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

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ESC GUIDELINES

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

The Task Force on the management of ST-segment elevation acute myocardial infarction of the European Society of Cardiology

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Preamble

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Classes of recommendations

Classes of recommendations	Definition	Suggested wording to use
Class I	Evidence and/or general agreement that a given treatment or procedure is beneficial, useful, effective.	Is recommmended/ 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 favour 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.

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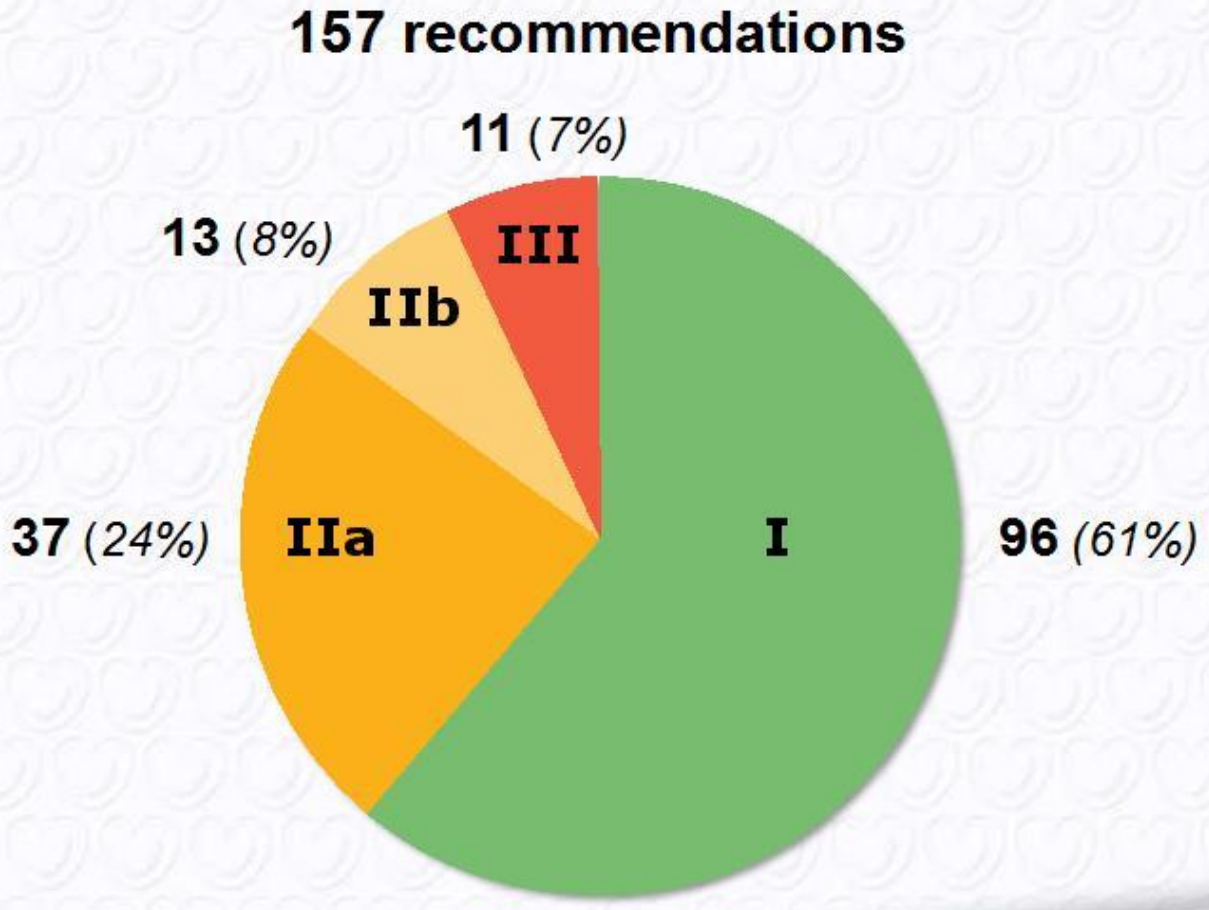
Classes of recommendation



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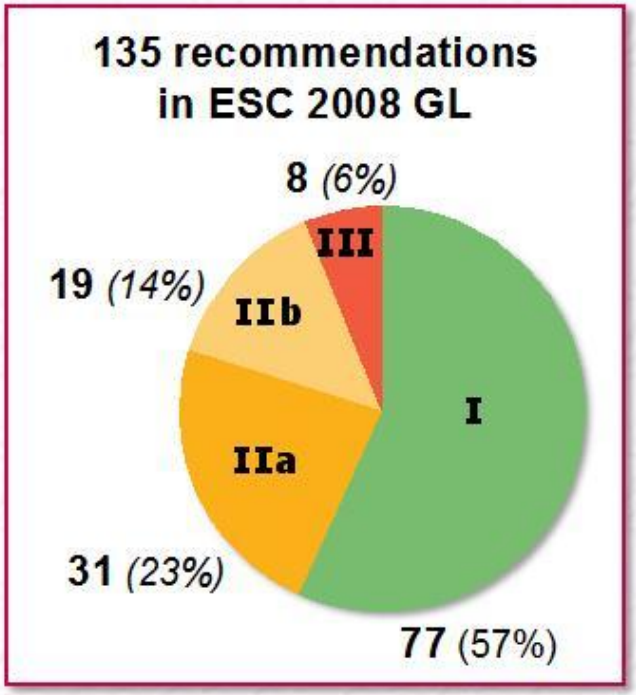

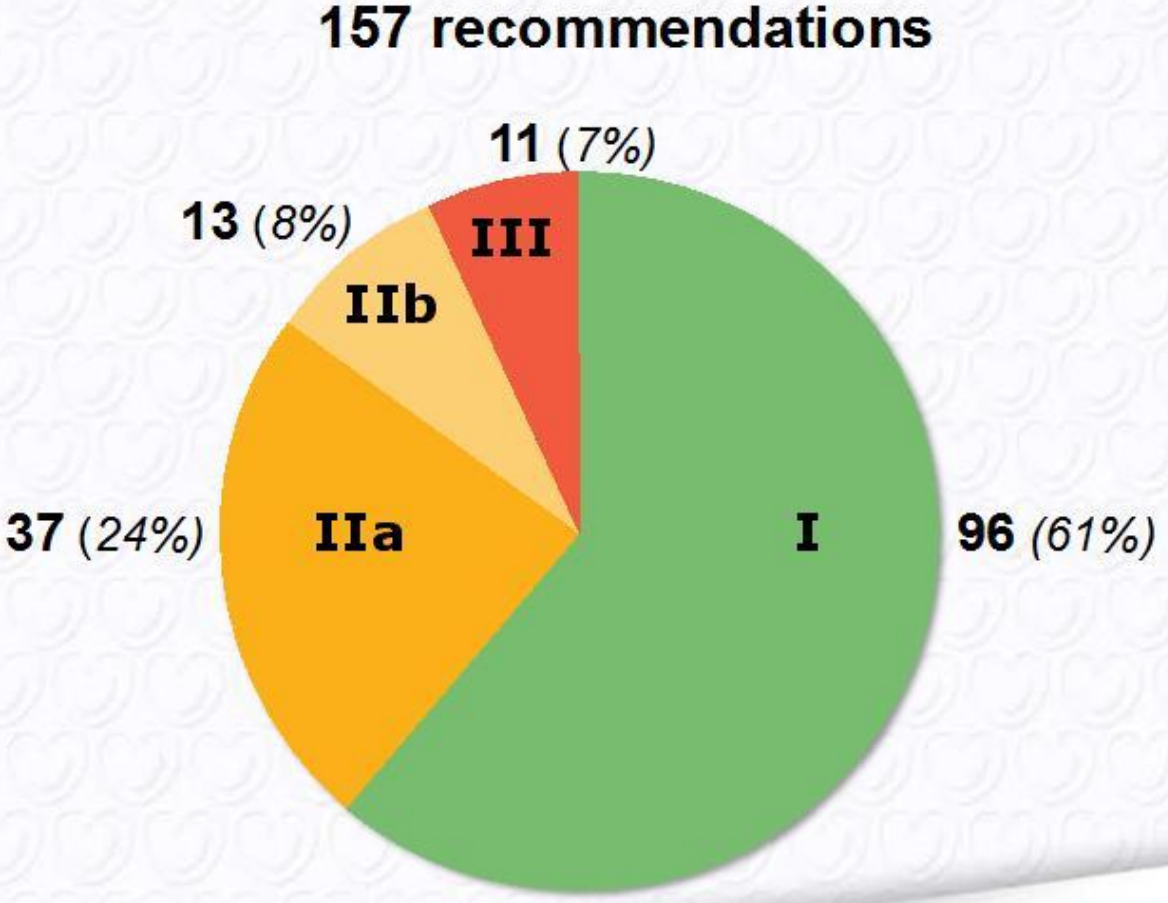

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Levels of evidence

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.

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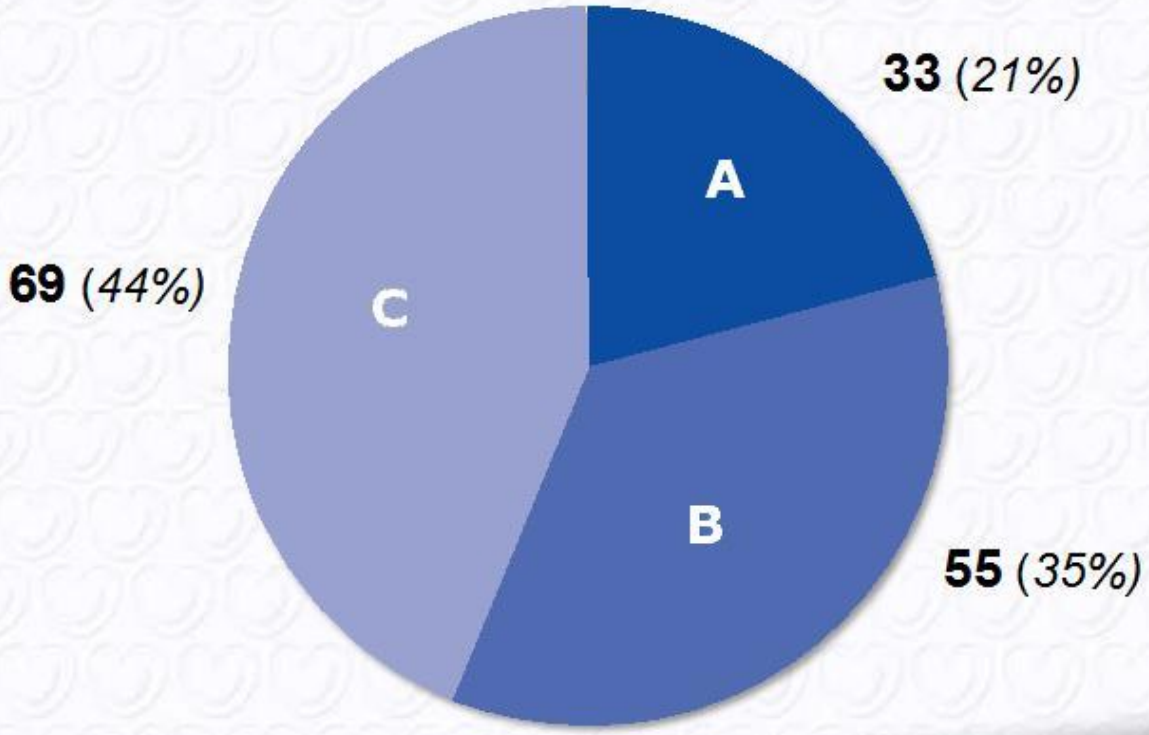
Levels of evidence

157 recommendations based on 346 references



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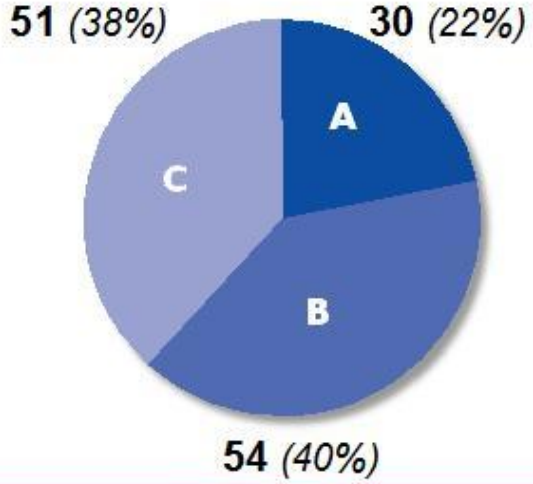
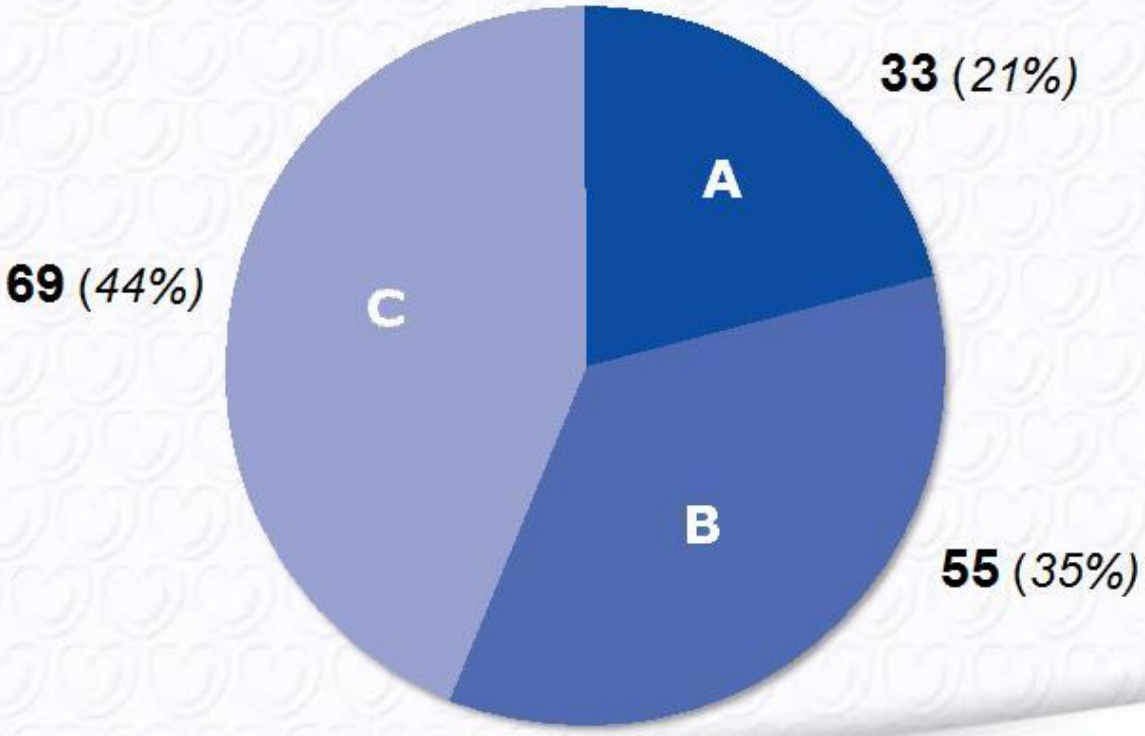
Levels of evidence

157 recommendations based on 346 references

ESC 2008 GL
135 recommendations based on 257 references





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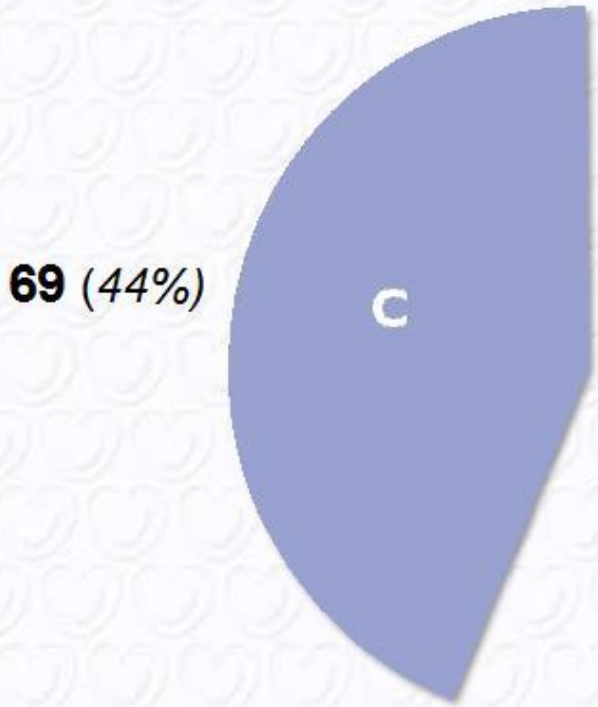
Levels of evidence

Remaining need for research



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Introduction

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What is new?

- **Early Diagnosis**
  - Expanded section, atypical presentations.
- **Cardiac Arrest**
  - Expanded section. The role of therapeutic hypothermia and angiography defined.
- **Pre Hospital Logistics of Care**
  - Expanded section, role of pre hospital diagnosis, triage and networks highlighted.
- **Reperfusion strategies**
  - Modified recommended maximal time delays.
- **PCI strategies**
  - Stent recommendations, anti thrombotic therapy.
- **Routine therapies and strategies**
  - Duration of hospital stay, secondary prevention, duration of anti thrombotic therapy, Evaluation of LV function and viability.

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Universal definition of myocardial infarction

Excluding myocardial infarction associated with revascularization procedures

- **Detection of rise and/or fall of cardiac biomarker values (preferably troponin) with at least one value above the 99th percentile of the upper reference limit and with at least one of the following:**
  - Symptoms of ischaemia;
  - New or presumably new significant ST-T changes or new LBBB;
  - Development of pathological Q waves in the ECG;
  - Imaging evidence of new loss of viable myocardium, or new regional wall motion abnormality;
  - Identification of an intracoronary thrombus by angiography or autopsy.
- **Cardiac death with symptoms suggestive of myocardial ischaemia, and presumably new ECG changes or new LBBB, but death occurring before blood cardiac biomarkers values are released or before cardiacbiomarker values would be increased.**
- **Stent thrombosis associated with MI when detected by coronary angiography or autopsy in the setting of myocardial ischaemia and with a rise and/or fall of cardiac biomarker values with at least one value above the 99th percentile URL.**

ECG = electrocardiogram; LBBB = left bundle branch block.

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Emergency care

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Recommendation for initial diagnosis

	Class	Level
A 12-lead ECG must be obtained as soon as possible at the point of FMC, with a target delay of ≤ 10 min.	I	B
ECG monitoring must be initiated as soon as possiblein all patients with suspected STEMI.	I	B
Blood sampling for serum markers is recommended routinely in the acute phase but one should not wait for the results before initiating reperfusion treatment.	I	C
The use of additional posterior chest wall leads (V7–V9 ≥ 0.05 mV) in patients with high suspicion of infero-basal myocardial infarction (circumflex occlusion) should be considered.	IIa	C
Echocardiography may assist in making the diagnosis in uncertain cases but should not delay transfer for angiography.	IIb	C

ECG = electrocardiogram; FMC = first medical contacts; STEMI = ST-segment elevation myocardial infarction.

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Atypical ECG presentations that deserve promt management in patients with signs and symptoms of ischemia

- LBBB.
- Ventricular paced rhythm.
- Patients without diagnostic ST-segment elevation but with persistent ischaemic symptoms.
- Isolated posterior myocardial infarction.
- ST-segment elevation in lead aVR.

ECG = electrocardiogram; LBBB = left bundle branch block.

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Relief of pain, breathlessness and anxiety

Recommendations	Class	Level
Titrated i.v. opioids are indicated to relieve pain.	I	C
Oxygen is indicated in patients with hypoxia (SaO_2 < 95%), breathlessness, or acute heart failure.	I	C
Tranquillizer may be considered in very anxious patients.	IIa	C

i.v. = intravenous; SaO2 = saturated oxygen.

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Cardiac arrest

Recommendations	Class	Level
All medical and paramedical personnel caring for a patient with suspected myocardial infarction must have access to defibrillation equipment and be trained in cardiac life support.	I	C
It is recommended to initiate ECG monitoring at the point of FMC in all patients with suspected myocardial infarction.	I	C
Therapeutic hypothermia is indicated early after resuscitation of cardiac arrest patients who are comatose or in deep sedation.	I	B
Immediate angiography with a view to primary PCI is recommended in patients with resuscitated cardiac arrest whose ECG shows STEMI.	I	B
Immediate angiography with a view to primary PCI should be considered in survivors of cardiac arrest without diagnostic ECG ST-segment elevation but with a high suspicion of ongoing infarction.	IIa	B

ECG = electrocardiogram; FMC = first medical contacts; PCI = percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction.

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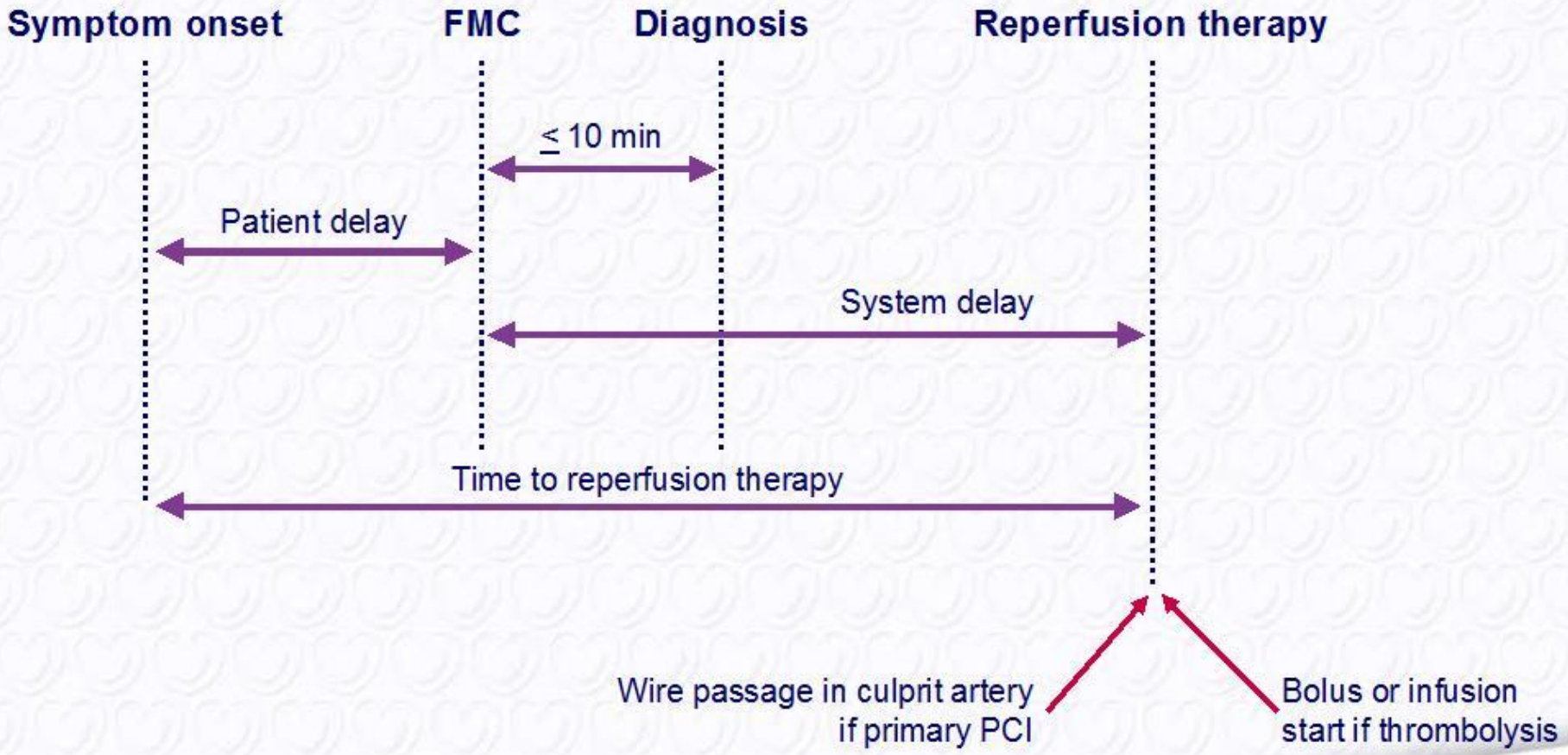
Components of delay in STEMI and ideal time intervals for intervention



All delays are related to FMC (first medical contact)

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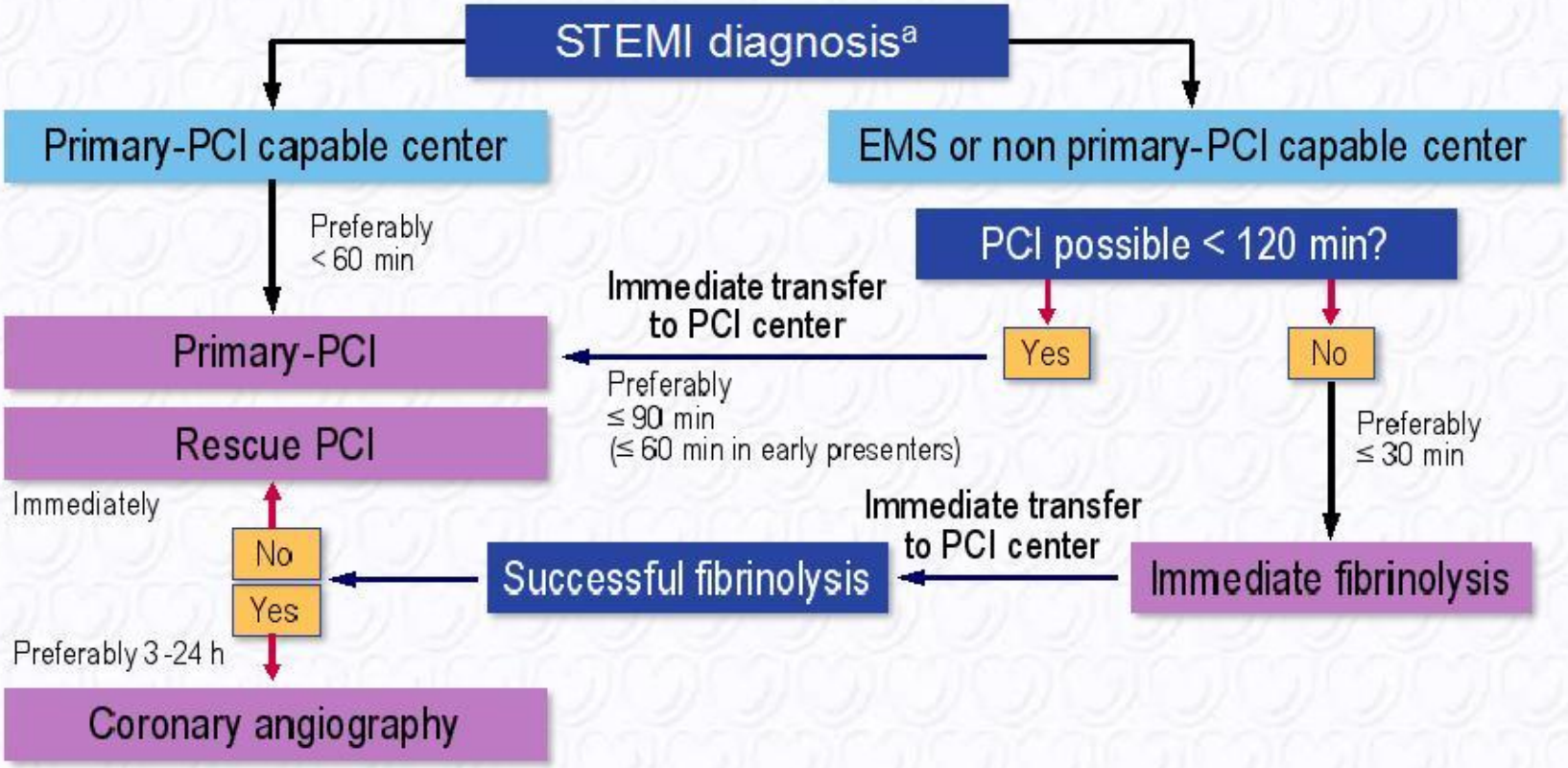
Prehospital and in-hospital management, and reperfusion strategies within 24 h of FMC



[a] The time point the diagnosis is confirmed with patient history and ECG ideally within 10 min from the first medical contact (FMC). All delays are related to FMC (first medical contact).

Cath = catheterization laboratory; EMS = emergency medical system; FMC = first medical contact; PCI = percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction.

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Logistics of pre-hospital care

Recommendations	Class	Level
Ambulance teams must be trained and equipped to identify STEMI (with use of ECG recorders and telemetry as necessary) and administer initial therapy, including thrombolysis where applicable.	I	B
The prehospital management of STEMI patients must be based on regional networks designed to deliver reperfusion therapy expeditiously and effectively, with efforts made to make primary PCI available to as many patients as possible.	I	B
Primary PCI-capable centres must deliver a 24/7 service and be able to start primary PCI as soon as possible but always within 60 min from the initial call.	I	B

ECG = electrocardiogram; EMC = emergency medical system; PCI = percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction.

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Logistics of pre-hospital care

Recommendations	Class	Level
All hospitals and EMSs participating in the care of patients with STEMI must record and monitor delay times and work to achieve and maintain the following quality targets: – first medical contact to first ECG ≤ 10 min; – first medical contact to reperfusion therapy; • for fibrinolysis ≤ 30 min; • for primary PCI ≤ 90 min (≤ 60 min if the patient presents within 120 min of symptom onset or directly to a PCI-capable hospital).	I	B
All EMSs, emergency departments, and coronary care units must have a written updated STEMI management protocol, preferably shared within geographic networks.	I	C
Patients presenting to a non-PCI-capable hospital and awaiting transportation for primary or rescue PCI must be attended in an appropriately monitored area.	I	C
Patients transferred to a PCI-capable centre for primary PCI should bypass the emergency department and be transferred directly to the catheterization laboratory.	IIa	B

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Reperfusion therapy

Recommendations	Class	Level
Reperfusion therapy is indicated in all patients with symptoms of <12 h duration and persistent ST-segment elevation or (presumed) new LBBB.	I	A
Reperfusion therapy (preferably primary PCI) is indicated if there is evidence of ongoing ischaemia, even if symptoms may have started > 12 h beforehand or if pain and ECG changes have been stuttering.	I	C
Reperfusion therapy with primary PCI may be considered in stable patients presenting 12-24 h after symptom onset.	IIb	B
Routine PCI of a totally occluded artery > 24 h after symptom onset in stable patients without signs of ischaemia (regardless of whether fibrinolysis was given or not) is not recommended.	III	A

ECG = electrocardiogram; i.v. = intravenous; LBBB = left bundle branch block; PCI = percutaneous coronary intervention.

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Important delays and treatment goals in the management of acute STEMI

Delays	Target
Preferred for FMC to ECG and diagnosis.	**≤ 10 min**
Preferred for FMC to fibrinolysis ('FMC to needle').	**≤ 30 min**
Preferred for FMC to primary PCI ('door to balloon') in primary PCI hospitals.	**≤ 60 min**
Preferred for FMC to primary PCI.	**≤ 90 min** (≤ 60 min if early presenter with large area at risk) if this target cannot be met, consider fibrinolysis.
Acceptable for primary PCI rather than fibrinolysis.	**≤ 120 min** (≤ 90 min if early presenter with large area at risk) if this target cannot be met, consider fibrinolysis.
Preferred for successful fibrinolysis to angiography.	**3-24 h**

FMC = first medical contacts; PCI = percutaneous coronary intervention.

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Primary PCI

Recommendations	Class	Level
Indications for primary PCI		
Primary PCI is the recommended reperfusion therapy over fibrinolysis if performed by an experienced team within 120 min of FMC.	I	A
Primary PCI is indicated for patients with severe acute heart failure or cardiogenic shock, unless the expected PCI related delay is excessive and the patient presents early after symptom onset.	I	B

FMC = first medical contacts; PCI = percutaneous coronary intervention.

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Procedural aspects of primary PCI

Recommendations	Class	Level
Procedural aspects of primary PCI		
Stenting is recommended (over balloon angioplasty alone) for primary PCI.	I	A
Primary PCI should be limited to the culprit vessel with the exception of cardiogenic shock and persistent ischaemia after PCI of the supposed culprit lesion.	IIa	B
If performed by an experienced radial operator, radial access should be preferred over femoral access.	IIa	B
If the patient has no contraindications to prolonged DAPT (indication for oral anticoagulation, or estimated high long-term bleeding risk) and is likely to be compliant, DES should be preferred over BMS.	IIa	A
Routine thrombus aspiration should be considered.	IIa	B
Routine use of distal protection devices is not recommended.	III	C
Routine use of IABP (in patients without shock) is not recommended.	III	A

BMS = bare-metal stent; DAPT = dual antiplatelet therapy; DES = drug-eluting stent; IABP = intra-aortic balloon pump; PCI = percutaneous coronary intervention.

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Periprocedural anti thrombotic medication in primary PCI

Recommendations	Class	Level
Antiplatelet therapy		
Aspirin oral or i.v. (if unable to swallow) is recommended	I	B
An ADP-receptor blocker is recommended in addition to aspirin. Options are:	I	A
• Prasugrel in clopidogrel-naive patients, if no history of prior stroke/TIA, age < 75 years.	I	B
• Ticagrelor.	I	B
• Clopidogrel, preferably when prasugrel or ticagrelor are either not available or contraindicated.	I	C

ADP = adenosine diphosphate.

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Periprocedural anti thrombotic medication in primary PCI, *con't*

Recommendations	Class	Level
GP IIb/IIIa inhibitors should be considered for bailout therapy if there is angiographic evidence of massive thrombus, slow or no-reflow or a thrombotic complication.	IIa	C
Routine use of a GP IIb/IIIa inhibitor as an adjunct to primary PCI performed with unfractionated heparin may be considered in patients without contraindications.	IIb	B
Upstream use of a GP IIb/IIIa inhibitor (vs. in-lab use) may be considered in high-risk patients undergoing transfer for primary PCI.	IIb	B
Options for GP IIb/IIIa inhibitors are (with LoE for each agent):		
• Abciximab		A
• Eptifibatide (with double bolus)		B
• Tirofiban (with a high bolus dose)		B

GP = glycoprotein; i.v. = intravenous; lab = catheterization laboratory.

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Periprocedural anti thrombotic medication in primary PCI, *con't*

Recommendations	Class	Level
Anticoagulants		
An injectable anticoagulant must be used in primary PCI.	I	C
Bivalirudin (with use of GP IIb/IIIa blocker restricted to bailout) is recommended over unfractionated heparin and a GP IIb/IIIa blocker.	I	B
Enoxaparin (with or without routine GP IIb/IIIa blocker) may be preferred over unfractionated heparin.	IIb	B
Unfractionated heparin with or without routine GP IIb/IIIa blocker must be used in patients not receiving bivalirudin or enoxaparin.	I	C
Fondaparinux is not recommended for primary PCI.	III	B
The use of fibrinolysis before planned primary PCI is not recommended.	III	A

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Contraindications to fibrinolytic therapy

Absolute
Previous intracranial haemorrhage or stroke of unknown origin at any time.
Ischaemic stroke in the preceding 6 months.
Central nervous system damage or neoplasms or atrioventricular malformation.
Recent major trauma/surgery/head injury (within the preceding 3 weeks).
Gastrointestinal bleeding within the past month.
Known bleeding disorder (excluding menses).
Aortic dissection.
Non-compressible punctures in the past 24 h (e.g. liver biopsy, lumbar puncture).

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Contraindications to fibrinolytic therapy

Relative
Transient ischaemic attack in the preceding 6 months.
Oral anticoagulant therapy.
Pregnancy or within 1 week postpartum.
Refractory hypertension (systolic blood pressure > 180 mmHg and/or diastolic blood pressure > 110 mmHg).
Advanced liver disease.
Infective endocarditis.
Active peptic ulcer.
Prolonged or traumatic resuscitation.

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Fibrinolytic therapy

Recommendations	Class	Level
Fibrinolytic therapy is recommended within 12 h of symptom onset in patients without contraindications if primary PCI cannot be performed by an experienced team within 120 min of FMC.	I	A
In patients presenting early (< 2 h after symptom onset) with a large infarct and low bleeding risk, fibrinolysis should be considered if time from FMC to balloon inflation is > 90 min.	IIa	B
If possible, fibrinolysis should start in the prehospital setting.	IIa	A
A fibrin-specific agent (tenecteplase, alteplase, reteplase) is recommended (over non-fibrin specific agents).	I	B
Oral or i.v. aspirin must be administered.	I	B
Clopidogrel is indicated in addition to aspirin.	I	A

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Fibrinolytic therapy, *con't*

Recommendations	Class	Level
Antithrombin co-therapy with fibrinolysis		
Anticoagulation is recommended in STEMI patients treated with lytics until revascularization (if performed) or for the duration of hospital stay up to 8 days. The anticoagulant can be:	I	A
• Enoxaparin i.v followed by s.c. (using the regimen described below) (preferred over UFH).	I	A
• UFH given as a weight-adjusted i.v. bolus and infusion.	I	C
In patients treated with streptokinase, fondaparinux i.v. bolus followed by s.c. dose 24 h later.	IIa	B

UFH = unfractionated heparin.

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Fibrinolytic therapy, *con't*

Recommendations	Class	Level
Transfer to a PCI-capable centre following fibrinolysis		
Is indicated in all patients after fibrinolysis	I	A
Interventions following fibrinolysis		
Rescue PCI is indicated immediately when fibrinolysis has failed (< 50 % ST-segment resolution at 60 min).	I	A
Emergency PCI is indicated in the case of recurrent ischaemia or evidence of reocclusion after initial successful fibrinolysis.	I	B

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Doses of fibrinolytics

	Initial treatment	Specific contraindications
Streptokinase (SK)	1.5 million units over 30–60 min i.v.	Prior SK or anistreplase.
Alteplase (tPA)	15 mg i.v. bolus. 0.75 mg/kg over 30 min (up to 50 mg) then 0.5 mg/kg over 60 min i.v. (up to 35 mg).	
Reteplase (r-PA)	10 units + 10 units i.v. bolus given 30 min apart.	
Tenecteplase (TNK–tPA)	Single i.v. bolus: 30 mg if < 60 kg; 35 mg if 60 to < 70 kg; 40 mg if 70 to < 80 kg; 45 mg if 80 to < 90 kg; 50 mg if ≥ 90 kg.	

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Doses of anti-platelet co-therapies

Doses of antiplatelet co-therapies	
With primary PCI	
Aspirin	Loading dose of 150-300 mg orally or of 80-150 mg i.v. if oral ingestion is not possible, followed by a maintenance dose of 75-100 mg/day.
Clopidogrel	Loading dose of 600 mg orally, followed by a maintenance dose of 75 mg/day.
Prasugrel	Loading dose of 60 mg orally, followed by a maintenance dose of 10 mg/day. In patients with body weight <60 kg, a maintenance dose of 5 mg is recommended. In patients > 75 years, prasugrel is generally not recommended, but a dose of 5 mg should be used if treatment is deemed necessary.
Ticagrelor	Loading dose of 180 mg orally, followed by a maintenance dose of 90 mg b.i.d.
Abciximab	Bolus of 0.25 mg/kg i.v. and 0.125 µg/kg/min infusion (maximum 10 µg/min) for 12 h.
Eptifibatide	Double bolus of 180 µg/kg i.v. (given at a 10-min interval) followed by an infusion of 2.0 µg/kg/min for 18 h.
Tirofiban	25 µg/kg over 3 min i.v., followed by a maintenance infusion of 0.15 µg/kg/min for 18 h.
With fibrinolytic therapy	
Aspirin	Starting dose 150-500 mg orally or i.v. dose of 250 mg if oral ingestion is not possible.
Clopidogrel	Loading dose of 300 mg orally if aged ≤ 75 years, followed by a maintenance dose of 75 mg/day.
Without reperfusion therapy	
Aspirin	Starting dose 150-500 mg orally.
Clopidogrel	75 mg/day orally.

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Doses of anti-thrombin co-therapies

Doses of antithrombin co-therapies	
With primary PCI	
Unfractionated heparin	70-100 U/kg i.v. bolus when no GP IIb/IIIa inhibitor is planned. 50-60 U/kg i.v. bolus with GP IIb/IIIa inhibitors.
Enoxaparin	0.5 mg/kg i.v. bolus.
Bivalirudin	0.75 mg/kg i.v. bolus followed by i.v infusion of 1.75 mg/kg/h for up to 4 h after the procedure as clinically warranted. After cessation of the 1.75 mg/kg/h infusion, a reduced infusion dose of 0.25 mg/kg/h may be continued for 4-12 h as clinically necessary.
With fibrinolytic therapy	
Unfractionated heparin	60 U/kg i.v. bolus with a maximum of 4000 U followed by an i.v. infusion of 12 U/kg with a maximum of 1000 U/h for 24-48 h. Target aPTT: 50-70 s or 1.5 to 2.0 times that of control to be monitored at 3, 6, 12 and 24 h.
Enoxaparin	In patients < 75 years of age: 30 mg i.v. bolus followed 15 min later by 1 mg/kg s.c. every 12 h until hospital discharge for a maximum of 8 days The first two doses should not exceed 100 mg. In patients > 75 years of age: no i.v. bolus; start with first s.c. dose of 0.75 mg/kg with a maximum of 75 mg for the first two s.c. doses. In patients with creatinine clearance of < 30 mL/min, regardless of age, the s.c. doses are given once every 24 h.
Fondaparinux	2.5 mg i.v. bolus followed by a s.c. dose of 2.5 mg once daily up to 8 days or hospital discharge.
Without reperfusion therapy	
Unfractionated heparin	Same dose as with fibrinolytic therapy.
Enoxaparin	Same dose as with fibrinolytic therapy.
Fondaparinux	Same dose as with fibrinolytic therapy.

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Special subsets

Recommendations	Class	Level
Both genders must be managed in a similar fashion.	I	C
A high index of suspicion for myocardial infarction must be maintained in women, diabetics, and elderly patients with atypical symptoms.	I	B
Special attention must be given to proper dosing of antithrombotics in elderly and renal failure patients.	I	B

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Initial dosing of anti thrombotic agents in patients with chronic kidney disease, estimated CrCl <60 ml/min

	Recommendations
Aspirin	No dose adjustment.
Clopidogrel	No dose adjustment.
Prasugrel	No dose adjustment. No experience with end-stage renal disease/dialysis.
Ticagrelor	No dose adjustment. No experience with end-stage renal disease/dialysis.
Enoxaparin	No adjustment of bolus dose. Following thrombolysis, in patients with creatinine clearance < 30 mL/min, the s.c. doses are given once every 24 h.
Unfractionated heparin	No adjustment of bolus dose.
Fondaparinux	No dose adjustment. No experience in patients with end-stage renal disease or dialysis patients.
Bivalirudin	• In patients with moderate renal insufficiency (GFR 30–59 mL/min) a lower initial infusion rate of 1.4 mg/kg/h should be given. The bolus dose should not be changed. • In patients with severe renal insufficiency (GFR < 30 mL/min) and in dialysis-dependent patients bivalirudin is contraindicated.
Abciximab	No specific recommendation. Careful consideration of bleeding risk.
Eptifibatide	• In patients with moderate renal insufficiency (GFR ≥ 30 to < 50 mL/min), an i.v. bolus of 180 µg should be administered followed by a continuous infusion dose of 1.0 µg/kg/min for the duration of therapy. • In patients with severe renal insufficiency (GFR < 30 mL/min) eptifibatide is contraindicated.
Tirofiban	In patients with severe renal insufficiency (GFR < 30 mL/min) the infusion dose should be reduced to 50%.

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Management of hyperglycemia in the acute phase of STEMI

Recommendations	Class	Level
Measurement of glycaemia is indicated at initial evaluation in all patients, and should be repeated in patients with known diabetes or hyper-glycaemia.	I	C
Plans for optimal outpatient glucose control and secondary prevention must be determined in patients with diabetes before discharge.	I	C
The goals of glucose control in the acute phase should be to maintain glucose concentrations ≤ 11.0 mmol/L (200 mg/dL) while avoiding fall of glycaemia < 5 mmol/L (< 90 mg/dL). In some patients, this may require a dose-adjusted insulin infusion with monitoring of glucose, as long as hypoglycaemia is avoided.	IIa	B
A measurement of fasting glucose and HbA1c and, in some cases, a post-discharge oral glucose tolerance test should be considered in patients with hyperglycaemia but without a history of diabetes.	IIa	B
Routine glucose-insulin-potassium infusion is not indicated.	III	A

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Management during hospitalization and at discharge

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Logistical issues during hospital stay

Recommendations	Class	Level
All hospitals participating in the care of STEMI patients should have a coronary care unit equipped to provide all aspects of care for STEMI patients, including treatment of ischaemia, severe heart failure, arrhythmias and common comorbidities.	I	C
Length of stay in the coronary care unit		
Patients undergoing uncomplicated successful reperfusion therapy should be kept in the coronary care unit for a minimum of 24 h, after which they may be moved to a step-down monitored bed for another 24-48 h.	I	C
Transfer back to a referring non-PCI hospital		
Early transfer (same day) may be considered in selected, low-risk patients after successful primary PCI without observed arrhythmia.	IIb	C
Hospital discharge		
Early discharge (after approximately 72 h) is reasonable in selected low-risk patients, if early rehabilitation and adequate follow-up are arranged.	IIb	B

PCI = percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction.

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Summary of indications for imaging and stress testing

Recommendations	Class	Level
At presentation		
In the acute phase, when diagnosis is uncertain, emergency echo-cardiography may be useful. However, if inconclusive or unavailable and persistent doubt, emergency angiography should be considered.	I	C
After the acute phase		
All patients should have an echocardiography for assessment of infarct size and resting LV function.	I	B
If echocardiography is not feasible, MRI may be used as an alternative.	IIb	C
Before or after discharge		
For patients with multivessel disease, or in whom revascularization of other vessels is considered, stress testing or imaging (e.g. using stress myocardial perfusion scintigraphy, stress echocardiography, positron emission tomography or MRI) for ischaemia and viability is indicated.	I	A
Computed tomography angiography has no role in the routine management of STEMI patients.	III	C

PCI = percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction.

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Routine therapies in the acute, subacute and long term phase of STEMI

Recommendations	Class	Level
Active smokers with STEMI must receive counselling and be referred to a smoking cessation programme	I	B
Each hospital participating in the care of STEMI patients must have a smoking cessation protocol.	I	C
Exercise-based rehabilitation is recommended	I	B
Antiplatelet therapy with low dose aspirin (75-100 mg) is indicated indefinitely after STEMI.	I	A
In patients who are intolerant to aspirin, clopidogrel is indicated as an alternative to aspirin.	I	B
DAPT with a combination of aspirin and prasugrel or aspirin and ticagrelor is recommended (over aspirin and clopidogrel) in patients treated with PCI	I	A
DAPT with aspirin and an oral ADP receptor antagonist must be continued for up to 12 months after STEMI, with a strict minimum of:	I	C
• 1 month for patients receiving BMS;	I	C
• 6 months for patients receiving DES.	IIb	B

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Routine therapies in the acute, subacute and long term phase of STEMI

Recommendations	Class	Level
In patients with left ventricular thrombus, anticoagulation should be instituted for a minimum of 3 months.	IIa	B
In patients with a clear indication for oral anticoagulation (e.g. atrial fibrillation with CHA_2DS_2-VASc Score ≥ 2 or mechanical valve prosthesis), oral anticoagulation must be implemented in addition to antiplatelet therapy.	I	C
In patients require triple antithrombotic therapy, combining DAPT and OAC, e.g. because of stent placement and an obligatory indication for OAC, the duration of dual antiplatelet therapy should be minimized to reduce bleeding risk.	I	C
In selected patients who receive aspirin and clopidogrel, low-dose rivaroxaban (2.5 mg twice daily) may be considered if the patient is at low bleeding risk.	IIb	B
DAPT should be used up to 1 year in patients with STEMI who did not receive a stent.	IIa	C
Gastric protection with a proton pump inhibitor should be considered for the duration of DAPT therapy in patients at high risk of bleeding.	IIa	C

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Routine therapies in the acute, subacute and long term phase of STEMI

Recommendations	Class	Level
Oral treatment with beta-blockers should be considered during hospital stay and continued thereafter in all STEMI patients without contra-indications.	IIa	B
Oral treatment with beta-blockers is indicated in patients with heart failure or LV dysfunction.	I	A
Intravenous beta-blockers must be avoided in patients with hypotention or heart failure.	III	B
Intravenous beta-blockers should be considered as the time of presentation in patients without contraindications, with high blood pressure, tachycardia and no signs of heart failure.	IIa	B
A fasting lipid profile must be obtained in all STEMI patients, as soos as possible after presentation.	I	C
It is recommended to initiate or continue high dose statins early after admission in all STEMI patients without contraindication or history of intolerance, regardless of initial cholesterol values.	I	A

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Routine therapies in the acute, subacute and long term phase of STEMI

Recommendations	Class	Level
Reassessment of LDL-cholesterol should be considered after 4-6 weeks to ensure that a target value of ≤1.8 mmol/L (70 mg/dL) has been reached.	IIa	C
Verapamil may be considered for secondary prevention in patients with absolute contraindications to beta-blockers and no heart failure.	IIb	B
ACE Inhibitors are indicated 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 or LV systolic dysfunction, particularly those who are intolerant to ACE inhibitors.	I	B
ACE inhibitors should be considered in all patients in the absence of contraindications.	IIa	A
Aldosterone antagonists, e.g. eplerenone, are indicated in patients with an ejection fraction ≤ 40% and heart failure or diabetes, provided no renal failure or hyperkalaemia.	I	B

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Complications following STEMI

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Treatment of mild HF (Killip class II)

Recommendations	Class	Level
Oxygen is indicated to maintain a saturation > 95%.	I	C
Loop diuretics, e.g. furosemide: 20-40 mg i.v., is recommended an should be repeated at 1-4 h intervals if necessary.	I	C
i.v. nitrates or sodium nitroprusside should be considered in patients with elevated systolic blool pressure.	IIa	C
An ACE inhitibor is indicated in all patients with signs or symptoms of heart failure and/or evidence of LV dysfunction in the absence of hypotension, hypovolaemia, or renal failure.	I	A
An ARB (valsartan) is an alternative to ACE inhibitor particularly if ACE inhibitors are not tolerated.	I	B
An aldosterone antagonist (eplerenone) is recommended in all patients with signs or symptoms of heart failure and/or evidence of LV dysfunction provided no renal failure or hyperkalaemia.	I	B
Hydralazine and isosorbide dinitrate should be considered if the patient is intolerant to both ACE inhibitors and ARBs.	IIa	C

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Treatment of mild HF (Killip class III)

Recommendations	Class	Level
Oxygen is indicated.	I	C
Ventilatory support should be instituted according to blood gasses.	I	C
Loop diuretics, e.g. furomeside: 20-40 mg i.v., are recommended and should be repeated at 1-4 h intervals if necessary.	I	C
Morphine is recommended. Respiration should be monitored. Nausea is common and an antiemetic may be required. Frequent low-dose therapy is advisable.	I	C
Nitrates are recommended if there is no hypotension.	I	C
Inotropic agents: • Dopamine;	IIa	C
• Dobutamine (inotropic);	IIa	C
• Levosimendan (inotropic/vasodilator).	IIb	C
An aldosterone antagonist such as spironolactone or eplerenone must be used if LVEF ≤ 40%.	I	B
Ultrafiltration should be considered.	IIa	B
Early revascularisation must be considered if the patient has not been previously revascularized.	I	C

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Treatment of cardiogenic shock (Killip class IV)

Recommendations	Class	Level
Oxygen/mechanical respiratory support is indicated according to blood gasses.	I	C
Urgent echocardiography/Doppler must be performed to detect mechanical complications, assess systolic function and loading conditions.	I	C
High-risk patients must be transferred early to tertiary centres.	I	C
Emergency revascularization with either PCI or CABG in suitable patients must be considered.	I	B
Fibrinolysis should be considered if revascularization is unavailable.	IIa	C
Intra-aortic balloon pumping may be considered.	IIb	B
LV assist devices may be considered for circulatory support in patients in refractory shock.	IIb	C
Haemodynamic assessment with balloon floating catheter may be considered.	IIb	B
Inotropic/vasopressor agents should be considered:		
• Dopamine;	IIa	C
• Dobutamine;	IIa	C
• Norepinephrine (preferred over dopamine when blood pressure is low).	IIb	B

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Management of atrial fibrillation

Recommendations	Class	Level
Rhythm control should be considered in patients with atrial fibrillation secondary to a trigger or substrate that has been corrected (e.g. ischaemia).	IIa	C
Acute rate control of atrial fibrillation		
Intravenous beta-blockers or non-dihydropyridine CCB (e.g. diltiazem, verapamil) are indicated if there are no clinical signs of acute heart failure.	I	A
Amiodarone or i.v. digitalis is indicated in case of rapid ventricular response in the presence of concomitant acute heart failure or hypotension.	I	B
Cardioversion		
Immediate electrical cardioversion is indicated when adequate rate control cannot be achieved promptly with pharmacological agents in patients with atrial fibrillation and on-going ischaemia, severe haemodynamic compromise or heart failure.	I	C
Intravenous amiodarone is indicated for conversion to sinus rhythm in stable patients with recent onset atrial fibrillation and structural heart disease.	I	A
Digoxin (LoE A), verapamil, sotalol, metoprolol (LoE B) and other beta-blocking agents (LoE C) are ineffective in converting recent onset atrial fibrillation to sinus rhythm and should not be used for rhythm control (although beta-blockers or digoxin may be used for rate control).	III	A B C

Recommended doses of anti-arrhythmic agents are given in Guidelines for management of patients with atrial fibrillation.
CCB = calcium-chanel blocker; i.v. = intravenous; LoA = level of evidence; LV = left ventricular.

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Management of ventricular arrhythmias and conduction disturbances in the acute phase

Recommendations	Class	Level
Direct current cardioversion is indicated for sustained VT and VF.	I	C
Sustained monomorphic VT that is recurrent or refractory to direct current cardioversion: should be considered to be treated with i.v. amiodarone.	IIa	C
may be treated with i.v. lidocaine or sotalol.	IIb	C
Transvenous catheter pace termination should be considered if VT is refractory to cardioversion or frequently recurrent despite antiarrhythmic medication.	IIa	C
Repetitive symptomatic salvoes of non-sustained monomorphic VT should be considered for either conservative management (watchful waiting) or treated with i.v. beta-blocker, or sotalol, or amiodarone.	IIa	C
Polymorphic VT		
• must be treated by i.v. beta-blocker;	I	B
• or i.v. amiodarone;	I	C
• urgent angiography must be performed when myocardial ischaemia cannot be excluded;	I	C
• may be treated with i.v. lidocaine;	IIb	C
• must prompt assessment and correction of electrolyte disturbances consider magnesium;	I	C
• should be treated with overdrive pacing using a temporary transvenous right ventricular lead or isoprotenerol infusion.	IIa	C

Risk evaluation for sudden cardiac death should be performed to assess indication for primary preventive ICD therapy by assessing LVEF (from echocardiography) at least 40 days after the acute event in patients with LVEF ≤ 40%.

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Management of ventricular arrhythmias and conduction disturbances in the acute phase

Recommendations	Class	Level
In cases of sinus bradycardia associated with hypotension, AV block II (Mobitz 2) or AV block III with bradycardia that causes hypotension or heart failure:		
• intravenous atropine is indicated;	I	C
• temporary pacing is indicated in cases of failure to respond to atropine;	I	C
• urgent angiography with a view to revascularization is indicated if the patient has not received prior reperfusion therapy.	I	C
Management of ventricular arrhythmias and risk evaluation for sudden death on long term		
Specialized electrophysiological evaluation of ICD implantation for secondary prevention of sudden cardiac death is indicated in patients with significant LV dysfunction, who suffer from haemodynamically unstable sustained VT or who are resuscitated from VF occurring beyond the initial acute phase.	I	A
Secondary preventive ICD therapy is indicated to reduce mortality in patients with significant LV dysfunction, and haemodynamically unstable sustained VT or survived VF, not occurring within the initial acute phase.	I	A
Risk evaluation for sudden cardiac death should be performed to assess indication for primary preventive ICD therapy by assessing LVEF (from echocardiography) at least 40 days after the acute event in patients with LVEF ≤ 40%.	I	A

Risk evaluation for sudden cardiac death should be performed to assess indication for primary preventive CD therapy by assessing LVEF (from echocardiography) at least 40 days after the acute event in patients with VEF ≤ 40%.

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Summary of novel aspects

- Importance of recognizing atypical ECG presentations.
- Immediate angiography with a view to PCI in survivors of cardiac arrest and STEMI or high suspicion of AMI.
- A delay of < 90 min from FMC to P-PCI is the target but a maximum of 120 min is acceptable for primary PCI rather than fibrinolysis.
- Delays must be recorded and monitored:
  - FMC to ECG: ≤ 10 min;
  - FMC to lysis: ≤ 30 min;
  - FMC to PPCI: ≤ 90 min (60 min in PCI hospitals or for early presenters).
- Primary PCI is indicated if there is evidence of ongoing ischaemia, even if symptoms may have started > 12 h.
- After fibrinolysis:
  - Transfer to a PCI-capable center is indicated in all patients;
  - Angio with a view to revascularization indicated after successful lysis (optimal timing 3-24 h).

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Summary of novel aspects

- DES preferred over BMS for P-PCI.
- Prasugrel or Ticagrelor preferred over clopidogrel as adjunct to ASA in P-PCI.
- DAPT is recommended for 12 months, with minimum of 1 for BMS, 6 for DES).
- Bivalirudin preferred as anticoagulant for P-PCI, or enoxaparin, over UFH.
- Routine use of GPIIb/IIIa blockers is downgraded in P-PCI.
- β-blockers downgraded after STEMI without CHF or LV dysfunction.
- Guidelines for managing hyperglycemia in the acute phase.

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Summary of novel aspects

- Special subsets are emphasized (gender, diabetes, renal failure).
- Minimal CCU (24 h) and hospital LOS (72 h), with early transfer possible.
- After the acute phase:
  - All pts should have an echocardiogram;
  - Stress testing or imaging for viability and ischemia is indicated in pts with MVD.
- High dose statins in all patients without contraindication or history of intolerance.
- LDL target of ≤ 1.8 mmol/L (0.7 g/dL).

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Major gaps in evidence

- Strategies to minimize early cardiac arrest.
- Improving patient and public awareness of STEMI symptoms.
- Optimizing clinical pathways for high-quality, homogeneous early STEMI diagnosis and management.
- Reducing or minimizing myocardial injury and left ventricular dysfunction following STEMI.
- Defining the optimal management strategy for non-culprit vessels in primary PCI patients.
- Defining the optimal long-term antithrombotic regimen in patients receiving stents and who have an indication for oral anticoagulants.
- Defining the role for pre-hospital thrombolysis in patients presenting early.

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Major gaps in evidence

- Defining the optimal combination and duration of antithrombotic therapies.
- Defining the optimal glucose-management goals and strategy in patients with known diabetes or acute hyperglycaemia.
- Developming percutaneous techniques for managing ventricular septal defects.
- Effective and safe of cell therapy to replace myocardium or minimize the consequences of myocardial injury.
- Strategy to minimize risk of sudden death in patients with ventricular tachycardia or ventricular fibrillation during or after STEMI.
- Effective strategies to achieve and maintain long-term effective risk factor control.

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

The Task Force on the management of ST-segment elevation acute myocardial infarction of the European Society of Cardiology

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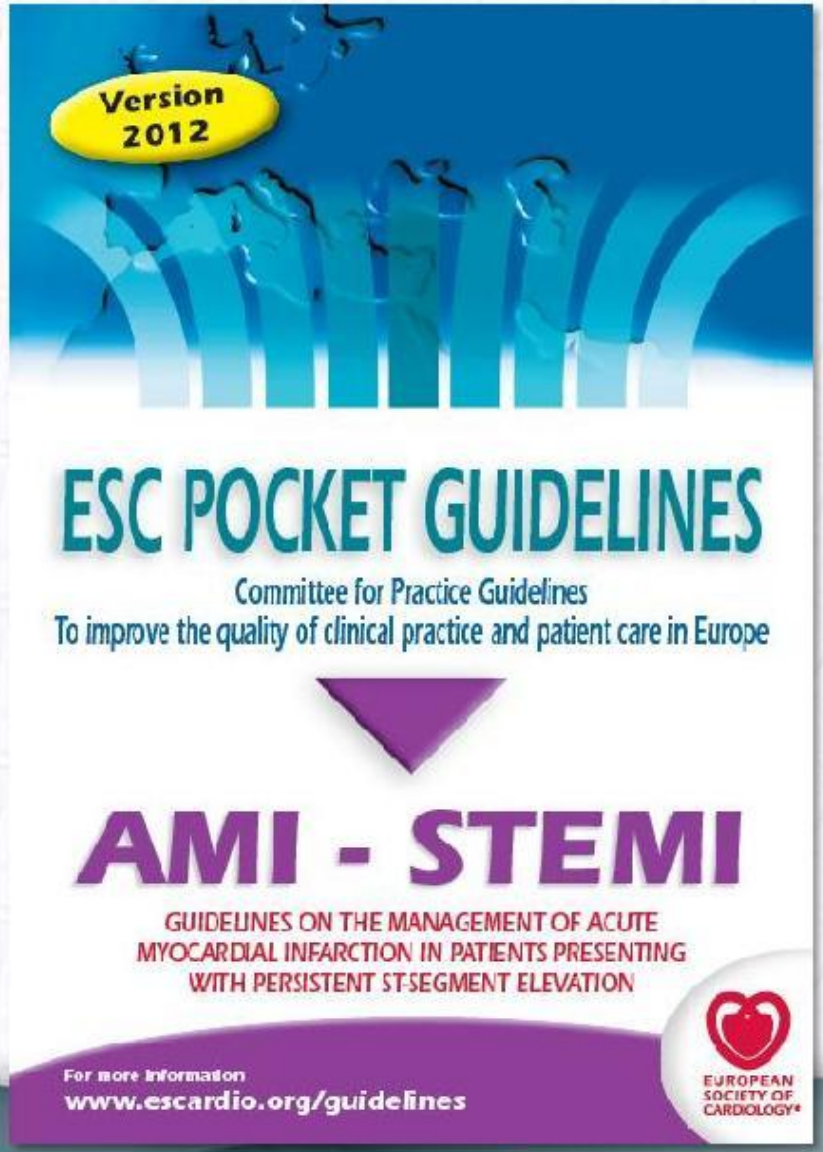

ESC Pocket Guidelines

Management of acute myocardial infarction in patients presenting with ST-segment elevation*

The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology

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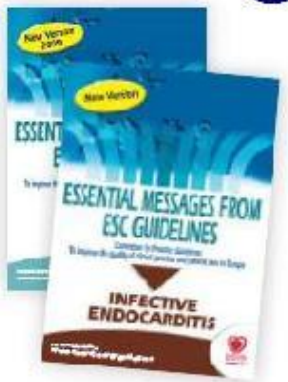

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