Acute Myocardial Infarction Management

Management of a patient with acute myocardial infarction (AMI) is a medical emergency. Local guidelines for the management of myocardial infarction should be followed where they exist.

Pre-hospital management

- Arrange an emergency ambulance if an AMI is suspected. Take an ECG as soon as possible but do not delay transfer to hospital, as an ECG is only of value in pre-hospital management if pre-hospital thrombolysis is being considered.
- Advise any patient known to have coronary heart disease to call for an emergency ambulance if the chest pain is unresponsive to glyceryl trinitrate (GTN) and has been present for longer than 15 minutes or on the basis of general clinical state - eg, severe dyspnoea or pain.
- Cardiopulmonary resuscitation and defibrillation in the event of a cardiac arrest.
- Oxygen: do not routinely administer oxygen but monitor oxygen saturation using pulse oximetry as soon as possible, ideally before hospital admission. Only offer supplemental oxygen to:
  - People with oxygen saturation less than 94% who are not at risk of hypercapnic respiratory failure, aiming for saturation of 94-98%.
  - People with chronic obstructive pulmonary disease who are at risk of hypercapnic respiratory failure, to achieve a target saturation of 88-92% until blood gas analysis is available.
- Pain relief with GTN sublingual/spray and/or an intravenous opioid 2.5-5 mg diamorphine or 5-10 mg morphine intravenously with an anti-emetic. Avoid intramuscular injections, as absorption is unreliable and the injection site may bleed if the patient later receives thrombolytic therapy.
- Aspirin 300 mg orally (dispersible or chewed).
- Insert a Venflon® for intravenous access and take blood tests for FBC, renal function and electrolytes, glucose, lipids, clotting screen, C-reactive protein (CRP) and cardiac enzymes (troponin I or T).
- Pre-hospital thrombolysis is indicated if the time from the initial call to arrival at hospital is likely to be over 30 minutes. When primary percutaneous coronary intervention cannot be provided within 120 minutes of ECG diagnosis, patients with an ST-segment-elevation acute coronary syndrome (ACS) should receive immediate (pre-hospital or admission) thrombolytic therapy.
- The National Institute for Health and Care Excellence (NICE) recommends using intravenous bolus (reteplase or tenecteplase) rather than an infusion for pre-hospital thrombolysis.

Management initiated in hospital

- If not already done, insert a Venflon® for intravenous access and take blood tests for cardiac enzymes (troponin I or T), FBC, renal function and electrolytes, glucose, lipids, CRP, and clotting screen. See separate Acute Myocardial Infarction article for a more detailed discussion of investigations.
- Continue close clinical monitoring (including symptoms, pulse, blood pressure, heart rhythm and oxygen saturation by pulse oximetry), oxygen therapy and pain relief.
- ECG monitoring: features that increase the likelihood of infarction are: new ST-segment elevation; new Q waves; any ST-segment elevation; new conduction defect. Other features of ischaemia are ST-segment depression and T-wave inversion.

Reperfusion

Patency of the occluded artery can be restored by percutaneous coronary intervention (PCI) or by giving a thrombolytic drug. PCI is the preferred method. Compared with fibrinolysis, PCI results in less reocclusion, improved left ventricular function and improved overall outcome (including reduced risk of stroke).
**Primary PCI**

- PCI (or percutaneous transluminal coronary angioplasty - PTCA) is regarded as superior to fibrinolysis in the management of AMI and is becoming increasingly available for initial patient care.\[^2\]
- Primary angioplasty provides an early assessment of the extent of the underlying disease. See the separate [*Percutaneous Coronary Intervention*](#) article.
- Any delay in primary PCI after a patient arrives at hospital is associated with higher mortality in hospital. Time to treatment should therefore be as short as possible. Door (or diagnosis) to treatment time should be less than 90 minutes, or less than 60 minutes if the hospital is PCI ready and symptoms started within 120 minutes.
- There is general agreement that PCI should be considered if there is an ST-elevation ACS, if symptoms started up to 12 hours previously. There is no consensus whether PCI is also beneficial in patients presenting more than 12 hours from the onset of symptoms in the absence of clinical and/or ECG evidence of ongoing ischaemia.
- Patients should receive a glycoprotein IIb/IIIa inhibitor to reduce the risk of immediate vascular occlusion and should also receive either unfractionated heparin, a low molecular weight heparin (eg, enoxaparin), or bivalirudin.\[^7\]
- Prasugrel in combination with aspirin is recommended as an option for preventing atherothrombotic events in adults with unstable angina, non-ST-elevation myocardial infarction (NSTEMI) or ST-elevation myocardial infarction (STEMI) having primary or delayed PCI.\[^8\]
- Balloon angioplasty following myocardial infarction reduces death, non-fatal myocardial infarction and stroke compared with thrombolytic reperfusion. However, up to 50% of patients experience re-stenosis and 3-5% recurrent myocardial infarction.\[^9\]
- There is no evidence to suggest that primary stenting reduces mortality when compared with balloon angioplasty but stenting seems to be associated with a reduced risk of re-infarction and target vessel revascularisation.\[^9\]
- NICE therefore recommends that intracoronary stent implantation should be used in patients undergoing primary PCI.\[^10\]

**Facilitated PCI**

- Facilitated PCI is the use of pharmacological reperfusion treatment delivered prior to a planned PCI.
- There is no evidence of a significant clinical benefit and so facilitated PCI is currently not recommended.

**Rescue PCI**

- Rescue PCI is defined as PCI performed on a coronary artery which remains occluded despite fibrinolytic therapy.
- Rescue PCI is associated with a significant reduction in heart failure and re-infarction and a lower all-cause mortality and so should be considered when there is evidence of failed fibrinolysis based on clinical signs and insufficient ST-segment resolution, if there is clinical or ECG evidence of a large infarct and if the procedure can be performed less than 12 hours after the onset of symptoms.

**Fibrinolytic drugs**

For patients who cannot be offered PCI within 90 minutes of diagnosis, a thrombolytic drug should be administered along with either unfractionated heparin (for maximum two days), a low molecular weight heparin (eg, enoxaparin) or fondaparinux. Thrombolytic drugs break down the thrombus so that the blood flow to the heart muscle can be restored to prevent further damage and assist healing.

Reperfusion by thrombolysis is often gradual and incomplete and may be inadequate. There is a risk of early or late reocclusion and a 1-2% risk of intracranial haemorrhage.

- Fibrinolytic drugs act as thrombolytics by activating plasminogen to form plasmin, which degrades fibrin and so breaks up the thrombi.
- Streptokinase and alteplase have been shown to reduce mortality. Reteplase and tenecteplase are also licensed for AMI.
- Streptokinase and alteplase are given by intravenous infusion. Reteplase and tenecteplase can be given by rapid bolus injection.
- The benefit is greatest in those with ECG changes that include ST-segment elevation (especially in those with anterior infarction) and in patients with bundle branch block.
The earlier the treatment is given, the greater the absolute benefit. Alteplase, reteplase and streptokinase need to be given within 12 hours of symptom onset, ideally within one hour. Tenecteplase should be given as early as possible and usually within six hours of symptom onset.

Bleeding complications are the main risks associated with thrombolysis. Contra-indications for thrombolysis include patients with bleeding disorders, or a history of recent haemorrhage, trauma, surgery or acute cerebrovascular event.

Persistence of antibodies to streptokinase can reduce the effectiveness of subsequent treatment and so streptokinase should not be used again after the first administration.

**Antithrombotic therapy without reperfusion therapy**

- In patients presenting within 12 hours after the onset of symptoms but reperfusion therapy is not given, or in patients presenting after 12 hours, aspirin, clopidogrel and an antithrombin agent (heparin, enoxaparin or fondaparinux) should be given as soon as possible.
- For patients who do not receive reperfusion therapy, angiography before hospital discharge is recommended (as for patients after successful fibrinolysis) if no contra-indications are present.

**Coronary bypass surgery**

- Only a few patients need a coronary artery bypass graft (CABG) in the acute phase but CABG may be indicated:
  - After failed PCI, coronary occlusion not amenable for PCI, or the presence of refractory symptoms after PCI.
  - Cardiogenic shock, or mechanical complications - eg, ventricular rupture, acute mitral regurgitation, or ventricular septal defect.
  - Multivessel disease.

- In patients with a non-emergency indication for CABG (eg, multisystem disease), it is recommended to treat the infarct-related lesion by PCI and to perform CABG later in more stable conditions if possible.

**Other initial management**

- **Antiplatelet agent:**
  - Long-term low-dose aspirin reduces overall mortality, non-fatal re-infarction, non-fatal stroke and vascular death.
  - Clopidogrel, in combination with low-dose aspirin, is recommended for AMI with ST-segment elevation; the combination is licensed for at least four weeks but the optimum treatment duration has not been established. Treatment with clopidogrel and aspirin for up to one year following PCI has also been shown to be cost-effective.\(^{[11]}\)
  - Clopidogrel monotherapy is an alternative when aspirin is contra-indicated.
  - Ticagrelor in combination with low-dose aspirin is recommended by NICE for up to 12 months as a treatment option in adults with STEMI that cardiologists intend to treat with primary PCI.\(^{[12]}\)
  - Warfarin (INR 2-3) or dabigatran can be considered for patients unable to take aspirin or clopidogrel.\(^{[13]}\)

- **Beta-blockers:**
  - When started within hours of infarction, beta-blockers reduce mortality, non-fatal cardiac arrest and non-fatal re-infarction.
  - Unless contra-indicated, the usual regime is to give intravenously on admission and then continue orally - titrate upwards to the maximum tolerated dose.\(^{[13]}\)
  - The calcium-channel blockers diltiazem or verapamil can be used if a beta-blocker cannot be used but diltiazem and verapamil are contra-indicated in patients with left ventricular dysfunction.

- **Angiotensin-converting enzyme (ACE) inhibitors:**
  - These reduce mortality whether or not patients have clinical heart failure or left ventricular dysfunction. They also reduce the risk of non-fatal heart failure.
  - Titrate the dose upwards to the maximum tolerated or target dose. Measure renal function, electrolytes and blood pressure before starting an ACE inhibitor (or angiotensin-II receptor antagonist) and again within 1-2 weeks.\(^{[13]}\)
Cholesterol-lowering agents:
- Ideally, initiate therapy with a statin as soon as possible for all patients with evidence of cardiovascular disease (CVD) unless contra-indicated.

Patients who have a left ventricular ejection fraction of 0.4 or less and either diabetes or clinical signs of heart failure should receive the aldosterone antagonist eplerenone (started within 3-14 days of the myocardial infarction and ideally after ACE inhibitor therapy) unless contra-indicated by renal impairment or hyperkalaemia (left ventricular function should be assessed in all patients with AMI during the initial hospital admission).[14]

Other treatment:
- Heparin infusion is used as an adjunctive agent in patients receiving alteplase but not with streptokinase. Heparin is also indicated in patients undergoing primary angioplasty.
- Prophylaxis against thromboembolism: if not already receiving heparin by infusion, then patients should be given regular subcutaneous heparin until fully mobile.
- Insulin-glucose infusion followed by intensive glucose control with subcutaneous insulin for all people with type 1 and type 2 diabetes.
- The routine use of nitrates, calcium antagonists, magnesium, and high-dose glucose-insulin-potassium infusion is not currently recommended during the acute phase of treatment of AMI.

Cardiac assessment and revascularisation
Early risk assessment will help identify high-risk patients who may require early further management with angiography, and coronary revascularisation. Methods of cardiac assessment vary according to local availability and expertise.

- Routine exercise ECG testing: submaximal testing is increasingly performed before hospital discharge at 4-7 days. A symptom-limited test can be performed at 3-6 weeks post-infarction in order to assess prognosis and to identify those patients with reversible ischaemia (who should then have an angiogram to assess the need for CABG).
- Myocardial perfusion imaging scintigraphy, using single photon emission computed tomography (SPECT), can be performed before hospital discharge to assess the extent of residual ischaemia if the patient has not already undergone cardiac catheterisation and angiography. NICE recommends that myocardial perfusion scintigraphy using SPECT should be the first test used for:[15]
  - People where stress ECG may not give accurate or clear results - eg, women, people who have certain unusual patterns in the electrical activity of their heart, people with diabetes or people for whom exercise is difficult or impossible.
  - The diagnosis of people who are less likely to have coronary artery disease and who are at lower risk of having heart problems in the future. The likelihood of a person having coronary artery disease can be assessed by considering a number of factors - eg, age, sex, ethnic background and family history as well as the results of physical examination and investigations.
  - As an investigation in people who still have symptoms following a myocardial infarction or despite having had treatment to improve coronary artery blood flow.

- Echocardiography is helpful if the diagnosis is in question, can define the extent of the infarction and can identify complications, such as acute mitral regurgitation, left ventricular rupture or pericardial effusion
- Coronary angiography should ideally be performed for all patients prior to discharge from hospital.

Further management of patients after a myocardial infarction[13]
See the separate Cardiovascular Risk Assessment article.
Driving after acute coronary syndromes (including acute myocardial infarction)\textsuperscript{[16]}

- Group 1 entitlement: ordinary driving licence for car or motorcycle:
  - If successfully treated by coronary angioplasty, driving may recommence after one week, provided:
    - No other URGENT revascularisation is planned (within four weeks from the acute event).
    - Left ventricular ejection fraction (the fraction of blood pumped out of the left ventricle with each heartbeat) is at least 40% prior to hospital discharge.
    - There is no other disqualifying condition.
  - If not successfully treated by coronary angioplasty, driving may recommence after four weeks provided there is no other disqualifying condition.
  - The Driver and Vehicle Licensing Agency (DVLA) does not need to be notified.

- Group 2 entitlement: vocational drivers of large goods vehicles or passenger-carrying vehicles:
  - All acute coronary syndromes disqualify the licence holder from driving for at least six weeks.
  - Relicensing may be permitted thereafter provided:
    - The exercise/other functional test requirements can be met.
    - There is no other disqualifying condition.
  - A left ventricular ejection fraction of below 40% is considered a bar to Group 2 entitlement.
  - The DVLA must be notified.

Employment

- Advice will vary according to the type of employment, general health of the patient, severity of infarction and complications.
- In most cases, returning to work should not be delayed beyond three months, as a successful return is less likely as time goes on.
- Patients who have had a cardiac arrest or undergone CABG generally take longer to recover physically and cognitively and may require up to six months off work.

Complications following a myocardial infarction

See the separate Complications of Acute Myocardial Infarction article.

Further reading & references

- Consensus guideline for recording a standard 12-lead electrocardiogram; Society for Cardiological Science & Technology, June 2014
- Myocardial infarction with ST-segment elevation: The acute management of myocardial infarction with ST-segment elevation; NICE Clinical Guideline (July 2013)
- Ticagrelor for preventing atherothrombotic events after myocardial infarction; NICE Technology Appraisal Guidance, December 2016
- Chest pain of recent onset; NICE Clinical Guideline (March 2010, updated Nov 2016)
- Management of Acute Myocardial Infarction in patients presenting with ST-segment elevation; European Society of Cardiology (2012)
- Acute coronary syndrome; Scottish Intercollegiate Guidelines Network - SIGN (2016)
- Myocardial infarction with ST-segment elevation: The acute management of myocardial infarction with ST-segment elevation; NICE Clinical Guideline (July 2013)
- British National Formulary; NICE Evidence Services (UK access only)
- Bivalirudin for the treatment of ST-segment-elevation myocardial infarction; NICE Technology Appraisal Guidance, July 2011
- Prasugrel with percutaneous coronary intervention for treating acute coronary syndromes; NICE Technology Appraisal Guidance, July 2014
10. Guidance on the use of coronary artery stents; NICE Technology Appraisal Guidance, October 2003
12. Ticagrelor for the treatment of acute coronary syndromes; NICE Technology Appraisal Guidance, October 2011
13. Myocardial infarction: cardiac rehabilitation and prevention of further MI; NICE Clinical Guideline (November 2013)
14. Cardiac arrhythmias in coronary heart disease; Scottish Intercollegiate Guidelines Network - SIGN (2007)
15. Myocardial perfusion scintigraphy for the diagnosis and management of angina and myocardial infarction; NICE Technology Appraisal Guidance, November 2003
16. Assessing fitness to drive: guide for medical professionals; Driver and Vehicle Licensing Agency

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