvastatin 40–80 mg and rosuvastatin 20–40 mg.

Several complications may occur in a patient with MI, such as left ventricular dysfunction and acute heart failure.

See Table 21 for additional therapy for the management of left ventricular dysfunction and acute heart failure in STEMI and Table 21 for the management of cardiogenic shock in ST-elevation myocardial infarction patients.

Table 21 – Co-therapy for the management of left ventricular dysfunction and acute heart failure in STEMI [2]

Recommendations for the management of left ventricular dysfunction and acute heart failure in ST-elevation myocardial infarction		
Recommendations	Class	Level
ACE inhibitors (or, if not tolerated, ARB) therapy is indicated for all patients with evidence of LVEF ≤ 40 % and/or heart failure as soon as they are haemodynamically stable to reduce the risk of hospitalization and death	I	A
Beta-blockers therapy is recommended in patients with LVEF ≤ 40 % and/or heart failure after stabilization to reduce the risk of death, recurrent MI, and hospitalization for heart failure	I	A

Continuation of Table 21

MRA is recommended in patients with heart failure and LVEF ≤ 40 % with no severe renal failure or hyperkalemia to reduce the risk of cardiovascular hospitalization and death	I	B
Loop diuretics are recommended in patients with acute heart failure with symptoms/signs of fluid overload to improve symptoms	I	C
Nitrates are recommended in patients with symptomatic heart failure with SBP > 90 mmHg to improve symptoms and reduce congestion	I	C
Oxygen is indicated in patients with pulmonary edema with SaO_2 < 90 % to maintain saturation at > 95 %	I	C
Patient intubation is indicated in patients with respiratory failure or exhaustion leading to hypoxemia, hypercapnia, or acidosis, and if not-invasive ventilation is not tolerated	I	C
Non-invasive positive pressure ventilation (continuous positive airway pressure, biphasic positive airway pressure) should be considered in patients with respiratory distress (respiratory rate > 25 breaths/min, SaO_2 < 90 %) without hypotension	IIa	B
Intravenous nitrates or sodium nitroprusside should be considered in patients with heart failure and elevated SBP to control blood pressure and improve symptoms	IIa	C
Opiates may be considered to relieve dyspnea and anxiety in patients with pulmonary edema and severe dyspnea. Respiration should be monitored	IIb	B
Inotropic agents may be considered in patients with severe heart failure with hypotension refractory to standard medical treatment	IIb	C
Either stress echocardiography, CMR, SPECT, or PET may be used to assess myocardial ischemia and viability, including in multivessel CAD	IIb	C

Table 22 – Therapy for the management of cardiogenic shock in ST-elevation myocardial infarction [2]

Recommendations for the management of cardiogenic shock in ST-elevation myocardial infarction		
Recommendations	Class	Level
Immediate PCI is indicated for patients with cardiogenic shock, if coronary anatomy is suitable. If coronary anatomy is not suitable for PCI, or PCI has failed, emergency CABG is recommended	I	B

Continuation of Table 22

Invasive blood pressure monitoring with an arterial line is recommended	I	C
Immediate Doppler echocardiography is indicated to assess ventricular and valvular function, loading conditions, and to detect mechanical complications	I	C
It is indicated that mechanical complications are treated as early as possible after discussion by the Heart Team	I	C
Oxygen/mechanical respiratory support is indicated according to blood gases	I	C
Fibrinolysis should be considered in patients presenting with cardiogenic shock if a primary PCI strategy is not available within 120 min from STEMI diagnosis and mechanical complications have been ruled out	IIa	C
Complete revascularization during the index procedure should be considered in patients presenting with cardiogenic shock	IIa	C
Intra-aortic balloon pumping should be considered in patients with haemodynamic instability/cardiogenic shock due to mechanical complications	IIa	C
Haemodynamic assessment with a pulmonary artery catheter may be considered for confirming the diagnosis or guiding therapy	IIb	B
Ultrafiltration may be considered for patients with refractory congestion, who failed to respond to diuretic-based strategies	IIb	B
Inotropic/vasopressor agents may be considered for haemodynamic stabilization	IIb	C
Short-term mechanical support may be considered in patients in refractory shock	IIb	C
Routine intra-aortic balloon pumping is not indicated.	III	B

Sinus bradycardia and atrioventricular block

Sinus bradycardia is common in the first hours of STEMI, especially in inferior MI. In some cases, opioids are responsible. It often requires no treatment. If accompanied by severe hypotension, sinus bradycardia should be treated with IV atropine.

AV block associated with inferior wall infarction is usually suprahisian and usually resolves spontaneously or after reperfusion. AV block associated with anterior wall MI is usually infrahisian and has a high mortality rate due to the extensive myocardial necrosis. The development of a new bundle branch block or hemiblock usually

indicates extensive anterior MI. A transvenous pacing electrode should be inserted in the presence of advanced AV block with a low escape rhythm, as described above, and considered if bifascicular or trifascicular block develops.

Long-term therapies for ST-segment elevation myocardial infarction

1) Lifestyle interventions and risk factor control.

Key lifestyle interventions include cessation of smoking, optimal blood pressure control (a target of < 120 mmHg may be considered, but systolic blood pressure (SBP) target of < 140 mmHg in the patients at a very high risk who tolerate multiple blood pressure lowering drugs, diet advice and weight control, and encouraging physical activity. It is recommended to identify smokers and provide repeated advice on stopping, offering help with follow-up support, nicotine replacement therapies, varenicline, and bupropion individually or in combination.

Current guidelines on prevention recommend:

(1) a diet similar to the Mediterranean diet, which includes a maximum of 10% of total energy intake from saturated fat, by replacing it with polyunsaturated fatty acids and as little as possible of trans fatty acids;

(2) salt intake of < 5 g per day;

(3) 30–45 g fiber per day;

(4) 200 g fruits and 200 g vegetables per day;

(5) fish 1–2 times per week (especially oily varieties);

(6) 30 g unsalted nuts daily;

(7) limited alcohol intake [maximum of 2 glasses (20 g of alcohol) daily for men and 1 for women]; and

(8) discouraging sugar-sweetened drinks.

2) Antiplatelet therapy with low-dose aspirin (75–100 mg) is indicated. DAPT, combining aspirin and a P2Y12 inhibitor (i. e., prasugrel, ticagrelor, or clopidogrel), is recommended in patients with STEMI who are undergoing primary PCI (for up to 12 months). Extension of DAPT beyond 1 year (up to 3 years) in the form of aspirin plus ticagrelor 60 mg b. i .d. may be considered in patients who have tolerated DAPT

without a bleeding complication and having one additional risk factor for ischaemic events.

3) Gastric protection with a PPI is recommended for patients with a history of gastrointestinal bleeding and is appropriate for patients with multiple risk factors for bleeding, such as advanced age, concurrent use of anticoagulants, steroids or nonsteroidal anti-inflammatory drugs, including high-dose aspirin, and Helicobacter pylori infection.
4) Beta-blockers are recommended in patients with reduced systolic LV function (LVEF < 40 %), in the absence of contraindications such as acute heart failure, haemodynamic instability, or higher degree AV block. Routine oral treatment with beta-blockers should be considered during the hospital stay and continued after that in all patients without contraindications.
5) Lipid-lowering therapy.
   The treatment goal is an LDL-C concentration of < 1.4 mmol/L (< 55 mg/dL), an LDL-C reduction of ≥ 50 % from baseline. It is recommended to start high-intensity statin therapy as early as possible, unless contraindicated, and maintain it long-term.
   In patients known to be intolerant of any dose of statin, treatment with ezetimibe should be considered. Adding proprotein convertase subtilisin/kexin type 9 (PCSK9) inhibitors to a statin dose, and ezetimibe also have beneficial effects on triglycerides and HDL.

Myocardial infarction with non-obstructive coronary arteries

A sizeable proportion of MIs, ranging between 1–14 %, occur in the absence of obstructive (> 50 % stenosis) CAD. The demonstration of non-obstructive (< 50 %) CAD in a patient presenting with symptoms suggestive of ischemia and ST-segment elevation or equivalent does not preclude an atherothrombosis etiology, as thrombosis is a very dynamic phenomenon and the underlying atherosclerotic plaque can be non-obstructive. MINOCA is a working diagnosis and should lead the treating physician to

investigate underlying causes. Failure to identify the underlying cause may result in inadequate and inappropriate therapy in these patients.

The diagnosis of MINOCA is made immediately upon coronary angiography in a patient presenting with features consistent with an AMI, as detailed by the following criteria:

1) universal AMI criteria;
2) non- obstructive coronary arteries on angiography, defined as no coronary stenosis ≥ 50 % in any potential infarct-related artery;
3) no clinically overt specific cause for the acute presentation.

The description of the pathophysiology of the different etiological entities leading to MINOCA is beyond the scope of the present document, and has been extensively described and defined in position papers from the ESC and in dedicated review papers. MINOCA patients can fulfill the criteria for both MI type 1 and type 2 according to the universal definition of MI.

There are disparate etiologies causing MINOCA and they can be grouped into:

1) secondary to epicardial coronary artery disorders (e. g., atherosclerotic plaque rupture, ulceration, fissuring, erosion, or coronary dissection with non-obstructive or no CAD) (MI type 1);

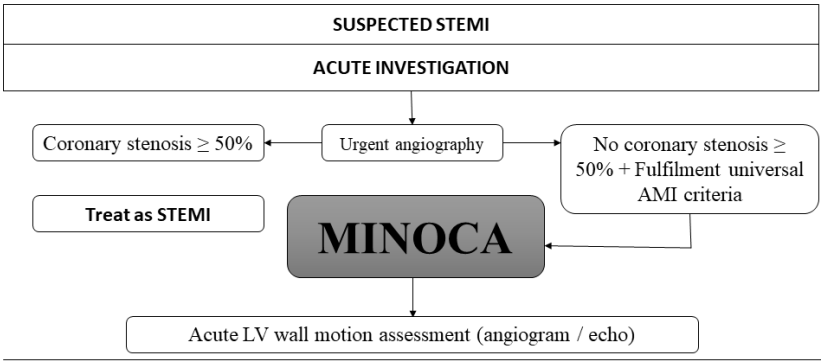
2) imbalance between oxygen supply and demand (e. g., coronary artery spasm and coronary embolism) (MI type 2);

3) coronary endothelial dysfunction (e. g., microvascular spasm) (MI type 2);

4) secondary to myocardial disorders without the involvement of the coronary arteries (e. g., myocarditis or Takotsubo syndrome).

The last two entities may mimic MI but are better classified as myocardial injury conditions. The identification of the underlying cause of MINOCA should lead to specific treatment strategies. Although the outcome of MINOCA strongly depends on the underlying cause, its overall prognosis is serious, with a 1-year mortality of about 3.5 %.

To determine the cause of MINOCA, the use of additional diagnostic tests beyond coronary angiography is recommended. In general, after ruling out obstructive CAD in a patient presenting with STEMI, an LV angiogram or echocardiography should be considered in the acute setting to assess wall motion or pericardial effusion. In addition, if any of the possible etiologies described above is suspected, additional diagnostic tests may be considered. CMR is a very helpful imaging technique due to its unique noninvasive tissue characterization, allowing the identification of wall motion abnormalities, presence of edema, and myocardial scar/fibrosis presence and pattern. Performance of CMR within 2 weeks after onset of symptoms should be considered to increase the diagnostic accuracy of the test for identifying the etiological cause of MINOCA (Fig. 5)



Suspected diagnosis and further diagnosis tests

	Non-invasive	Invasive
Myocarditis	**TTE Echo** (pericardial effusion) **CMR** (myocarditis, pericarditis)	**Endomyocardial biopsy** (myocarditis)
Coronary (epicardial/ microvascular)	**TTE Echo** (Regional wall motion abnormalities, embolic source) **CMR** (small infarction) **TOE/Bubble Contrast Echo** (Patent foramen ovale, atrial septal defect)	**IVUS/OCT** (plaque disruption/dissection) **Ergonovine/Ach test'** (spasm) **Pressure/Doppler wire** (microvascular dysfunction)
Myocardial disease	**TTE Echo** **CMR** (Takotsubo, others)	
Pulmonary Embolism	**D-dimer** (Pulmonary embolism) **CT scan** (Pulmonary embolism) **Thrombophilia screen**	
Oxygen supply/demand imbalance-Type 2 MI	**Blood tests, Extracardiac investigation**	

Figure 5 – Diagnostic test flowchart in MINOCA [2]

TESTS

1. **What clinical conditions are united by the term "acute coronary syndrome"?**
   a. myocardial infarction with ST-segment elevation;
   b. myocardial infarction without ST-segment elevation;
   c. unstable angina;
   d. all the above.

2. The leading mechanism for the development of acute coronary syndromes is:
   a. interstitial myocardial fibrosis;
   b. stable atherosclerotic plaque;
   c. diffuse cardiosclerosis;
   d. atherothrombosis, an unstable atherosclerotic plaque.

3. ECG criteria for acute myocardial ischemia:

a. new ST-elevation at the J-point in two contiguous leads with the cut-point ≥ 1 mm in all leads other than V2–V3 where the following cut-points apply: ≥ 2 mm in men ≥ 40 years; ≥ 2.5 mm in men < 40 years, or ≥ 1.5 mm in women regardless of age;

b. new ST- depression at the J-point in two contiguous leads with the cut-point ≥ 1 mm in all leads other than V2–V3 where the following cut-points apply: ≥ 2 mm in men ≥40 years; ≥ 2.5 mm in men < 40 years, or ≥ 1.5 mm in women regardless of age;

c. new horizontal or downsloping ST-elevation ≥ 0.5 mm in two contiguous leads and/or T inversion in two contiguous leads with prominent R wave or R/S ratio > 1;

d. new ST-elevation at the J-point in two contiguous leads with the cut-point ≥ 2 mm in all leads other than V2–V3 where the following cut-points apply: ≥ 2.5 mm in men ≥ 40 years; ≥ 3 mm in men < 40 years, or ≥ 2 mm in women regardless of age.

4. Over what time period ECG should be made and interpreted after the first medical contact of a patient with suspected ACS?
   a. in the first 10 minutes;
   b. in the first 30 minutes;
   c. in the first 60 minutes;
   d. in the first 120 minutes.

5. **What is the most cardiospecific and sensitive marker of myocardial injury?**

a. myoglobin;
b. CK-MB or creatine kinase (CK);
c. AST;
d. troponin T/I.

6. Over what time period after the onset of acute myocardial infarction, should we expect an increase in troponin level?

a. after 30 min;
b. after 3 hours;
c. after 120 min;
d. after 12 hours.

7. Oxygen is indicated for patients with ACS and:

a. hypoxaemia (SaO_2 < 95 % or PaO_2 60 % mmHg);
b. hypoxaemia (SaO_2 < 90 % or PaO_2 60 % mmHg);
c. hypoxaemia (SaO_2 < 80 % or PaO_2 60 % mmHg);
d. oxygen is indicated for all patients with ACS.

8. What does DAPT include?

a. aspirin + Clopidogrel;
b. aspirin + Heparin;
c. aspirin + Enoxaparin;
d. aspirin + Alteplase.

9. DAPT duration in patients after PCI:

a. lifelong;
b. the duration depends on the type of stent;
c. a minimum of 12 months, but the duration may be reconsidered depending on the risk of bleeding and ischemia;
d. a minimum of 6 months, but the duration may be reconsidered depending on the risk of bleeding and ischemia.

10. B-blockers in ACS are used to:

a. reduce myocardial oxygen demand and increase the blood supply of the myocardium;
b. reduce heart rate;
c. prolong diastole;
d. all of the above.

11. Fibrinolytic therapy for patients with acute coronary syndrome is indicated:

a. only with STEMI up to 12 hours;
b. only with NSTEMI up to 12 hours;

c. only with unstable angina up to 12 hours;

d. a working diagnosis of ACS is the basis for fibrinolytic therapy.

12. When is fibrinolytic therapy NOT indicated in a non-PCI-capable facility?

a. a 74-year-old female with a blood pressure of 160/100 during an inferior ST-elevation myocardial infarction;
b. a 68-year-old male with an anterior STEMI and a prior intracranial hemorrhage having occurred 5 years ago;
c. a 45-year-old male with 3 mm of ST-depression in leads V1–V3 with R:S ratio of > 1 in lead V1 and a peripheral artery disease;
d. an 88-year-old male with an anterior ST-elevation myocardial infarction and a prior ischemic stroke having occurred 5 years ago.

13. In the absence of ST-segment elevation, a primary PCI strategy is indicated in patients with suspected ongoing ischemic symptoms suggestive of MI and at least one of the following criteria present:

a. haemodynamic instability or cardiogenic shock;
b. premature supraventricular contractions;
c. chronic kidney disease;
d. arterial hypertension.

14. When fibrinolytic therapy ensures the best benefit?

a. first 2 hours after symptom onset;
b. up to 6 hours;
c. up to 12 hours;
d. up to 24 hours.

15. Indications for primary PCI:

a. NSTEMI, GRACE < 140;
b. unstable angina, GRACE < 140;
c. STEMI up to 24 hours;
d. STEMI up to 12 hours.

16. Maximum time for primary PCI in STEMI patients:

a. less than 120 minutes;
b. less than 60 minutes;
c. 24 hours after symptom onset;

d. 72 hours after symptom onset.

16. Syntax-SCORE helps to evaluate:

a. risk of bleeding in patients receiving DAPT;
b. risk of ischemic complications in patients receiving DAPT;
c. lesion volume/choice of revascularization tactics;
d. no correct answer.

18. The goal of nitrates indication in ACS patients is:

a. to decrease myocardial oxygen demand;
b. to relieve pain and increase the blood supply of the myocardium;
c. to prevent further thrombosis;
d. as a fibrinolytic therapy.

19. Doses of enoxaparin before PCI in STEMI patients of < 75 years of age:

a. 30 mg IV bolus, followed 15 min later by 1 mg/kg SC every 12 hours until revascularization or hospital discharge for a maximum of 8 days;
b. no IV bolus; start with the first SC dose of 75 mg/day with a maximum of 75 mg per injection for the first two SC doses;
c. 60 IU/kg IV bolus with a maximum of 4 000 IU, followed by IV infusion of 12 IU/kg with a maximum of 1 000 IU/hour for 24–48 hours;
d. 2.5 mg IV bolus, followed by a SC dose of 2.5 mg once daily up to 8 days or until hospital discharge.

20. What time is the safest for PCI after fibrinolytic therapy?

a. immediately after intravenous administration of a fibrinolytic drug;
b. 1 hour after intravenous administration of a fibrinolytic drug;
c. 2–3 hours after intravenous administration of a fibrinolytic drug;
d. after fibrinolysis, PCI is contraindicated due to the risk of bleeding and life-threatening arrhythmias.

21. What does "rescue PCI" mean?

a. it is performed within 60 minutes after the first medical contact;

b. it is performed within 120 minutes after the first medical contact;

c. it is performed in a patient with cardiogenic shock;

d. it is performed after failed fibrinolytic treatment.

22. What stages of primary PCI operation are recommended for patients with STEMI?

a. balloon angioplasty of all stenosed vessels;

b. balloon angioplasty and stenting of the infarct-related artery only;

c. balloon angioplasty and stenting of the artery, in which stenosis diameter is > 90 %;

d. balloon angioplasty, thrombus extraction and stenting of the infarct-related artery only.

23. **What is the goal of hypolipidemic therapy in patients after acute myocardial infarction?**

a. LDL-C < 1.4 mmol/L;

b. LDL-C < 1.8 mmol/L;

c. LDL-C < 1.6 mmol/L;

d. TG < 1.4 mmol/L.

24. What medications are indicated for patients with acute left ventricular failure to stabilize the condition?

a. nitrates, diuretics, beta-blockers, opiates;

b. nitrates, calcium channel antagonists, diuretics, ACE inhibitors;

c. opiates, diuretics, nitrates, oxygen;

d. opiates, oxygen, aspirin, heparin.

25. **What is the management strategy for a patient with myocardial infarction complicated by cardiogenic shock?**

a. urgent PCI;

b. urgent CABG;

c. urgent fibrinolysis within the first 120 minutes;

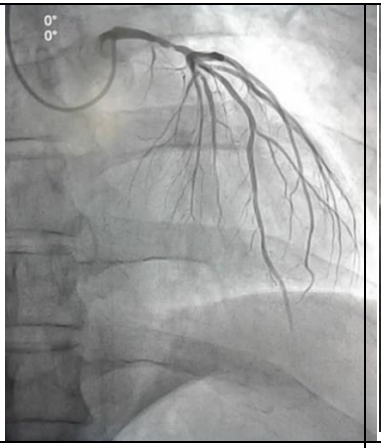
d. medical therapy to stabilize the condition, then PCI.

ANSWERS

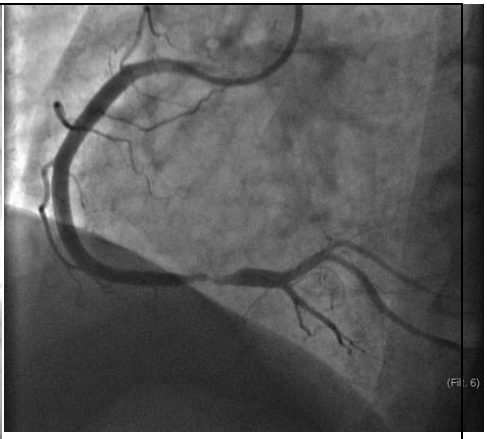
Question No.	Correct answer	Question No.	Correct answer
1.	D	13.	A
2	D	14.	D
3.	A	15.	D
4.	A	16	C
5.	D	17.	C
6.	B	18.	B
7.	B	19.	B
8.	A	20.	C
9.	C	21.	D
10.	D	22.	B
11.	A	23.	A
12.	B	24	C
		25.	A

Questions:

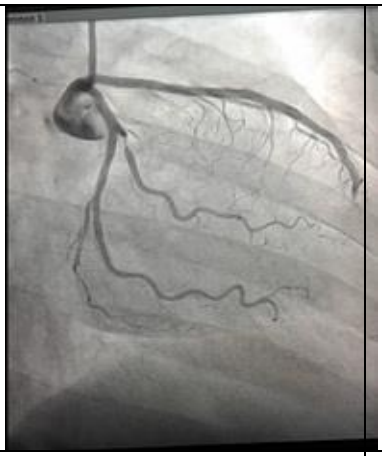
1. Describe the changes found in the coronary angiograms.
2. What diseases can occur in patients with such lesions?



Picture 1



Picture 2

	
Picture 3	

Correct answers:

Picture 1

1. Occlusion of the main trunk of the left coronary artery (80–85 %).
2. Acute appearance of these changes can lead to the development of anterior-lateral myocardial infarction.

Picture 2

1. Occlusion of the distal part of the right coronary artery by 95 %.
2. Acute appearance of these changes can be observed in a patient with posterior-inferior myocardial infarction.

Picture 3

1. Occlusion of the obtuse marginal artery (80–85 %).
2. These changes can lead to the development of stable angina or lateral myocardial infarction.

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Abbreviations and acronyms

ACS – acute coronary syndrome
AMI – acute myocardial infarction
aPTT – activated partial thromboplastin time
ARB – angiotensin II receptor blockers
CABG – coronary artery bypass graft surgery
CCS – Canadian Cardiovascular Society
CMR – cardiac magnetic resonance imaging
CT – computer tomography
DAPT – dual antiplatelet therapy
EAC – European Atherosclerosis Society
ECG – electrocardiogram
ECLS – extracorporeal life support
ECMO – extracorporeal membrane oxygenation
ESC – European Society of Cardiology
FMC – first medical contact
IRA – infarct-related artery
IVUS – intravascular ultrasound
LMWH – low molecular weight heparin
LV – left ventricle
LVEF – left ventricular ejection fraction
MINOCA – myocardial infarction with non-obstructive coronary arteries
MRA – mineralocorticoid receptor antagonists
NSTEMI – ST-segment elevation myocardial infarction
PCI – percutaneous coronary intervention
PET – positron emission tomography
OCT – optical coherence tomography
STEMI – ST-segment elevation myocardial infarction
TOE – trans-oesofageal echocardiography
TTE – trans-thoracic echocardiography
UNF – unfractionated heparin
URL – upper reference limit

Contents

Навчальне видання

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