ST-elevation myocardial infarction: New Zealand management guidelines, 2013

ST-Elevation Myocardial Infarction Guidelines Group* and the New Zealand Branch of the Cardiac Society of Australia and New Zealand (*See Appendix 1)

Abstract
The New Zealand branch of the Cardiac Society of Australia and New Zealand have produced guidelines on the management of acute coronary symptoms since 2005. These have been developed by clinicians throughout New Zealand with the aim to improve quality of care. They focus on the most effective strategies based on evidence from clinical trials. The evidence is graded and the recommendations are patient focused. Patients should be informed of the risks and benefits of treatment and share in decision making.

Glossary

| ACS  | Acute coronary syndromes  |
| ACET | Angiotensin converting enzyme |
| AF   | Atrial fibrillation |
| AMI  | Acute myocardial infarction |
| ARB  | Angiotensin receptor blocker |
| BP   | Blood pressure |
| CABG | Coronary artery bypass grafting |
| CCU  | Coronary care unit |
| CPR  | Cardiopulmonary resuscitation |
| CKMB | Creatine kinase MB fraction |
| DAPT | Dual antiplatelet therapy |
| ED   | Emergency department |
| EF   | Ejection fraction |
| GTN  | Glyceryl trinitrate |
| IRA  | Infarct related artery |
| IC   | Intracoronary |
| IV   | Intravenous |
| LV   | Left ventricular |
| LDL  | Low density lipoprotein |
| LBBB | Left bundle branch block |
| MI   | Myocardial infarction |
| PCI  | Percutaneous coronary intervention |
| r-PA | Reteplase |
| SC   | Subcutaneous |
| SL   | Sublingual |
| STEMI| ST-elevation myocardial infarction |
| TIMI | Thrombolysis in myocardial infarction |
| TNK  | Tenecteplase |
| TPA  | Tissue plasminogen activator |
| UFH  | Unfractionated heparin |
Purpose

These guidelines apply to the management of patients with ST-elevation myocardial infarction (STEMI) and are an update from the 2005 guidelines.¹

They have been developed by representatives of all major New Zealand hospitals including general cardiologists, invasive cardiologists, non-invasive cardiologists, emergency department physicians and experts in rehabilitation and nursing (Appendix 1).

The purpose of these guidelines are to provide a summary of the most up-to-date New Zealand² and overseas evidence as well as recommendations of recent European Society of Cardiology (2012) and US (2013)³,⁴ guidelines and to make recommendations based on the evidence that will lead to the best outcomes for patients with STEMI in New Zealand.

The guidelines are recommended for all health providers who care for patients with STEMI. For a detailed description of the levels of evidence cited in these guidelines, please see Appendix 2.

These guidelines are intended for best clinical practice. Treatments and approaches need to be modified according to individualised assessment of patients risk and likelihood to benefit as well as patient preferences.

Where doctors or hospitals are not able to meet the guidelines because of resource constraints it is important that there is documentation of communication between doctors and managers clearly defining the clinical implications of any resource shortages.

Management

ST segment elevation on the electrocardiogram (ECG) persisting for ≥20 minutes in the context of an acute coronary syndrome (ACS) is indicative of an occluded epicardial artery. Included within this subset are those patients presenting with presumed new left bundle branch block pattern on the ECG.

When patients first present with ischaemic symptoms (chest pain or a surrogate such as shortness of breath) lasting ≥20 minutes, or syncope, their management (Figure 1) depends on whether ST elevation or presumed new onset (left bundle branch block) LBBB is present on the ECG or not.

If the symptoms are ≤ 12 hours, urgent reperfusion with fibrinolysis, or catheter-based reperfusion is mandatory (Appendix 2). Good nursing care is a very important component of the care of patients with STEMI.
Figure 1. STEMI algorithm
Diagnosis

The diagnosis of STEMI is defined as new ST elevation at the J point in at least 2 contiguous leads using the cut points defined below or presumed new LBBB.

Investigations

ECGs—An ECG should be performed ≤10 minutes of presentation and reviewed immediately on first assessment. **Class I; Level of Evidence B**

The ECG criteria eligibility for reperfusion are new ST elevation at the J point in two contiguous leads.

Sex differences require different cut-points for women, since J point elevation in healthy women in leads V2 and V3 is less than in men.5,6 The following cut-points should be used: ≥2 mm in men ≥40 years, ≥2.5 mm in men <40 years, or ≥1.5 mm in women in leads V2–V3, and/or ≥1 mm in other leads. ST elevation may be observed in other conditions, such as acute pericarditis, LBBB, Brugada syndrome, stress cardiomyopathy and early re-polarization pattern.

Supplemental leads, as well as serial ECG recordings, should always be considered in patients that present with ischaemic chest pain and a non-diagnostic initial ECG.7 Circumflex occlusion with ECG evidence of ischaemia in the left circumflex territory of the infero-basal wall of the LV is often overlooked. With an infero-basal MI due to circumflex artery occlusion there may be marked ST segment depression in leads V1 to V4 associated with tall R waves and upright T waves in the right precordial leads (V1 to V3).

The best leads for recording circumflex territory ischemia are the posterior leads in the fifth interspace; V7 at the left posterior axillary line, V8 at the left midscapular line, and V9 at the left paraspinous border. These leads should be recorded when there is a high clinical suspicion for circumflex occlusion e.g.: ST segment depression in leads V1–3 or ongoing ischaemic symptoms or haemodynamic instability and a normal ECG. **Class IIa; Level of Evidence C** Patients are eligible for reperfusion if ST elevation is ≥0.5 mm.

Right ventricular leads (V3R & V4R) reflect the free wall of the right ventricle and should be recorded in patients with inferior infarction. If there is ST elevation >0.5 mm, (≥1 mm in men <30 years) this is diagnostic of RV infarction. **Class IIa; Level of Evidence C**

Often patients with new LBBB may not have an acute thrombotic occlusion and the diagnosis of MI is more difficult in the presence of LBBB.8,9 However, concordant ST-segment elevation or a previous ECG may be helpful to determine the presence of an acute MI in this setting. The Sgarbossa criteria define 3 criteria for diagnosing acute MI during LBBB. The 2 criteria with independent diagnostic value were concordant ST elevation ≥1 mm (i.e., ST elevation with positive QRS complex) and precordial V1–3 ST depression ≥1 mm, a third criterion of discordant ST elevation ≥5 mm was suggestive but not diagnostic of acute MI. Patients with old LBBB, with ST elevation changes as above, and a good ischaemic history should have acute angiography.
Atypical ECG presentations that require consideration for urgent reperfusion include ventricular paced rhythm and ST-segment elevation in lead aVR. In the context of symptoms of an ACS, and widespread ST depression, ST elevation in aVR suggests proximal LAD or left main disease and should be regarded as a STEMI equivalent.

If the initial ECG is normal, and there is a high clinical suspicion of ongoing MI, serial ECGs should be performed at 5 to 10 minute intervals and optimally continuous ST segment monitoring should be performed. ECGs should be obtained every 6 to 8 hours in all other patients until an established diagnosis has been made.

Patients who present with a history consistent with acute myocardial ischaemia and have an ECG with new or presumed new LBBB should be classified and managed as a STEMI.

The absence of ST elevation or a new LBBB pattern does not exclude the presence of epicardial coronary artery occlusion, but the benefit of reperfusion has not been demonstrated among these patients.

**Cardiac biomarkers**—Blood samples for measurement of troponin levels, which are the preferred cardiac markers, should be obtained within 10 minutes of presentation. **Class I; Level of Evidence C** Measurement should be repeated 3 hours later and again if prolonged recurrent ischaemia occurs. Decisions on immediate management of STEMI should not await biomarker results. **Class I; Level of Evidence C**

High sensitivity (hs) troponins are detected in many individuals and for the diagnosis of MI a ≥ 50% change (rise and/or fall) above the 99th/1st% is required at low levels (e.g. hsTroponin T ≥ 15–50 ng/L) and a ≥ 20% change with higher levels e.g. > 50 ng/L hsTroponin T. 11,12

Troponins (which are specific cardiac markers), may be elevated in conditions other than an MI. 13,14 CKMB should not be measured if troponin assays are available.

**Other blood tests**—Blood should also be obtained for full blood count, electrolytes, glucose, renal function, liver functions and lipids. A chest X-ray should be performed, but in the absence of clinical features suggesting aortic dissection or other differential diagnoses, not before initiation of treatment.

**Acute echocardiography**—Acute echocardiography may be a useful adjunct when the diagnosis of MI is uncertain but must not delay primary PCI or administration of fibrinolytic therapy in clear cases. **Class I; Level of Evidence C**

Regional wall motion abnormalities occur within minutes following coronary occlusion and their presence supports but is not specific for the diagnosis of MI. Echocardiography may also suggest alternative diagnoses such as pulmonary embolism, pericardial effusion, myocarditis and aortic dissection. The absence of wall-motion abnormalities excludes major MI.

Echocardiography should be performed early in patients with shock and is useful in the detection and assessment of complications such as ventricular septal defect, sub acute rupture and LV thrombus.

**Computed tomographic angiography**—In the emergency setting, the role of computed tomographic (CT) scanning should be confined to the differential diagnosis of acute aortic dissection or pulmonary embolism.
Management

Pre-hospital—Pre-hospital triage has been one of the biggest advances in the management of STEMI and is strongly recommended as a critical factor in reducing times to reperfusion. Class I; Level of Evidence C Availability of automated external defibrillators is a key factor in increasing survival. Class I; Level of Evidence C

Patients presenting at locations requiring transport times to the nearest hospital of greater than 45 minutes, and ‘first medical contact to device time’ >120 minutes, should be considered for administration of pre-hospital fibrinolysis. Class I; Level of Evidence B

Fibrinolytic therapy should be administered in patients without contraindications (see Table 8), if there are trained medical or paramedical staff able to interpret ECGs on-site (or able to transmit the ECG for interpretation) and trained in how to administer fibrinolytic therapy. Bolus thrombolytic agents (TNK or r-PA) should be administered together with aspirin and enoxaparin (see doses below). Class I; Level of Evidence B

Monitoring

Continuous ECG monitoring should be performed from first medical contact in all patients with suspected MI Class I; Level of Evidence B 12-lead ECGs should be recorded to assess ST segment recovery. This is recommended to be performed at 60 minutes after start of fibrinolytic infusion. Failure of reperfusion is defined as <50% ST segment resolution

Adjunctive therapies for all patients

Oxygen should be administered to patients who are breathless, hypoxic (saturations <93%), or who have heart failure or cardiogenic shock. Oxygen may be harmful if saturations are ≥93%. Oxygen may increase afterload via arterial vasoconstriction. A recent Cochrane analysis showed increased mortality with oxygen therapy.

Sublingual GTN and morphine or fentanyl should be administered for pain relief (observe BP and RR). IV antiemetics should be given with morphine (metoclopramide 10 mg or cyclizine 25 mg).

Aspirin—All patients should immediately receive aspirin 150–300 mg which should be chewed if enteric-coated and 75–150 mg continued indefinitely (if there are no contraindications). Class I; Level of Evidence A This recommendation is based on the collaborative meta-analysis of randomised trials of antiplatelet therapy showing no relation of dose with efficacy and information from other studies showing increased bleeding with increasing aspirin doses.
Table 1. Pre-hospital therapies

- Oxygen by face mask if short of breath, heart failure cardiogenic shock or saturation <93%
- SL GTN
- IV morphine or fentanyl as appropriate with an antiemetic
- Aspirin 150mg which should be chewed if enteric coated
- **Fibrinolytic therapy**: TNK or r-PA
  - clopidogrel 300mg <75 years; 75mg ≥75 years;
  - enoxaparin 30mg IV bolus and then 1mg bid if <75 years no bolus and 0.75mg bid if ≥75 years

Table 2. Emergency Department therapies

If not already given

- Oxygen by face mask if short of breath, heart failure cardiogenic shock or saturation <93%. Consider using nasal prongs if possible severe COPD or history of high CO2 levels and reduce oxygen if oxygen saturation is >93%.
- SL GTN
- Morphine as appropriate with an antiemetic
- Aspirin 150mg chewed
- **Primary angioplasty**: ticagrelor 180mg is the preferred P2Y12 Inhibitor
  - bivalirudin or unfractionated heparin according to local protocols
- **Fibrinolytic therapy**: TNK or r-PA,
  - clopidogrel 300mg <75 years, 75mg, ≥75 years;
  - enoxaparin 30mg IV bolus and then 1mg bid if <75 years no bolus and 0.75mg bid if ≥75 years
- Atorvastatin 80mg

**Reperfusion therapy**—Urgent reperfusion of the ischaemic myocardium by restoration of flow in the occluded epicardial coronary artery is the primary therapeutic goal in patients with STEMI who present ≤ 12 hours of symptom onset. If
reperfusion therapies are initiated early after symptom onset, the infarctions are smaller, complications are reduced and survival is greater.\textsuperscript{21} When epicardial flow is restored within 30 minutes of occlusion infarction may be aborted. Reperfusion can be achieved using a strategy of primary PCI, fibrinolysis or a pharmacoinvasive approach.

Primary angioplasty is superior to fibrinolytic therapy in reducing mortality, reinfarction, and stroke. Therefore the preferred reperfusion strategy for STEMI is primary angioplasty if performed by an experienced team. \textbf{Class I; Level of Evidence A}

However there may be situations where fibrinolytic therapy is appropriate such as treatment within 1 hour of symptom onset when outcomes with fibrinolytic therapy may be similar to those achieved with primary angioplasty.

\textbf{Table 3. Primary angioplasty compared with fibrinolytic therapy}

<table>
<thead>
<tr>
<th>Primary PCI preferred</th>
<th>Fibrinolytic therapy preferred</th>
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<tbody>
<tr>
<td>Primary PCI capable catheterisation laboratory available (door-to-balloon time &lt;90 minutes)</td>
<td>Primary PCI capable catheterisation laboratory not available</td>
</tr>
<tr>
<td>Appropriate operator and team experience</td>
<td>Transfer for PCI not possible &lt;120 min</td>
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<tr>
<td>Duration of symptoms ≥1 hour</td>
<td>Duration of symptoms &lt;1 hour (and delay to laboratory)</td>
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<tr>
<td>Cardiogenic shock</td>
<td>Difficult vascular access</td>
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<td>Contraindications to fibrinolysis (Table 8)</td>
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</table>

- Primary PCI should be performed in patients with STEMI and cardiogenic shock or acute severe heart failure, irrespective of time delay from MI onset\textsuperscript{22–24} \textbf{Class I; Level of Evidence: B}

- Reperfusion therapy is reasonable for patients with STEMI and symptom onset within the prior 12 to 24 hours who have clinical and/or ECG evidence of ongoing ischaemia. Primary PCI is the preferred strategy in this population. \textbf{Class I; Level of Evidence C}

- Reperfusion therapy with primary PCI may be considered in stable patients presenting 12–24 hours after symptom onset. \textbf{Class IIa; Level of Evidence B}

\textbf{Primary angioplasty}

The catheterisation laboratory staff should be notified by a single call,\textsuperscript{25} preferably while the patient is enroute to hospital, laboratory staff should aim to arrive in the catheterisation laboratory within 20 min of being contacted.

- On arrival at hospital, the patient should be taken to the catheterisation laboratory as soon as catheterisation laboratory staff are available. \textbf{Class IIa; Level of Evidence B}
Table 4. Primary angioplasty: exclusion criteria

- Dementia
- Inability to perform activities of daily living
- Life expectancy <3 months

Frailty, comorbidities, procedural risk, ability to benefit, and patient preferences must be taken into account. **Class I; Level of Evidence C**

There should be no age criteria. Peripheral vascular disease, inability to lie flat (patients can be intubated), renal impairment and severe respiratory disease are not exclusions.

Table 5. Angiography and PCI

- Radial approach is preferred
- UFH or bivalirudin
- Thrombectomy may be considered
- Drug-eluting or bare metal stents—depending upon patient factors (adherence, bleeding risk, planned surgery etc) and lesion characteristics
- Non-culprit vessel PCI may be considered.
- Selective IIb/IIIa antagonist use IC or IV is recommended for slow flow, angiographic thrombus or embolism

**Intra-aortic balloon pumping**

- Routine use of Intra-aortic balloon pumping IABP (in patients without shock) is not recommended. **Class III; Level of Evidence A**

The Counterpulsation to Reduce Infarct Size Pre-PCI-Acute MI (CRISP AMI) trial showed no benefit of routine insertion of an IABP in patients with anterior MI without shock, and showed increased bleeding, which is consistent with previous data regarding the role of IABPs in patients with acute MI without cardiogenic shock.

**Aspiration thrombectomy**

Aspiration thrombectomy may be considered in patients undergoing primary PCI. **Class IIb, Level of Evidence B**
One single-centre randomised trial, the Thrombus Aspiration during Percutaneous coronary intervention in Acute myocardial infarction (TAPAS) trial,\textsuperscript{31,32} showed improvement in indices of myocardial reperfusion (ST-segment resolution and myocardial blush) with routine use of manual thrombus aspiration before a balloon or a stent was introduced into the coronary artery. One-year follow-up showed a reduction in mortality with thrombus aspiration as a secondary endpoint.

In the TASTE (Thrombus Aspiration in ST-Elevation Myocardial Infarction in Scandinavia) trial\textsuperscript{72} 44 patients were randomised to receive thrombus aspiration. Thrombus aspiration resulted in no difference in 30-day mortality; 2.8\% vs 3.0\% or other efficacy or safety endpoints. Long-term follow-up is awaited.\textsuperscript{33}

**Stenting**

Stenting is recommended over balloon angioplasty alone. \textbf{Class I; Level of Evidence A}

Drug eluting stents are be preferred, according to standard PCI guidelines. \textbf{Class IIa, Level of Evidence A}

Bare-metal stents should be considered in patients with high bleeding risk, inability to comply with 6 months of dual antiplatelet therapy (DAPT), or anticipated invasive or surgical procedures in the next 6 months.

**Culprit vessel or multivessel PCI**

PCI of non-culprit lesions may be considered in patients with cardiogenic shock \textbf{Class IIa; Level of Evidence B} and persistent ischaemia after PCI of the culprit lesion. PCI of the non-culprit lesions at the time of primary PCI may also be considered in stenosis of >50\%. \textbf{Class IIb; Level of Evidence B}\textsuperscript{34-39} In the PRAMI (Preventive Angioplasty in Acute Myocardial Infarction) trial\textsuperscript{39} 246 patients with PCI of the non-infarct culprit lesions > 50\% resulted in a reduction in the endpoint of cardiovascular death, MI or refractory angina at 23 months; HR 0.35; 95\% CI 0.21 – 0.58; p<0.001. There was a trend for cardiac death to be reduced; HR 0.34; 95\% CI 0.11 – 1.08; p=0.07.

**P2Y12 inhibitors**

\textbf{Ticagrelor—Administration of ticagrelor is the preferred P2Y12 inhibitor and should be given at presentation in all patients with STEMI undergoing primary PCI, with a 180 mg loading dose, even in patients who have already received clopidogrel, and then 90 mg bid for a year. Class I; Level of Evidence B}

Ticagrelor should be stopped 5 days prior to surgery.

This recommendation is based on one trial, the PLATelet inhibition and patient Outcome (PLATO) trial, where there was a 22\% (1.4\% absolute) reduction in total mortality with a significant 16\% (1.9\% absolute) reduction in CV death, MI and stroke with diverging event curves up to 12 months. There was an increase in non CABG-related PLATO defined major bleeding (4.5\% vs 3.8\%, p=0.03)\textsuperscript{340}

Contraindications are those on dialysis, those with ≥ moderate liver dysfunction, those with severe lung disease, and those with advanced conduction system disease (≥ Mobitz type 2).
Prasugrel—Prasugrel (60 mg loading dose, then 10 mg daily) can be considered for patients who are not receiving a P2Y12 inhibitor (safety of switching is not well defined) and in diabetes, where a larger effect was shown in the Therapeutic Outcomes by Optimizing Platelet Inhibition with Prasugrel (TRITON) trial unless patients have had a previous stroke, transient ischaemic attack, <60 kg, or are at high bleeding risk. Class I; Level of Evidence B

Prasugrel is funded by PHARMAC for 7 days after STEMI and for patients who have undergone drug eluting stent implantation, angioplasty or had a bare metal stent implanted in the previous 4 weeks and are clopidogrel-allergic or have experienced stent thrombosis whilst on clopidogrel.

Prasugrel should be stopped 7 days prior to surgery.

Clopidogrel—Clopidogrel should be considered for use in patient cohorts with contraindications to ticagrelor and prasugrel and in patients at very high bleeding risk. In general clopidogrel should not be used unless ticagrelor or prasugrel are not available or these drugs have to be stopped for a major side effect. Class I; Level of Evidence C

Antithrombotic therapy with primary PCI

Unfractionated heparin (UFH) Class I; Level of Evidence C or bivalirudin Class I; Level of Evidence B can be used for primary PCI. In the absence of a single trial showing benefit enoxaparin is not recommended.

There have been no placebo-controlled trials evaluating UFH in primary PCI but there is a large body of experience with this agent. One large open-label trial demonstrated the superiority of bivalirudin over the combination of UFH+GP IIb/IIIa inhibitor, with the benefit being driven by a marked reduction in bleeding. There was also decreased thrombocytopenia. There was an increase in stent thrombosis in the first 30 days in the bivalirudin arm. The reduction in all cause and cardiovascular mortality at 30 days, was maintained up to 3 years.

In the EUROMAX (European Ambulance Acute Coronary Syndrome Angiography) trial pre-hospital administration of bivalirudin in 2218 patients with STEMI reduced major bleeding by 47%; 2.6% vs 6.0%; p<0.001. There was no difference in death. There was an increase in stent thrombosis within 24 hours (1% vs 0.2%; p=0.007).

Unfractionated heparin dosing—With GP IIb/IIIa receptor antagonist planned: 50–to 70 -U/kg IV bolus.

With no GP IIb/IIIa receptor antagonist planned: 70–to 100 -U/kg bolus.

Bivalirudin dosing—Bivalirudin: 0.75-mg/kg IV bolus, then 1.75-mg/kg/h infusion with or without prior treatment with UFH. Reduce infusion to 1 mg/kg/h with estimated creatinine clearance <30 mL/min. A bolus only can be given if the procedure is expected to be <1 hour.

Bivalirudin is preferred over UFH in patients at high risk of bleeding. Class I; Level of Evidence C
Glycoprotein IIb/IIIa inhibitors with primary PCI

Routine upstream administration of IIb/IIIa inhibitors is not recommended for PCI and stenting. **Class III; Level of Evidence B**

IIb/IIIa inhibitors (eptifibatide **Class IIb; Level of Evidence B** or abximab **Class IIb; Level of Evidence A** are recommended to be considered to be given selectively when there is angiographic thrombus, embolism or slow flow. **Class II; Level of Evidence B**

High bolus dose tirofiban can be given upstream and has shown benefit \(^{45,46}\) but is no longer funded by PHARMAC.

IC rather than i.v. administration of GP IIb/IIIa inhibitors has been tested in several small studies with variable results. \(^{47}\) In the Intracoronary Abciximab Infusion and Aspiration Thrombectomy in Patients Undergoing Percutaneous Coronary Intervention for Anterior ST Segment Elevation Myocardial Infarction (INFUSE-AMI) trial comparing IC abximab versus no abximab there was a reduction in infarct size as measured by magnetic resonance imaging (MRI).\(^ {30}\)

In the large Abciximab Intracoronary versus Intravenous Drug Application 4 in STEMI (AIDA-4) trial there was a significant reduction in heart failure at 90 days but not at 12 months (p=0.07) with IC versus IV abximab.\(^ {48}\) There was no reduction in the primary composite of death, reinfarction and heart failure at one year.

There have been no trials of IC IIb/IIIa administration versus placebo for poor coronary flow, distal embolisation or large thrombus burden. There has been no evidence of harm with IC administration.

It is recommended that IC administration and continuing IV administration be given for 18–24 hours in these circumstances. **Class IIa; Level of Evidence C**

**Dosing**

Abciximab: 0.25-mg/kg IV bolus, then 0.125 mcg/kg/min (maximum 10mcg/min).

IC abximab 0.25-mg/kg bolus.

Eptifibatide: (double bolus): 180-mcg/kg IV bolus, then 2 mcg/kg/min; a second 180-mcg/kg bolus is administered 10 minutes after the first bolus. In patients with creatinine clearance <50 mL/min the infusion should be reduced by 50%. The boluses can be given IC.

**PCI of a non-infarct artery before hospital discharge**

PCI is indicated in a non-infarct artery at a time separate from the primary PCI if recurrent ischaemia occurs at rest or on mild to moderate exercise. **Class I; Level of Evidence C**, and is reasonable in patients with inducible ischaemia on non-invasive testing or decreased fractional flow reserve <0.80. **Class IIa; Level of Evidence B**
Table 6. Time targets for primary PCI

- First medical contact to ECG <10 minutes
- Door to device times <90 minutes
- Transfer to device times <120 minutes

Table 7. Audit of primary PCI

A person should be identified at each hospital that is responsible for audit and feedback

- Onset of symptoms to time to seek medical help
- First medical contact to ECG ≤10 minutes
- Single call to alert PCI team
- Door to device: ≤ 90 minutes

All aspects of delay should be audited with regular feedback to all parties involved.

Fibrinolytic therapy

Fibrinolytic therapy is recommended within 12 hours of onset of ischaemic symptoms in patients without contraindications or primary PCI cannot be performed by an experienced team within 120 minutes of first medical contact. Class I; Level of Evidence A

Choice of fibrinolytic—In the absence of contraindications (Table 8) a fibrin specific agent (tPA, TNK, r-PA) is most effective and are recommended.49 Class I; Level of Evidence B
Table 8a. Major contraindications to fibrinolytic therapy

- Suspected aortic dissection
- Cerebral aneurysm, arteriovenous malformation or intracranial neoplasm
- Major trauma, head injury within 6 weeks
- Head trauma or brain surgery within 6 months
- Active bleeding or known bleeding disorder
- Traumatic cardiopulmonary resuscitation <3 weeks
- Ischaemic stroke <1 year
- Previous haemorrhagic stroke or stroke of unknown origin at any time
- Gastrointestinal bleeding <1 month
- Other internal bleeding last 6 weeks
- Non-compressible vascular punctures in the last 24 hours (e.g. central venous lines, liver biopsy)
- Dementia
- Severe uncontrolled hypertension (BP >180/110mmHg)

Table 8b. Relative contraindications to fibrinolytic therapy

- Transient ischaemic attack <6 months
- Known bleeding diathesis
- Severe renal dysfunction i.e. glomerular filtration rate <30mL/min
- Advanced liver disease (bilirubin elevated or enzymes >5× normal)
- Internal bleeding last 6 months
- Pregnancy or <1 week postpartum
- Lumbar puncture within previous month
- Acute pancreatitis
- Acute peptic ulceration
- Active cavitating pulmonary tuberculosis
- Infective endocarditis
- Intracardiac thrombi
- Previous streptokinase therapy (use a fibrin specific agent)
- Warfarin therapy
- Dabigatran, rivaroxaban, apixaban, edoxaban or other novel anticoagulants
Dosing of fibrinolytic agents

- Streptokinase – infusion (1.5 MU over 30 minutes)
- TPA – infusion (weight based up to 100 mg over 90 minutes
- r-PA – 10 units over 2 minutes repeated after 30 minutes
- TNK– weight adjusted bolus 30–50 mg over 5–10 seconds, reduced to 50% of dose in patients ≥75 years

**P2Y12 inhibitors with fibrinolytic therapy**

For patients who are <75 years it is recommended that a loading dose of 300 mg of clopidogrel be given. For patients >75 years 75 mg of clopidogrel should be given at presentation. Class I; Level of Evidence A

Prasugrel and ticagrelor have not been studied as adjuncts to fibrinolysis and should not be given in the first 24 hours.

Ticagrelor should be started 24 hours after beginning fibrinolysis with a loading dose of 180 mg and continued 90 mg bid for a year. Class IIa; Level of Evidence C

**Antithrombotic therapy with fibrinolytic therapy**

Enoxaparin is the preferred antithrombotic therapy with fibrinolytic therapy. Class I; Level of Evidence A In the Enoxaparin and Thrombolysis Reperfusion for Acute MI (EXTRACT) trial 30-day death or MI was reduced by 17% with enoxaparin compared with UFH (12.0% vs 9.9%) p<0.0001. Major bleeding was increased by 0.7% absolute in patients treated with enoxaparin (1.4% UFH vs 2.1% enoxaparin) with similar rates of intracranial haemorrhage 0.7% UFH vs 0.8% enoxaparin. In patients ≥75 years the absolute benefit of enoxaparin was similar to the benefit in younger patients and major bleeding (2.9% vs 3.3%) and intracranial haemorrhage (1.7% vs 1.6%) was similar in patients treated with UFH and enoxaparin.

In patients <75 years an IV bolus of 30 mg followed by 1.0 mg/kg 12 sc hourly should be given for at least 48 hours. In patients aged ≥75 years the bolus should be omitted and 0.75 mg given sc 12 hourly. For patients with creatinine clearance ≤30 ml/min the dose of enoxaparin should be reduced to 1.0 mg/kg once a day.

Enoxaparin should be continued up to the time of revascularisation or hospital discharge. Class I; Level of Evidence A

If patients have been pre-treated with enoxaparin no additional enoxaparin is necessary if PCI is performed within 8 hours of the previous dose. If the previous dose of enoxaparin was >8 hours an additional 0.3 mg/kg IV is required.

In view of increased bleeding and events if patients are switched from one antithrombotic agent to another, patients should continue on the initial antithrombotic agent. Class III; Level of Evidence B
IIB/IIIa receptor antagonists with fibrinolytic therapy

IIB/IIIa receptor antagonists should not be used in patients receiving fibrinolytic therapy because of increased bleeding and lack of effectiveness. Class III; Level of Evidence A

Time targets for fibrinolytic therapy

Door to needle time should be <30 minutes.

Table 9. Audit of fibrinolytic therapy

<table>
<thead>
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<th>Target</th>
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<tbody>
<tr>
<td>A person should be identified at each hospital who is responsible for audit and feedback</td>
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<tr>
<td>Onset of symptoms to time to seek medical help</td>
</tr>
<tr>
<td>Time from seeking medical help to arrival at hospital</td>
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<tr>
<td>Door to ECG ≤10 minutes</td>
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<tr>
<td>Door to needle time ≤30 minutes as appropriate</td>
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<tr>
<td>Time to angiogram</td>
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<tr>
<td>Percentage of patients having an angiogram</td>
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<tr>
<td>Percentage of patients having PCI</td>
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</table>

Rescue PCI

Patients with ongoing ischaemic symptoms or haemodynamic instability should be urgently transferred to a PCI capable centre for angiography and PCI as appropriate. Class I; Level of Evidence A

Facilitated PCI

Large scale clinical trials have shown that facilitated PCI i.e. all patients are taken directly to the cardiac catheterisation laboratory immediately following fibrinolysis failed to improve outcomes compared to primary PCI alone, perhaps due to the prothrombotic state induced by fibrinolysis.\textsuperscript{53,54} Facilitated PCI is not recommended. Class III; Level of Evidence A

Pharmacoinvasive strategy

The pharmacoinvasive strategy aims at ensuring an open artery acutely with fibrinolysis and rescue PCI for failure of reperfusion and stenting of the culprit stenosis in successfully reperfused patients 3–24 hours after commencing fibrinolytic therapy.
In a recent combined data overview (n=2961) of trials comparing the pharmacoinvasive strategy to fibrinolytic therapy with standard of care with PCI only being performed for rescue or recurrent ischaemia there was a significant reduction in reinfarction (OR 0.55, 95% CI 0.36–0.82; p=0.003) and recurrent ischaemia (OR 0.25, 95% CI 0.13–0.49; p=0.001) at 30 days with the pharmaco-invasive strategy but there was no benefit on 30 day (OR 0.87, 95% CI 0.59–1.30) or 6 month (OR 0.88, 95% CI 0.62–1.25) mortality. These benefits were achieved without an increased risk of major bleeding (OR 0.93, 95% CI 0.67–1.31) or stroke (OR 0.63, 95% CI 0.31–1.26).

In the recent Strategic Reperfusion Early after Myocardial Infarction (STREAM) study 1892 patients with STEMI who presented <3 hours after symptom onset and who were unable to undergo primary PCI within 1 hour, were randomised to either primary PCI or fibrinolytic therapy. In the fibrinolysis group bolus TNK was given (amended to half dose in patients ≥75 years of age when the data and safety monitoring board noticed increased intracranial haemorrhage), clopidogrel, and enoxaparin before transport to a PCI-capable hospital. Emergency coronary angiography was performed if fibrinolysis failed (ST resolution <50% at 90 minutes); otherwise, angiography was performed 6 to 24 hours after randomisation. The primary end point was a composite of death, shock, congestive heart failure, or reinfarction at 30 days. The primary end point occurred in 116 of 939 patients (12.4%) in the fibrinolysis group and in 135 of 943 patients (14.3%) in the primary PCI group (relative risk in the fibrinolysis group, 0.86; 95% confidence interval, 0.68 to 1.09; P=0.21). Emergency angiography was required in 36.3% of patients in the fibrinolysis group, whereas the remainder of patients underwent angiography at a median of 17 hours after randomisation. More intracranial haemorrhages occurred in the fibrinolysis group than in the primary PCI group (1.0% vs. 0.2%, P=0.04; after protocol amendment, 0.5% vs. 0.3%, P=0.45).

**Recommendations**

- Patients with a door to device time >120 minutes should receive fibrinolytic therapy followed by PCI as appropriate. **Class I; Level of Evidence A**

- Patients with failure of ≥50% ST segment resolution or new ST depression at 60 minutes after beginning fibrinolytic therapy should be immediately transferred to a PCI capable centre. **Class I; Level of Evidence A** This doesn’t mean that hospital should wait for 60 minutes before starting the transfer process. The emergent process (accessing availability of transport, time delays etc) can be started as soon as fibrinolytic therapy is begun in patients who are felt to be potentially eligible for emergent transfer if they fail to reperfuse.

- All patients with successful reperfusion should be transferred to a PCI capable centre for angiography **Class I; Level of Evidence A** and PCI as appropriate 3-24 hours after beginning fibrinolytic therapy. **Class IIa; Level of Evidence A** This should include patients with a GRACE score ≥155. If this cannot be achieved it definitely should be achieved <72 hours. **Class IIa; Level of Evidence A**
Table 10. Time targets for referral hospital

- First medical contact to ECG: goal ≤10 minutes
- Time to call transport – goal ≤45 minutes
- Transport to PCI hospital: goal ≤45 minutes
- Door to device at PCI hospital goal <30 minutes
- Total time to device goal <120 minutes

Reinfarction

Approximately 2–6% of patients experience reinfarction in hospital and this is associated with increased mortality and more frequent heart failure, cardiogenic shock and ventricular arrhythmias.

If new ST elevation is evident on a 12 lead ECG urgent PCI should be considered in PCI capable hospitals. Class I; Level of Evidence A

In hospitals without PCI facilities re-administration of a fibrin-specific agent (50% of dose in first 24 hours and full dosage if ST elevation reinfarction occurs after 24 hours) should be considered, followed by urgent transfer for PCI. Class IIa; Level of Evidence A

Therapy in patients failing to receive reperfusion therapy

Unfortunately 27% of patients in New Zealand who are eligible to receive reperfusion therapy fail to receive it.59

Patients should receive aspirin 150 mg and ticagrelor as a 180 mg loading dose and then 90 mg bid for a year. An antithrombin agent either UFH or enoxaparin should be begun immediately, if there are no contraindications, and continued for at least 48 hours. Glycoprotein IIb/IIIa inhibitors are not recommended. Class III; Level of Evidence C

Surgical revascularisation

The success of PCI and fibrinolysis for STEMI has meant that the need for urgent surgical coronary artery bypass grafting (CABG) is limited to a very few select circumstances although it may be used as the primary reperfusion strategy in 2–5% of patients with STEMI. Surgery may be appropriate in the following circumstances:

- Failed PCI (primary or rescue) with ongoing symptoms and/or haemodynamic compromise. Class I; Level of Evidence B
- In patients who require surgical management of severe mitral regurgitation due to ischaemic papillary muscle rupture or repair of ventricular septal rupture, or sub acute rupture. Class I; Level of Evidence B
• Patients who are unsuitable for fibrinolysis or PCI who have persistent or recurrent ischaemia refractory to medical therapy. **Class I; Level of Evidence B**

• Patients <75 years (and selected older patients without important comorbidity) who develop cardiogenic shock within 36 hours of STEMI, have left main or severe 3 vessel coronary artery disease and can undergo CABG within 18 hours of the development of shock. **Class I; Level of Evidence B**

All patients undergoing CABG should be prescribed evidence based therapies at discharge such as aspirin, ticagrelor for 12 months if after ACS, β-blockers, angiotensin converting enzyme (ACE) inhibitors or angiotensin receptor blockers (ARBs) and statins. **Class IIa; Level of Evidence B**

**Table 11. Adjunctive therapies for all STEMI patients**

- Continue aspirin ≤100mg long-term
- Ticagrelor (or prasugrel or clopidogrel) for 1 year
- ACE inhibitors or ARBs to reduce remodelling as the first drug (compared to β-blocker) if hypotensive i.e.: BP <105mmHg
- Oral β-blocker if patients not in decompensated heart failure and continue 1-3 years. For patients with heart failure should be initiated when stable and along with patients with decreased ejection fractions should be continued long-term.
- Statin therapy to optimise LDL <1.6mmol/L
- Spironolactone in patients treated with ACE inhibitors and β-blockers with EF ≤ 40% or heart failure or diabetes
- Antihypertensive therapy (non pharmacologic or pharmacologic) should be initiated and continued long-term to maintain BP <130/80mmHg
- Nitrates for angina or hypertension
- Calcium channel blockers for angina or hypertension and coronary artery spasm
- Nicotine patches and lozenges for smoking cessation
- Anticoagulation as appropriate for AF

**β-blockers**

IV β-blockers can be used during PCI for pain and/or electrical instability and should be considered for administration immediately following primary PCI or initiation of fibrinolysis in patients who are haemodynamically stable without decompensated heart failure and without contraindications (asthma, systolic BP <110 mmHg, heart rate <50 minutes, PR Interval >0.24 msecs, Mobitz Type II 2nd degree or 3rd degree
heart block). **Class IIa; Level of Evidence B** e.g. metoprolol 5 mg IV bolus every 2 minutes up to 15 mg followed 15 minutes later by 50 mg orally. For patients with heart failure or decreased ejection fraction it is recommended that β-blockers (carvedilol, metoprolol or bisoprolol) be begun when the patient is stable for 24–48 hours and continued long-term. **Class I; Level of Evidence A**

The data for long-term β-blockers was obtained prior to the reperfusion era and the trials were not performed with background therapy of aspirin and statins. β-blockers can be stopped at 1–3 years after MI or continued in the absence of side-effects. **Class IIa; Level of Evidence B**

**ACE inhibitors and ARBs**

All patients with evidence of heart failure, anterior infarction, LV systolic dysfunction, diabetes, or a history of previous infarction should be considered to receive oral ACE inhibitors beginning 2 hours after admission if the systolic BP is >100 mmHg usually commencing with a low dose of a short acting drug and then increasing over several days to maximally tolerated doses. **Class I; Level of Evidence A** In all other patients ACE inhibitors are recommended to be begun on day 1 and continued long term. **Class IIa; Level of Evidence A** An ARB should be commenced if an ACE inhibitor is not tolerated.

If a choice has to be made between β-blockers and ACE inhibitors because of hypotension, ACE inhibitors are the preferred initial therapy (because of their effect on remodelling). If patients are intolerant of ACE inhibitors they should be started on an ARB. **Class I; Level of Evidence B**

**Aldosterone antagonists**

Aldosterone antagonists are recommended in patients treated with β-blockers and ACE inhibitors or ARBS who have an ejection fraction ≤40%, heart failure (defined as the presence of basal crepitations, pulmonary hypertension on a chest X-ray, or a third heart sound) or diabetes, provided that the serum creatinine is <220 μmol/L in men and <180 μmol/L in women, and potassium is <5.0 mEq/L. **Class I; Level of Evidence B**

**Lipid modifying therapy**

Initiation of statin therapy should begin on admission to hospital in high dose (e.g. atorvastatin 80 mg). **Class I; Level of Evidence A** Administration of high dose statins is reasonable before PCI to reduce the risk of type 4a (periprocedural MI). **Class IIa; Level of Evidence A** The long-term aim is to reduce events, and to improve adherence. **Class I; Level of Evidence B**

Meta-analysis of trials comparing more versus less-intensive LDL-cholesterol lowering with statins show that, compared with less-intensive regimes, more-intensive statin therapy results in reduced cardiovascular death, MI, ischaemic stroke and coronary revascularisation.

The LDL should be reduced to <1.6 mmol/L. **Class IIa; Level of Evidence C**
Nitrates

Nitrates are appropriate for the control of angina and hypertension and can be used for coronary artery spasm during PCI and for coronary artery spasm longterm.

Calcium channel blockers

There is no evidence that calcium antagonists improve prognosis following STEMI, but they can be used for angina preferably in combination with a β-blocker and for hypertension or coronary artery spasm. Heart rate limiting calcium channel blockers are preferred if patients cannot tolerate a β-blocker e.g. verapamil or diltiazem. Class IIb; Level of Evidence B

Calcium channel blockers that increase heart rate should not be used without concomitant β-blocker therapy. Class III; Level of Evidence A

Long-term anticoagulation—Patients with pedunculated or mobile left ventricular thrombus should be anticoagulated for a minimum of 3–4 months Class IIa; Level of Evidence B with repeat echocardiography at this time to determine if continuation of anticoagulation is appropriate. Anticoagulation of patients with low ejection fractions and no LV thrombus is controversial and treatment should be individualised.
Anticoagulation can be considered in patients with large anterior wall motion abnormalities, if they are at low risk of bleeding, to prevent the development of thrombi. There is no need to anticoagulate patients with transient AF (<24 hours). Class IIa; Level of Evidence B

Patients with persistent AF and a CHADSVASC score>2 should be anticoagulated long-term. Class I; Level of Evidence C dabigatran is preferred to warfarin because of the greater effect on reduction of stroke and embolism with high dose (150mg bid) and lower bleeding with low dose (110 mg bid) and significantly lower rates of intracranial haemorrhage (5–6 events per 100 patient years) with both doses compared with good international normalised ratio (INR) control (INR in therapeutic range >73% of the time) on warfarin.

Bleeding risk should be assessed by the HAS-BLED score (www.qxmd.com/calculate-online/cardiology/has-bled-score-bleeding-in-atrial-fibrillation), which is available for iPods and iPhones. There is also a pocket guide available (Figure 2).
Figure 2. HAS-BLED pocket guide\textsuperscript{78} (published in HAS-BLED Pocket Guide)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>Hypertension (systolic BP &gt;160mmHg)</td>
</tr>
<tr>
<td>A</td>
<td>Abnormal renal function creatinine &gt;200μmol/L</td>
</tr>
<tr>
<td></td>
<td>Liver function bilirubin &gt;2x normal, AST/ALT &gt;2x normal</td>
</tr>
<tr>
<td>S</td>
<td>Stroke History</td>
</tr>
<tr>
<td>B</td>
<td>Predisposition to/prior major bleeding</td>
</tr>
<tr>
<td>L</td>
<td>Labile INR</td>
</tr>
<tr>
<td>E</td>
<td>Elderly age &gt;65</td>
</tr>
<tr>
<td>D</td>
<td>Drugs alcohol, antiplatelet agents, NSAIDS</td>
</tr>
</tbody>
</table>

Score Bleeding risk classification (% bleeds per 100 patients-years)

<table>
<thead>
<tr>
<th>Score</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>Low risk (1.1%)</td>
</tr>
<tr>
<td>2</td>
<td>Intermediate risk (1.9%)</td>
</tr>
<tr>
<td>≥3</td>
<td>High risk (4.9%)</td>
</tr>
</tbody>
</table>

Apixaban\textsuperscript{79} has been shown to decrease stroke, systemic embolism and mortality as compared with warfarin therapy. Rivaroxaban,\textsuperscript{80} and edoxaban\textsuperscript{81} have been shown to be non-inferior to warfarin with respect to stroke and systemic embolism but to have lower rates of bleeding. Edoxaban also had lower mortality than warfarin. These drugs may be funded by PHARMAC in the future.

**Diabetes mellitus**

Diabetics are a high-risk group and all patients with glucose >11mmol/L should be treated with a dose-adjusted insulin regimen. Class IIa; Level of Evidence B\textsuperscript{82} There are several appropriate regimens, a routine glucose, insulin, potassium regimen is not recommended Class III, Level of Evidence A (see local regimens).

**Renal dysfunction**—Renal dysfunction is present in approximately 30–40% of patients with ACS and is associated with a worse prognosis and increased bleeding risk.

In patients with known or anticipated reduction of renal function, several antithrombotic agents (e.g. enoxaparin and eptifibatide) should be either withheld or their doses reduced appropriately. Ensuring proper hydration before (IV fluids started)
and after primary PCI, and limiting the dose of contrast agents are important for minimizing the risk of contrast-induced nephropathy.

In the PLATO trial the benefit of ticagrelor was consistent or enhanced in patients with renal dysfunction i.e. GFR <60 ml/min.83

Risk stratification—Risk assessment plays an important role in predicting patient prognosis and initiating appropriate evidence-based therapies in patients who are most likely to benefit from them. There are a number of risk scores. The Global Registry of Acute Coronary Events (GRACE) risk score for early risk stratification in patients with STEMI is used most commonly for predicting mortality 6 months after the MI and should be calculated on admission and at discharge84,85 (Figure 3) (It is available on IPODS and iPads (www.outcomes.org/GRACE).

Table 12. Admission GRACE Risk Score84

<table>
<thead>
<tr>
<th>Variables</th>
<th>Points</th>
<th>Variables</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
<td>Creatinine (μmol/L)</td>
<td></td>
</tr>
<tr>
<td>&lt;40</td>
<td>0</td>
<td>0-34</td>
<td>2</td>
</tr>
<tr>
<td>40-49</td>
<td>18</td>
<td>35-70</td>
<td>5</td>
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<tr>
<td>50-59</td>
<td>36</td>
<td>71-105</td>
<td>8</td>
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<td>60-69</td>
<td>55</td>
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<td>70-79</td>
<td>73</td>
<td>141-176</td>
<td>14</td>
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<tr>
<td>≥80</td>
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<td></td>
<td></td>
<td>≥354</td>
<td>31</td>
</tr>
<tr>
<td>Heart Rate (beats per min)</td>
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<td>Heart Failure</td>
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<tr>
<td>&lt;70</td>
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<td>Class I (No heart failure)</td>
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<tr>
<td>70-89</td>
<td>13</td>
<td>Class II (Rales – JVP)</td>
<td>21</td>
</tr>
<tr>
<td>90-109</td>
<td>23</td>
<td>Class III (Pulmonary oedema)</td>
<td>43</td>
</tr>
<tr>
<td>110-149</td>
<td>36</td>
<td>Class IV (SHOCK)</td>
<td>64</td>
</tr>
<tr>
<td>150-199</td>
<td>46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥200</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
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<td>Other risk factors</td>
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</tr>
<tr>
<td>&lt;80</td>
<td>63</td>
<td>Cardiac arrest at admission</td>
<td>43</td>
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<tr>
<td>80-99</td>
<td>58</td>
<td>Elevated cardiac markers</td>
<td>15</td>
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<tr>
<td>100-119</td>
<td>47</td>
<td>ST segment deviation</td>
<td>30</td>
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<tr>
<td>120-139</td>
<td>37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>140-159</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>160-199</td>
<td>11</td>
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<td></td>
</tr>
<tr>
<td>≥200</td>
<td>0</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Points</th>
<th>Probability of in-hospital death (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤60</td>
<td>≤0.2</td>
</tr>
<tr>
<td>70</td>
<td>0.3</td>
</tr>
<tr>
<td>80</td>
<td>0.4</td>
</tr>
<tr>
<td>90</td>
<td>0.6</td>
</tr>
<tr>
<td>100</td>
<td>0.8</td>
</tr>
<tr>
<td>110</td>
<td>1.1</td>
</tr>
<tr>
<td>120</td>
<td>1.6</td>
</tr>
<tr>
<td>130</td>
<td>2.1</td>
</tr>
<tr>
<td>140</td>
<td>2.9</td>
</tr>
<tr>
<td>150</td>
<td>3.9</td>
</tr>
</tbody>
</table>
160 5.4  
170 7.3  
180 8.9  
190 13  
200 18  
210 23  
220 29  
230 36  
240 44  
≥250 ≥52

This score should be recorded in all ACS patients to aid medical management to determine whether an invasive strategy is appropriate and its timing, taking into account co-morbidities, including frailty and renal failure, risk of an invasive procedure, likelihood to benefit and patient preferences. A score >155 denotes high risk (>5% in-hospital mortality). The score should also be recorded at discharge to determine 6 month prognosis

Figure 3. GRACE Risk calculator for 6 month post discharge mortality after hospitalization\(^8\) (Adapted with permission from Eagle KA, et al. JAMA. 2004;291(22):2727 – Figure 2.)
Management of patients with STEMI and out-of-hospital cardiac arrest

Immediate angiography and PCI, when indicated, should be performed in resuscitated out-of-hospital cardiac arrest patients whose initial ECG shows STEMI or LBBB not known to be old. Class I; Level of Evidence B

Therapeutic hypothermia should be started as soon as possible in comatose patients with STEMI and out-of-hospital cardiac arrest caused by ventricular fibrillation or pulseless ventricular tachycardia, including patients who undergo primary PCI. Class I; Level of Evidence B

Immediate angiography and PCI should be considered in survivors of cardiac arrest without diagnostic ECG changes of STEMI but with a high suspicion of ongoing infarction. Class IIa; Level of Evidence B

Complications of myocardial infarction

The majority of deaths in hospitalised patients with STEMI are due to LV pump failure and mechanical complications. Compared to the pre-reperfusion era, death from ventricular tachyarrhythmias is now less common.

Mechanical complications—A number of mechanical complications may occur including mitral regurgitation, ventricular septal defect and free wall rupture—all of which require urgent echocardiography, and may require urgent insertion of an IABP and urgent surgical consultation.

Arrhythmias—Ventricular or atrial arrhythmias are frequent. Local CCUs have standard protocols for treatment.

Ongoing ischaemia

If patients have ongoing ischaemia expeditious angiography should be performed and PCI or CABG performed as appropriate. CABG is recommended for consideration in patients with a high syntax score (>32)66 Class IIa; Level of Evidence B and patients with diabetes.67 Class IIa; Level of Evidence A

An ECG should be obtained during symptoms to document the degree and extent of ischaemia.

Cardiogenic shock

The presence of shock due to left ventricular dysfunction following MI implies ischaemia/infarction of a large area of myocardium and is associated with 70–80% inhospital mortality. Shock is defined as hypotension (BP <90 mmHg or requiring inotropes to keep the BP >90 mmHg for 30 minutes) unresponsive to fluid loading and associated with decreased tissue perfusion and decreased urine output.

The Should we emergently revascularize Occluded coronaries for Cardiogenic Shock (SHOCK) trial shown that mortality is reduced to ~50% when aggressive support measures including administration of fibrinolytic therapy, intra-aortic balloon counter-pulsation, mechanical ventilation and early revascularisation are performed.22 In patients without important comorbidity the interventional team, including an anaesthetist should be contacted immediately and oxygen, appropriate ventilation and
inotropic support should be begun immediately, insertion of IABP and emergency angiography should be undertaken. For patients where PCI is not appropriate, surgery should be considered. **Class I; Level of Evidence B**

**Heart failure**—Furosemide should be given to decrease breathlessness. All patients should be placed on evidence based therapies including β-blockers, ACE inhibitors or ARBs and spironolactone. **Class I; Level of Evidence A**

Enoxaparin 40 mg/day should be given to prevent deep vein thrombosis and pulmonary embolism. **Class I; Level of Evidence A** Digoxin should be considered for patients in sinus rhythm who continue to be symptomatic despite the above therapies as it has been shown to decrease rehospitalisation. **Class IIa; Level of Evidence B**

**Right ventricular infarction**—Right ventricular infarction is usually diagnosed clinically or by ST elevation in right precordial ECG leads (see above) or on echocardiography. Patients may have raised jugular venous pressure, hypotension and clear lung fields. It is important that all patients get adequate fluids—i.e. at least 2 litres in the first 24 hours. If patients are hypotensive a fluid challenge should be given—e.g. 200 mL of IV saline over 10–15 minutes. Swan Ganz catheterisation may help monitor volume status. **Class IIa; Level of Evidence C**

**Pericarditis**

Anti-inflammatory therapy: anti-inflammatory drugs should be avoided in the first week after MI. and paracetamol used.

Glucocorticoids and nonsteroidal anti-inflammatory drugs are potentially harmful for the treatment of pericarditis after STEMI with reports of causing scar thinning and infarct expansion and increased free wall rupture. **Class III; Level of Evidence C**

**Harm**

Colchicine has been shown to have benefit in acute pericarditis and can be used in a dose of 0.6 mg 12 hourly.

**Other complications**

Delayed complications include post myocardial infarction syndrome and Deep Vein Thrombosis/Pulmonary Embolism.

**Testing for inducible ischaemia**

Most patients, except where adjustment of therapy based on the test results would not help management, those who have not had angiography or those who have had incomplete revascularisation, should undergo testing for inducible ischaemia—e.g. by treadmill, stress echo, or nuclear imaging prior to hospital discharge. **Class I; Level of Evidence A**

**Management of an occluded infarct-related artery**

Delayed PCI of a totally occluded artery >24 hours after STEMI should not be performed in asymptomatic patients with 1 or 2 vessel coronary artery disease in the absence of haemodynamic instability, ventricular arrhythmias, or recurrent ischaemia at rest or on mild to moderate exercise or inducible ischaemia on non-invasive testing. **Class III; Level of Evidence A**
Echocardiography

Echocardiography is useful for the assessment of cardiac structure and function, in particular myocardial thickness, thickening and motion. It is the imaging technique of choice for detecting complications of acute MI, including myocardial free wall rupture, acute ventricular septal defect and mitral regurgitation secondary to papillary muscle rupture or ischaemia. Echocardiography also defines valve structure and function as well as assessment of differential diagnoses.

Assessment of left ventricular function should be performed to assess left ventricular function in all patients if this has not been assessed by other means. Class I; Level of Evidence B

Magnetic Resonance Imaging

MRI can also be used for the assessment of LV Function and viability. Class IIb; Level of Evidence C

Holter monitoring

Routine Holter monitoring is not recommended. Class III; Level of Evidence C

Pacing in STEMI

Temporary pacing is indicated for symptomatic bradycardia unresponsive to medical treatment. Class I; Level of Evidence C

ICD implantation

Recommendations for primary ICD implantation in New Zealand are as follows:

Patients ≥3 months after acute myocardial infarction with EF ≤30% measured ≥3 months after optimal heart failure treatment.93

Optimal treatment is defined as maximal heart failure medications, including ACE inhibitors or angiotensin receptor blockers, β blockers and spironolactone as tolerated.

Patients receiving warfarin or dabigatran

There are no clinical trials to guide management in STEMI. A recent study has shown that aspirin may not be necessary after stenting in patients receiving warfarin and clopidogrel. In the What is the Optimal antiplatelet and anticoagulant therapy in patients with oral anticoagulant at coronary StenTing (WOEST) study 573 patients undergoing stenting were randomised in an open design to receive warfarin plus clopidogrel plus aspirin versus warfarin plus clopidogrel. The primary endpoint of all bleeding events at 1 year was reduced by 64% in patients not receiving aspirin, p<0.0001, without an increase in ischaemic events.94

In a non-randomised small study the rate of TIMI major bleeding was 5 fold greater in patients after stenting in patients receiving prasugrel as compared with patients receiving clopidogrel on background aspirin and warfarin therapy.95

The stopping of aspirin may be considered in patients receiving an oral anticoagulant and a P2Y12. Class IIb; Level of Evidence C
At the time of PCI if the patient is on warfarin and the INR is therapeutic, or the patient is on dabigatran full dose bolus bivalirudin rather than UFH should be considered at the time of primary PCI. Class IIb; Level of Evidence C

Table 13. Approach for patients receiving warfarin or dabigatran. Class IIa; Level of Evidence C

<table>
<thead>
<tr>
<th>PCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Radial approach</td>
</tr>
<tr>
<td>• Aspirin 150mg</td>
</tr>
<tr>
<td>• Bivalirudin in usual doses</td>
</tr>
<tr>
<td>• Full dose P2Y12 inhibitors</td>
</tr>
<tr>
<td>• Prasugrel should not be prescribed with warfarin</td>
</tr>
<tr>
<td>• Restricted use of drug-eluting stents</td>
</tr>
<tr>
<td>• P2Y12 inhibition should be given for the shortest time appropriate e.g. 1 month for bare metal stents or 6 months for standard drug eluting stents</td>
</tr>
<tr>
<td>• Triple therapy for 1 month and then stopping aspirin if warfarin or dabigatran are indicated long-term e.g. AF and CHADSVASC score of 2</td>
</tr>
<tr>
<td>• Decrease dabigatran to 110 mg bid</td>
</tr>
<tr>
<td>• Warfarin with target INR 2–2.5 with close monitoring e.g. INR weekly</td>
</tr>
<tr>
<td>• Proton pump inhibitor e.g. pantoprazole</td>
</tr>
<tr>
<td>• Assiduous control of blood pressure &lt;130/80 mmHg&lt;sup&gt;6&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Fibrinolytic Therapy

Fibrinolytic therapy is relatively contraindicated in patients taking warfarin (should not be given if INR is > therapeutic) or dabigatran or other novel anticoagulants. Adjunctive antithrombotic therapy should be omitted. Class IIb; Level of Evidence C

Hospital stay

Patients undergoing uncomplicated successful reperfusion therapy should be kept in the coronary care unit for a minimum of 24 hours, after which they may be moved to a step-down monitored bed for another 24–48 hours. Class I; Level of Evidence C
Early transfer (same day) may be considered in selected low risk patients after successful primary PCI without observed ventricular arrhythmias. **Class IIb; Level of Evidence C**

Early discharge (after 72 hours) is reasonable in selected low-risk patients, if rehabilitation and appropriate follow-up are arranged. **Class IIb; Level of Evidence B**

**Resource availability**

It is recognised that in New Zealand there are limitations on resources. Equitable provision of care for patients with STEMI must be provided for rural communities.

**Rehabilitation**

All patients should be referred to a Rehabilitation Service **Class I; Level of Evidence A** and be encouraged to attend rehabilitation programmes, to stop smoking, avoid second-hand smoke, undergo regular exercise, (30 minutes of brisk walking or equivalent on >5 days of the week), to achieve ideal weight, to have a cardioprotective diet, and to adhere with medications.

Advice about return to work and sexual activities should be tailored to the individual patient. The National Heart Foundation of New Zealand has several excellent patient information brochures. For driving guidelines, refer to the “Medical Aspects of Fitness to Drive” book issued by the Land Transport Safety Authority.

**Table 14. Cardiac rehabilitation**

- Smoking cessation
- Training in CPR for family and whanau
- Advice on nutrition including a healthy heart diet
- Advice about weight reduction and maintenance of ideal weight
- Exercise for at least 30 minutes/day on at least 5 days per week
- Advice about adherence
- Advice about returning to work, sexual activity, driving, able to fly etc

**Clinical networks**

Clinical networks with predefined protocols for transport from hospitals without PCI capacity to hospitals with PCI capacity must be further developed. **Class I; Level of Evidence C**
Measurement of performance indicators

Routine audit should be integrated into all clinical services that provide care to patients with ACS. This should include prescribing and adherence with aspirin, P2Y12 inhibitor, B-blockers, ACE inhibitors or ARBS, statins, cardiac rehabilitation and smoking cessation. Metrics including percentages of patients receiving reperfusion, primary angioplasty, fibrinolytic therapy, and PCI following fibrinolytic therapy. “First medical contact to device and to needle”, “Door to device”, and “door to needle” times should also be monitored with feedback to all involved. Class I; Level of Evidence B

Conclusion

It is very important that patients with STEMI receive reperfusion therapy either PCI or fibrinolysis as quickly as possible along with the other evidence based therapies and that access across New Zealand be equitable. In New Zealand approximately 30% of patients don’t receive reperfusion therapy and cost effective therapies are underutilised. These guidelines provide the evidence and recommendation for best practice management of patients with STEMI.

Competing interests: Nil.

Author information: ST-Elevation Acute Coronary Syndrome Guidelines Group (refer to Appendix 1 below), The New Zealand Branch of The Cardiac Society of Australia and New Zealand, Wellington

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Correspondence: Professor Harvey White, Green Lane Cardiovascular Service, Auckland City Hospital, Private Bag 92024, Victoria St West, Auckland 1142, New Zealand. Fax: +64 (0)9 6309915; email: HarveyW@adhb.govt.nz

References:


Appendix 1. ST-Elevation Myocardial Infarction Guidelines Group

Andrew Hamer  Nelson Marlborough Health Service, Nelson
Andrew Kerr  Middlemore Hospital, Auckland
Brandon Wong  Whangarei Hospital, Whangarei
Charles Renner  Kew Hospital, Invercargill
Cheuk-Kit Wong  Dunedin School of Medicine, Dunedin
Chris Ellis  Green Lane Cardiovascular Service, Auckland City Hospital, Auckland
Chris Nunn  Waikato Hospital, Hamilton
David Smyth  Christchurch Hospital, Christchurch
Gerry Devlin  Waikato Hospital, Hamilton
Gerry Wilkins  Dunedin Hospital, Dunedin
Guy Armstrong  North Shore Hospital, Auckland
Hamish Hart  North Shore Hospital, Auckland
Harvey White  Green Lane Cardiovascular Service, Auckland City Hospital, Auckland
Hitesh Patel  North Shore Hospital, Auckland
Ian Crozier  Christchurch Hospital, Christchurch
Ian Temouth  Taranaki Base Hospital, Taranaki
John Elliott  Christchurch Hospital, Christchurch
Lynne Belz  Green Lane Cardiovascular Service, Auckland City Hospital, Auckland
Malcolm Abemathy  Wakefield Hospital, Wellington
Mark Sammonds  Wellington Hospital, Wellington
Mark Webster  Green Lane Cardiovascular Service, Auckland City Hospital, Auckland
Michael Williams  Dunedin Hospital, Dunedin
Nigel Harrison  Whangarei Hospital, Whangarei
Phil Matis  Wellington Hospital, Wellington
Ralph Stewart  Green Lane Cardiovascular Service, Auckland City Hospital, Auckland
Richard Luke  Napier Hospital, Napier
Ryan Howard  Whangarei Hospital, Whangarei
Scott Harding  Wellington Hospital, Wellington
Seif El-Jack  North Shore/Whaitake Hospital, Auckland
Stewart Mann  Wellington Hospital, Wellington
Appendix 2. European Society of Cardiology classes of recommendation and grading levels of evidence

<table>
<thead>
<tr>
<th>Classes of recommendation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>Evidence and/or general agreement that a given treatment or procedure is beneficial, useful effective.</td>
</tr>
<tr>
<td>Class II</td>
<td>Conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of the given treatment or procedure.</td>
</tr>
<tr>
<td>Class IIa</td>
<td>Weight of evidence/opinion is in favour of usefulness/efficacy.</td>
</tr>
<tr>
<td>Class IIb</td>
<td>Usefulness/efficacy is less well established by evidence/opinion.</td>
</tr>
<tr>
<td>Class III</td>
<td>Evidence or general agreement that the given treatment or procedure is not useful/effective, and in some cases may be harmful.</td>
</tr>
</tbody>
</table>

**Levels of evidence**

<table>
<thead>
<tr>
<th>Level of Evidence A</th>
<th>Data derived from multiple randomised clinical trials or meta-analysis.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of Evidence B</td>
<td>Data derived from a single randomised clinical trial or large non-randomised studies.</td>
</tr>
<tr>
<td>Level of Evidence C</td>
<td>Consensus of opinion of the experts and /or small studies, retrospective studies, registries.</td>
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