



Complete Summary

GUIDELINE TITLE

Myocardial infarction.

BIBLIOGRAPHIC SOURCE(S)

Finnish Medical Society Duodecim. Myocardial infarction. In: EBM Guidelines. Evidence-Based Medicine [Internet]. Helsinki, Finland: Wiley Interscience. John Wiley & Sons; 2008 Apr 2 [Various]. [6 references]

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Finnish Medical Society Duodecim. Myocardial infarction. In: EBM Guidelines. Evidence-Based Medicine [Internet]. Helsinki, Finland: Wiley Interscience. John Wiley & Sons; 2006 Apr 26 [Various].

** REGULATORY ALERT **

FDA WARNING/REGULATORY ALERT

Note from the National Guideline Clearinghouse: This guideline references drugs for which important revised regulatory information has been released.

- [February 28, 2008, Heparin Sodium Injection](#): The U.S. Food and Drug Administration (FDA) informed the public that Baxter Healthcare Corporation has voluntarily recalled all of their multi-dose and single-use vials of heparin sodium for injection and their heparin lock flush solutions. Alternate heparin manufacturers are expected to be able to increase heparin products sufficiently to supply the U.S. market. There have been reports of serious adverse events including allergic or hypersensitivity-type reactions, with symptoms of oral swelling, nausea, vomiting, sweating, shortness of breath, and cases of severe hypotension.

COMPLETE SUMMARY CONTENT

** REGULATORY ALERT **

SCOPE

METHODOLOGY - including Rating Scheme and Cost Analysis

RECOMMENDATIONS

EVIDENCE SUPPORTING THE RECOMMENDATIONS

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

CONTRAINDICATIONS

IMPLEMENTATION OF THE GUIDELINE

SCOPE

DISEASE/CONDITION(S)

- Myocardial infarction
- Arrhythmias in myocardial infarction, including: ventricular fibrillation, ventricular tachycardia, ventricular ectopic beats, idioventricular rhythm, atrial fibrillation, and bradyarrhythmias

GUIDELINE CATEGORY

Diagnosis
Evaluation
Management
Risk Assessment
Treatment

CLINICAL SPECIALTY

Cardiology
Critical Care
Emergency Medicine
Family Practice
Internal Medicine

INTENDED USERS

Health Care Providers
Physicians

GUIDELINE OBJECTIVE(S)

Evidence-Based Medicine Guidelines collect, summarize, and update the core clinical knowledge essential in general practice. The guidelines also describe the scientific evidence underlying the given recommendations.

TARGET POPULATION

Individuals with suspected or known myocardial infarction

INTERVENTIONS AND PRACTICES CONSIDERED

Diagnosis/Evaluation

1. Evaluation of signs and symptoms (e.g., pain)

2. Differential diagnosis of chest pain, including; myopericarditis, aortic dissection, pulmonary embolism, unstable angina pectoris, oesophageal pain
3. Electrocardiograph (ECG) and echocardiograph monitoring
4. Measurement of myocardial enzymes (creatinine kinase [CK], creatine kinase-MB [CK-MB], creatine kinase-MB mass [CK-MB mass], cardiac troponins T and I)
5. Blood count, C-reactive protein (CRP), d-dimers
6. Serum sodium and potassium and chest x-ray, if needed

Treatment of Myocardial Infarction

1. Oxygen
2. Glyceryl nitrate (mouth spray or sublingual tablet), intravenous morphine, or oxycodone
3. Beta-blocker (e.g., metoprolol)
4. Aspirin
5. Thrombolytic therapy
6. Angiotensin-converting enzyme (ACE) inhibitors (e.g., captopril)
7. Percutaneous transluminal coronary angioplasty (with or without stent insertion)
8. Aspirin combined with clopidogrel
9. Continuous nitrate therapy
10. Heparin (low molecular weight [LMW])
11. Warfarin

Treatment of Infarction-related Arrhythmias

1. Cardiac monitoring
2. Defibrillation or cardiopulmonary resuscitation followed by defibrillation
3. Amiodarone or lidocaine
4. Beta-blocker (e.g., metoprolol)
5. Digitalis
6. Cardioversion shock
7. Pacemaker
8. Atropine
9. Hydration

Assessment of Risk Factors

1. Evaluation of risk factors for mortality
2. Evaluation of ischaemia and need for coronary surgery or angioplasty

Follow-up Care

1. Aspirin
2. Beta-blockers
3. ACE inhibitors (or angiotensin receptor blockers)
4. Statins
5. Diuretics, nitrates, and anticoagulants (when indicated)
6. Measurement of serum lipids
7. Counseling for a healthy lifestyle and cholesterol lowering diet
8. Evaluation of symptoms and ability to return to work

MAJOR OUTCOMES CONSIDERED

- Mortality rate
- Sudden cardiac death rate
- Reinfarction rate
- Recurrent ischaemia rate
- Ischaemic stroke rate
- Hemorrhagic stroke rate
- Post-myocardial infarction depression rate
- Post-angioplasty thrombosis/restenosis rate

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Hand-searches of Published Literature (Primary Sources)
Hand-searches of Published Literature (Secondary Sources)
Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

The evidence reviewed was collected from the Cochrane database of systematic reviews and the Database of Abstracts of Reviews of Effectiveness (DARE). In addition, the Cochrane Library and medical journals were searched specifically for original publications.

NUMBER OF SOURCE DOCUMENTS

Not stated

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Classification of the Quality of Evidence

Code	Quality of Evidence	Definition
A	High	Further research is very unlikely to change our confidence in the estimate of effect. <ul style="list-style-type: none">• Several high-quality studies with consistent results• In special cases: one large, high-quality multi-centre trial

Code	Quality of Evidence	Definition
B	Moderate	<p>Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate.</p> <ul style="list-style-type: none"> • One high-quality study • Several studies with some limitations
C	Low	<p>Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate.</p> <ul style="list-style-type: none"> • One or more studies with severe limitations
D	Very Low	<p>Any estimate of effect is very uncertain.</p> <ul style="list-style-type: none"> • Expert opinion • No direct research evidence • One or more studies with very severe limitations

GRADE (Grading of Recommendations Assessment, Development and Evaluation) Working Group 2007 (modified by the EBM Guidelines Editorial Team).

METHODS USED TO ANALYZE THE EVIDENCE

Review of Published Meta-Analyses
Systematic Review

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

Not stated

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Not stated

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Not stated

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

The levels of evidence [A-D] supporting the recommendations are defined at the end of the "Major Recommendations" field.

Essentials

- If a person at risk of a myocardial infarction (MI) has an acute coronary syndrome lasting over 20 minutes, imminent MI must be suspected. Instead of chest pain, acute dyspnoea may be the primary symptom.
- An acute coronary syndrome without myocardial damage is often unstable angina, which calls for active treatment.
- The diagnosis should be made without delay since early therapy improves the prognosis decisively.
- Acute angioplasty (percutaneous transluminal coronary angioplasty [PTCA], percutaneous coronary intervention [PCI]) is the treatment of choice for reperfusion (Keeley, Boura, & Grines, 2003; Grines et al., 2003) [**A**] wherever it is available.
- Thrombolytic therapy is given as early as possible in all cases with a clinical picture of imminent MI and corresponding electrocardiogram (ECG) changes (See the Finnish Medical Society Duodecim guideline "Thrombolytic Therapy and Balloon Angioplasty in Acute ST Elevation Myocardial Infarction [STEMI]").
- If there are no contraindications, aspirin and a beta-blocker should be started for all patients and, for most patients, also an angiotensin-converting enzyme (ACE) inhibitor and a statin on the first days of treatment.
- Health care system should include a planned care pathway for coronary patients.

Diagnosis

- Classic locations in ECG: see pictures 1, 2, 3, and 4 in the original guideline document
- Diagnostic classification based on ECG findings and troponin concentrations: see picture 5 (Diagnostic classification of acute coronary syndromes based on ECG findings and troponin concentrations) in the original guideline document.
- During first aid, pain is the primary symptom in younger patients. Presentation in the elderly is often atypical.
 - Besides the ischaemic pain, changes of the ST segment on the ECG are to be taken into account when reperfusion treatment is considered (see the Finnish Medical Society Duodecim guideline "Thrombolytic Therapy and Balloon Angioplasty in Acute ST Elevation Myocardial Infarction [STEMI]").

- In addition to pain and ECG findings, determination of the myocardial infarction marker concentrations is needed for definite clinical diagnosis.
- For differential diagnosis of chest pain, see the Finnish Medical Society Duodecim guideline "Differential Diagnosis of Chest Pain".
- The pain in MI lasts over 20 minutes and is localized in the retrosternal area, transfers to the arms, back, neck, or lower jaw.
 - The pain is squeezing and is experienced as tightness, heaviness, and pressure or pressing. Breathing or changing posture does not influence the intensity of pain. Nitroglycerin may relieve but does not remove the pain.
 - The pain is usually severe and consistent. It may be localized in the upper abdomen, in which case, if nausea and vomiting are also present, it simulates acute abdominal disease.
 - During the pain the patient is often pale, in a cold sweat, nauseatic and solemn.
- MI may also present without chest pain as acute pulmonary oedema, unconsciousness, or sudden death.
- Thrombolytic therapy or PCI is indicated if the pain has lasted less than 6 to 12 hours and there is at least a 2-mm elevation in the ST segment in at least two chest leads, or a 1-mm elevation of ST in at least two leads in the extremities, or a recent left bundle branch block (LBBB). The contraindications for thrombolytic therapy must always be considered (see the Finnish Medical Society Duodecim guideline "Thrombolytic Therapy and Balloon Angioplasty in Acute ST Elevation Myocardial Infarction [STEMI]").
- In clinical investigation, remember that the ECG and myocardial markers change with the course of the disease.
 - First there is an ST elevation, after that development of the Q-wave, and finally T-wave inversion.
 - In a T wave infarction (non-Q-wave infarction), no classical Q waves are present, but the diagnosis is based on an increase of myocardial enzymes, chest pain, or ST-T changes.
 - Classical Q-wave changes, ST elevations, and T inversions may be caused by various other diseases, which should be remembered in the differential diagnosis (see tables in the Finnish Medical Society Duodecim guideline "Differential Diagnosis of Chest Pain").
 - An old infarction, bundle branch block (BBB), and early repolarization make the diagnosis difficult, in which case the change in ECG is important and an old ECG recording valuable.
 - When added to other criteria, "minor" signs of infarction are also important.
- European and American cardiac societies (European Society of Cardiology [ESC], American College of Cardiology Foundation [ACCF], American Heart Association [AHA], World Heart Federation [WHF]) have agreed on the universal criteria for acute MI (see <http://www.acc.org>; Thygesen, Alpert, & White, 2007)
 - Rise and/or fall of cardiac biomarkers (preferably troponin) together with evidence of myocardial ischaemia with at least one of the following:
 - Symptoms of ischaemia
 - ECG changes indicative of new ischaemia (new ST-T changes or new left bundle branch block, LBBB)
 - Development of pathological Q waves in the ECG

- Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality.

ECG Diagnosis

- Points for taking an ECG: acute care, emergency room, 12 hours later, on day 2, upon discharge from hospital, and thereafter as deemed necessary.
- ECG is the most important diagnostic procedure. To start with, the positions of the chest leads must be marked on the skin to allow detection of significant changes on the ECG. By monitoring the ECG, the efficacy of the treatment can be assessed. However, in the early stages there may be no changes in ECG, and the changes may be first evident after hours or even days. An ECG diagnosis is made more difficult by an old infarction, LBBB, or posterior infarction.
- In posterior wall infarction, a reciprocal ST segment depression in V1-V4 simulates ischaemia. A posterior infarction is, however, often inferoposterior and, in addition to ST segment depression, ST segment elevations are found in the inferior leads II, III and aVF.
- ST depression is suggestive of ischaemia and/or unstable angina pectoris. Extensive ST depressions in connection with a clinical picture of MI can indicate subendocardial damage.
- The ECG-diagnosis of myocardial infarction may be complicated by changes caused by (e.g., hypertrophic obstructive cardiomyopathy [HOCM], Wolff-Parkinson-White [WPW] syndrome, pulmonary embolism [massive], myopericarditis, and tachyarrhythmias or their sequelae).

Tests Following the ECG

- Troponin is the most important new marker and is replacing creatine kinase (CK).
- CK and CK-myocardial band (MB) or CK-MB mass
- A negative troponin T, troponin I, or CK-MB mass result 9 to 12 hours after the onset of symptoms practically rules out MI.
- Troponin T test is also valuable, if the time lapse since the beginning of the symptoms is more than 24 hours (the concentration remains elevated longer than that of CK). An elevated troponin T or troponin I concentration predicts adverse events irrespective of ECG findings (Olatidoye et al., 1998) [**A**].
- The tests should be performed 3 times in case of suspected infarction: on arrival of the patient and 12 and 24 hours after arrival. If necessary, an additional test is performed after a new episode of pain. Treatment is commenced before the results of the marker assays are available.
- Basic blood picture (haemoglobin, haematocrit, total red blood cell and white counts) C-reactive protein (CRP), D-dimers
- Serum sodium and potassium, and chest x-ray if needed

Troponin-T or Troponin-I

- Principal indicators of myocardial damage, which can also be determined by means of rapid testing methods suited for primary health care. A reading device facilitates the interpretation.
- Troponin is more myocardium-specific than CK-MB and is also very sensitive.

- The concentration increases rapidly (in 4 to 6 hours) after myocardial damage, and the elevated levels persist for at least one week. A very rapid increase in the marker concentration is noted when the obstructed artery is reopened by thrombolytic therapy.
- Indications:
 - The primary marker to verify or exclude MI (or myocarditis) when at least 6 to 8 hours have elapsed from the onset of pain. A positive result is a sign of myocardial damage. Prognosis is then serious regardless of the ECG findings (Olatidoye et al., 1998) [**A**] and active treatment is necessary. The normal reference concentration is zero, or the method-dependent threshold is often given as <0.5 micrograms/L.
 - A negative result within 12 hours after the onset of pain excludes infarction.
 - Also used for the diagnosis of infarction when the patient's arrival for treatment is delayed, and CK has returned to normal.
 - Troponin verifies MI in cases where high CK concentration from skeletal muscle increases the CK-MB concentration over normal limits.
- Mild elevations in the concentration that exceed the threshold are often seen in cardiac surgery. Reference values that would justify the diagnosis of MI in these situations are not defined. Mild elevations may also occur when prolonged tachycardia causes a strain on the sick heart or when the right ventricle is stretched due to cardiac insufficiency or pulmonary embolism. Other, non-cardiac causes of mild increases in troponin concentrations include sepsis, liver cirrhosis, renal insufficiency, and rheumatoid arthritis.
- If the patient has an increased serum creatinine concentration, use serum CK-MB mass instead of troponin for the diagnostics of MI.

Serum CK-MB Mass

- More specific and sensitive than CK-MB
- Abnormal within 6 to 8 hours from the beginning of the pain, and remains abnormal for 1 to 2 days.
- Slightly positive values may indicate mild myocardial damage that requires active treatment. Unlike with troponin, the normal concentration of CK-MB is not zero. There is an uncertain borderline area of 5 to 10 micrograms/L between the positive and negative result.

Differential Diagnosis of Chest Pain

- The most important differential diagnoses include
 - Myopericarditis (See the Finnish Medical Society Duodecim guideline "Myocarditis")
 - Aortic dissection (See the Finnish Medical Society Duodecim guideline "Aortic Aneurysm and Dissection").
 - Pulmonary embolism (See the Finnish Medical Society Duodecim guideline "Pulmonary embolism [PE]")
 - Unstable angina pectoris (See the Finnish Medical Society Duodecim guideline " Acute coronary syndromes: unstable angina pectoris and non-ST segment elevation myocardial infarction (NSTEMI).)
 - Oesophageal pain (See the Finnish Medical Society Duodecim guideline "Heartburn; Reflux Oesophagitis")

- See the Finnish Medical Society Duodecim guideline "Differential Diagnosis of Chest Pain."

Treatment

- Oxygen, if there are problems in oxygenation (pulmonary oedema)
- For treating pain
 - Glyceryl nitrate: mouth spray or sublingual tablet
 - Morphine 4 to 6 mg intravenously (i.v.), additionally 4 mg 1 to 3 times at 5-minute intervals, if necessary. Oxycodone 3 to 5 mg i.v. is an alternative.
 - A beta-blocker (metoprolol) 2 to 5 mg i.v. may sometimes be sufficient to ease the pain.
- Aspirin 250 mg, chewable tablet or dissolved in water, unless there are contraindications (active ulcer, hypersensitivity to aspirin, anticoagulation) (Antithrombotic Trialists' Collaboration, 2002) [**A**].
- Clopidogrel (Chen et al., 2005; Sabatine et al., 2005) [**A**] initial dose 300–600 mg orally, then 75 mg × 1
- A beta-blocker (Danchin, De Benedetti, & Urban, 2002) [**A**] is always instituted, unless there are contraindications (asthma, hypotension, heart insufficiency, conduction disturbance, bradycardia). The first dose can be given intravenously (Chen et al., 2005) [**A**] if the patient is in pain, or orally if the patient is pain-free and time has passed since the infarction. Beta-blockers are useful especially in patients who are tachycardic and hypertensive but do not have heart failure.
 - i.v. dose: metoprolol 2 to 5 mg
 - Orally: metoprolol 25 to 50 mg × 2
- **Immediate PTCA** (Grines et al., 2003; Keeley, Boura, & Grines, 2003) [**A**] if available. May be performed when thrombolytic therapy is contraindicated. The effect is better than that of thrombolysis in the acute phase and also in long-term follow-up. Stenting is always performed in association with PTCA (Meads et al., 2000; Grines et al., 1999) [**A**]. Further treatment is aspirin combined with clopidogrel for 3 to 12 months to prevent thrombosis and restenosis. Endothelialization of drug-eluting stents is slow, and therefore an uninterrupted antithrombotic medication for 12 months is especially important (Iakovou et al., 2005).
- Thrombolytic therapy, unless there are contraindications (See the Finnish Medical Society Duodecim guideline "Thrombolytic Therapy and Balloon Angioplasty in Acute ST Elevation Myocardial Infarction [STEMI].") ("Indications," 1994) [**A**].
- An ACE inhibitor to all patients with signs or symptoms of heart failure or ejection fraction (EF) <40, anterior wall infarction, or reinfarction (Domanski et al., 1999; Danchin, De Benedetti, & Urban, 2002) [**A**]. Therapy is not usually started on the first day.
 - For example: captopril. Start with 6.25 mg and increase the dose rapidly.
- Continuous nitrate therapy (Mehta & Yusuf, 2000) [**A**]
 - Administered as an infusion, if the patient has ischaemic pain and pain medication has no effect. Nitrate infusion (see the Finnish Medical Society Duodecim guideline "Nitrate Infusion in Angina Pectoris and Myocardial Infarction").
 - Orally (e.g., isosorbide dinitrate 10 to 20 mg × 2 to 3)

- Heparinization (with low molecular weight heparin [LMWH]) is indicated at least for two days in association with reperfusion.
 - Treatment dose is used, if the patient has a thromboembolic complication.
 - Prophylactic dose is given if the bed rest is prolonged and the patient is significantly overweight.
 - If the patient has ventricular aneurysm or atrial fibrillation, anticoagulation therapy is gradually switched over to warfarin (possibly permanent), when the haemostatic situation is stabilized.
- Anticoagulation with warfarin is often started in massive anterior infarction and when transient ischemic attack (TIA) or stroke (mural thrombosis) occurs with MI.
- If the patient has atrial fibrillation and a stent, he/she requires permanent anticoagulant therapy and clopidogrel therapy (without aspirin [ASA]) of limited duration.

Arrhythmias in Myocardial Infarction

Causes of Arrhythmias

- Myocardial damage, ischaemia, and sympathetic stimulation are associated with ventricular arrhythmias.
- Ejection failure causes supraventricular tachyarrhythmias and atrial fibrillation.
- Vagal stimulation causes bradyarrhythmias and atrioventricular (AV) conduction disturbances, especially in cases of inferior-posterior wall infarction.
- Reperfusion often causes benign ventricular rhythm; however, it also causes severe ventricular arrhythmias.

Ventricular Fibrillation

- Often occurs within 2 to 4 hours of infarction. After 12 hours, primary ventricular fibrillation is rare. Ventricular fibrillation that is rapidly treated in the initial phase does not necessarily worsen the prognosis.
- An early ectopic beat may initiate ventricular fibrillation in an ischaemic myocardium. Ectopic beats are not treated if cardiac monitoring is effective.
- Treatment
 - Acute ventricular fibrillation is treated by immediate defibrillation. Prolonged ventricular fibrillation frequently calls for cardiopulmonary resuscitation (CPR) (see the Finnish Medical Society guideline "Cardiopulmonary Resuscitation").
 - To prevent recurrence of fibrillation, lidocaine was formerly often used (initially as a bolus of 100 mg, repeated if necessary, and continued as an infusion of 1 to 3 mg/minutes). Lidocaine has currently been replaced by amiodarone: 5 mg/kg/30 min intravenously, thereafter infusion at 900 to 1200 mg/24 hours.
 - A beta-blocker is usually added to the therapy.

Ventricular Tachycardia

- More than three ectopic beats and a heart rate over 120 beats/minute (bpm).

- Brief, spontaneously ending bursts are seen in over 50% of patients with infarction during the first two days. They occur mainly 8 to 14 hours after, not immediately after the infarction, as does ventricular fibrillation.
- Rapid ventricular tachycardia often leads to haemodynamic collapse or ventricular fibrillation. The severity depends on the duration, morphology, and rate of tachycardia. Polymorphic ventricular tachycardia in the initial phase is associated with ischaemia and electrolyte disturbances; in a later phase, ventricular tachycardia is often monomorphic.
- Treatment
 - Beta-blocker: metoprolol 5 mg intravenously, repeatedly if necessary
 - Lidocaine boluses and infusion as in ventricular fibrillation, if haemodynamics compromise. Amiodarone may be a better alternative and currently often the primary choice.
 - If necessary, synchronized cardioversion shock is performed.
 - Late in infarction, monomorphic ventricular tachycardia is, like ventricular fibrillation, a serious problem considering the prognosis and requires further specialist examinations and often treatment with an implantable cardioverter defibrillator.

Ventricular Ectopic Beats

- Occur in nearly all patients with painful MI
- Are considered dangerous if they are frequent (more than 5/min), are polymorphic, or occur concomitantly with an early T wave
- Treatment is usually not necessary if cardiac monitoring is effective. A beta-blocker may be indicated.

Idioventricular Rhythm

- Idioventricular rhythm ("slow ventricular tachycardia", accelerated idioventricular rhythm [AIVR]) is an arrhythmia often associated with MI. In the reperfusion phase, it may even indicate that thrombolysis has been successful. The frequency is often economical 70 to 80 bpm but may be as high as 100 bpm; drug therapy is not necessary.

Atrial Fibrillation

- Atrial fibrillation (AF) in a patient with infarction is often associated with extensive infarction and cardiac insufficiency and it worsens the prognosis. Atrial fibrillation increases the risk of stroke, which is why LMWH and warfarin therapy are indicated if AF is prolonged.
- AF is common in the acute phase of MI (15 to 20%), is often self-terminated, and does not always require treatment.
- In cardiac insufficiency, rapid atrial fibrillation requires active direct current (DC) cardioversion. Often, the achieved sinus rhythm does not remain. In such a case, haemodynamics must be stabilised (oxygenation, treatment of pulmonary oedema, controlling of ventricular response with a beta-blocker and digitalis) after which spontaneous reversal of the rhythm is waited for. The effect of the beta-blocker is seen rapidly but that of digitalis not before several hours. Rapid ventricular response may be controlled even if cardiac insufficiency is present: the benefit often outweighs the disadvantage.

- Selective beta-blockers are best suited for maintaining the achieved sinus rhythm.
- Intravenous amiodarone will not reduce the contraction of the myocardium. It is effective in prophylaxis of AF (together with a beta-blocker) and it may be used in cardioversion of AF and/or slowing down the ventricular response.
- Note: A broad QRS complex tachycardia in a patient with infarction must always be treated as a ventricular tachycardia.

Bradyarrhythmias

- A strong vagal reaction in the early stages of infarction may lead to a circulatory collapse.
- Postero-inferior wall infarction is often associated with a functional AV block. The QRS complex is narrow and the heart rhythm is 50 to 60 even in cases of a total block. A pacemaker is rarely needed.
- In anterior wall infarction, the proximal conduction system may be blocked: the QRS complex is wide, the substituting rhythm is slow (30 to 40), the patient is in a poor condition, and pacing is necessary. Prognosis is poor even with pacing.
- Drug treatment
 - Atropine 0.5 mg i.v., repeated as necessary, for treatment of functional sinus bradycardia if the heart rate is less than 40 bpm.

Pacemaker

- In anterior wall infarction, pacing is indicated if there is a 2nd or 3rd degree block. Pacing should be anticipated in case of a trifascicular block, alternating right and left bundle branch block, or if an extensive infarction is associated with left anterior fascicular block (LAFB) or left posterior fascicular block (LPFB).
- Postero-inferior wall infarction associated with a 3rd degree AV block requires pacing if bradycardia is detrimental to haemodynamics and not responsive to treatment with atropine.
- If temporary pacing is not possible, isoprenaline may be cautiously administered.

Right Ventricle Infarction

- The clinical picture and treatment principles of right ventricle infarction differ from pure left ventricle infarction.
- The clinical picture is dominated by hypotonia without pulmonary oedema or without severe dysfunction of the left ventricle. Simulates pulmonary embolism.
- Verified in lead V4R on the ECG.
- Treated with hydration, even if venous pressure is high.
- Associated with an occlusion of the stem of the right coronary artery; the patient has concomitantly an inferior infarction.

Symptoms and Signs

- Hypotension, bradycardia, and high venous pressure without pulmonary oedema and cold limbs are characteristic symptoms.

- The lead V4R on the ECG gives a conclusive diagnosis: a 1-mm elevation is sensitive (70%) and specific (nearly 100%). ECG usually shows a concomitant left ventricular inferoposterior wall infarction (see picture 6 in the original guideline document).
- The tricuspid valve is insufficient, but regurgitation is usually not audible (detected on echocardiography).
- As the right coronary artery usually (90%) supplies blood to the AV node, a partial or complete AV block is often present.

Differential Diagnosis

- All diseases that cause hypotension, pulmonary embolism being the most important.

Treatment

- Early reperfusion primarily with PCI
- Thrombolytic therapy is performed with tissue plasminogen activator (TPA), which does not cause hypotension (see the Finnish Medical Society Duodecim guideline "Thrombolytic Therapy and Balloon Angioplasty in Acute ST Elevation Myocardial Infarction [STEMI]").
- Rapid correction of the hypotension by hydration (500 to 1000 mL) is essential.
- Hypotensive drugs (nitrates) must be avoided.
- Atropine for bradycardia
- If pacing is required, a sequential pacemaker is preferable.

Treatment in Hospital

Follow-up and Treatment

- Pain: morphine, nitro, beta-blocker
- Blood pressure
- Skin, peripheral circulation
- Increased respiratory rate suggests cardiac insufficiency.
- Monitoring of arrhythmias
- ST segment changes
- Oxygen saturation; oxygen or continuous positive airway pressure (CPAP)
- A comfortable posture
- Informing and reassuring the patient
- Nicotine replacement therapy is started already in the hospital. Nicotine addiction may be evaluated by using the Fagerstrom test, and the planning of further treatment may be based on it.
- In an uncomplicated infarction, patients are allowed to sit as soon as they want, they can eat unassisted, and they can be helped to a portable toilet at the bedside. Intensive monitoring is usually needed for 1 to 2 days.
- The infarction is complicated and treatment lasts longer if the patient has had
 - Shock (associated with an extensive myocardial damage in the initial phase)
 - Hypotension
 - Obvious cardiac insufficiency (usually requires thrombosis prophylaxis or anticoagulation, especially if in connection with atrial fibrillation)

- Prolonged chest pain or recurrence of ischaemia
- Serious ventricular arrhythmias after the initial phase
- Thromboembolic complications
- Structural injuries (papillary muscle dysfunction or rupture), often occur at day 3 to 5 from the onset and lead to severe cardiac failure
- Pericarditis at days 2 to 4, often resolves spontaneously

Level of Care

- Treatment of the patient in primary health care (in a primary health care hospital) is justifiable if the patient's prognosis is otherwise poor: those who are permanent inpatients or otherwise severely disabled and for whom invasive treatment has not been planned.

Assessment of Prognosis in an MI Patient

- The most important causes of mortality are
 - Reinfarction
 - Cardiac insufficiency
 - Arrhythmias: especially late phase ventricular tachycardia
- During hospitalization, a poor prognosis is indicated by
 - Cardiac insufficiency and extensive infarction (EF <25%)
 - Chest pain and ischaemic ST changes (send to angiography)
 - In connection with non-Q-wave infarction, risk factors for coronary heart disease (CHD) and especially diabetes mellitus
- Evaluation of ischaemia and need for active treatment
 - Risk is highest during the first few weeks and months after infarction. Therefore, at the end of the hospital treatment, an early symptom-limited exercise test is performed on many patients to estimate the need for angioplasty and coronary surgery in particular (see Table below).
- For indications of coronary angiography, see the Finnish Medical Society Duodecim guideline "Diagnostic Coronary Angiography."

Table: Assessment of Risk of Reinfarction and Patient's Prognosis

Ejection Fraction	Performance				Symptoms and Findings
Low risk	>40%	and	>100 W* or >2 W/kg	and	No ischaemia or arrhythmia in exertion, blood pressure rises >10%
Moderate risk	25% to 40%	and/or	ca. 100 W* or 1.5-2 W/kg	and/or	a. In moderate exertion chest pain or some ischaemia, but no cardiac failure or arrhythmia b. Severe ischaemia or low ejection fraction, but no symptoms in moderate exertion c. Successive ventricular ectopic

Ejection Fraction	Performance				Symptoms and Findings
					beats, symptomless ventricular tachycardia
High risk	<25%	and/or	<100W* or <1 W/kg	and/or	a. Enlarged and failing heart and/or chest pain or ischaemia with low exertion and pulse (<120/min) or blood pressure doesn't rise with exertion b. Low ejection fraction and symptomatic cardiac failure requiring medication c. Stenosis of left main coronary artery or three arteries in angiography

*Mean workload of last 4 minutes

Care After Myocardial Infarction

Drug Treatment

- Aspirin, beta-blocker (Freemantle et al., 1999; Sudlow et al., 2002) [**A**], ACE inhibitors, and statins have been shown to improve the prognosis. Glycaemic control is also important.
- Unnecessary drugs instituted during the initial phase should be discontinued already towards the end of hospital treatment or when the patient comes to the first check-up, not on the last day in hospital.
- Only those with cardiac insufficiency or poorly controlled blood pressure need a diuretic.
- Aspirin 50 to 100 (-250) mg is given unless there are contraindications (Antithrombotic Trialists' Collaboration, 2002) [**A**]. In case of aspirin allergy or resistance, consider clopidogrel for 3 to 6 months.
- Clopidogrel without a pause for 3 to 12 months in all patients with a stent, for (6 to)12 months after the insertion of a medicated stent
- Patients with hypertension, angina pectoris, ventricular arrhythmias, ischaemia during an exercise test, previous infarction, an enlarged heart, low ejection fraction, or a cardiac insufficiency need a beta-blocker. In practice, these drugs are given to all patients who have no contraindications. Adequate beta-blockade is achieved when the heart rate at rest is about 60 bpm.
 - The evidence is strongest for bisoprolol, carvedilol, and metoprolol for patients with heart failure.
- Nitrate plus a beta-blocker are given to all patients with angina pectoris or ischaemia during an exercise test. Nitrate is a drug used for symptom relief that can often be discontinued, especially if the patient is hypotensive.
- An ACE inhibitor is given to all patients with clear systolic dysfunction (EF <40%) (Sudlow et al., 2002) [**A**]. A milder systolic dysfunction is treated with

an ACE inhibitor if the patient has cardiac insufficiency (symptomatic or asymptomatic), valvular regurgitation, hypertension, or diabetic nephropathy. The indications of ACE inhibitors have been constantly extended, and they are now given to almost every patient who has had an infarction. So-called "asymptomatic cardiac insufficiency" and even secondary prevention (according to the Heart Outcomes Prevention Evaluation [HOPE] study) in high-risk patients have become indications (Yusuf et al., 2000). ACE inhibitor therapy may be more difficult if the patient has hypotension or renal failure. Patients on diuretics have a risk of hypotension, especially when treatment with an ACE inhibitor is started. The ACE inhibitor dose should not remain at the level of the initial dose unless hypotension and creatinine elevation prevent the titration.

- An angiotensin receptor blocker may be used if ACE inhibitors are not suitable because of cough or angio-oedema.
- A lipid-lowering drug (a statin) is given to all MI patients regardless of serum cholesterol concentrations (Rembold, 1996) [**A**].
- An anticoagulant is given if the patient has atrial fibrillation, an embolic complication, or ventricular aneurysm verified by echocardiography.
- Short-term anticoagulation is also often used in the treatment of an extensive anterior wall infarction.
 - Treatment is continued for 3 months, but if the cardiac insufficiency is not corrected and EF remains below 35, anticoagulation is continued permanently. If the insufficiency is corrected later, discontinuation may be considered, preferably under ultrasonographic control.
- Hyperglycaemia in a patient with diabetes is carefully treated right from the initial phase.
- A quiet moment should be reserved for discussing life after MI and living with coronary artery disease (CAD) while the patient is still in the hospital.
 - Such a discussion helps to reduce psychological problems and disability.
 - Give instructions for dealing with possible exacerbation of the disease.
 - The motivation to quit smoking is highest after an infarction:
 - Nicotine replacement therapy according to individual evaluation (Fagerstrom test)
 - A cholesterol and saturated fatty acid-restriction diet and/or drug treatment
 - Exercise counseling according to individual evaluation: the patient must be able to talk while exercising.
 - Rehabilitation course
 - Secondary prevention

Sick Leave

- The need for sick leave is individually assessed. Two weeks may be sufficient after a small non-ST damage if the patient is not in physically straining work.
- Re-examination after about one month, usually within specialist health care.
 - History of symptoms: if the patient has had angina pectoris symptoms, consider testing exercise capacity, if the test has not been performed yet.
 - Remind the patient of the principles of healthy life style.
 - Serum lipids should be measured if they were high on an earlier measurement.

- Control the adequacy of beta-blockade: target heart rate 50 to 60 bpm.
- Possible depression should be diagnosed.
- The ability to work is evaluated before the end of the sick leave. If necessary, an exercise test is carried out to assess working ability.

Related Resources

Refer to the original guideline document for related evidence, including Cochrane reviews and other evidence summaries.

Definitions:

Classification of the Quality of Evidence

Code	Quality of Evidence	Definition
A	High	Further research is very unlikely to change our confidence in the estimate of effect. <ul style="list-style-type: none"> • Several high-quality studies with consistent results • In special cases: one large, high-quality multi-centre trial
B	Moderate	Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate. <ul style="list-style-type: none"> • One high-quality study • Several studies with some limitations
C	Low	Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate. <ul style="list-style-type: none"> • One or more studies with severe limitations
D	Very Low	Any estimate of effect is very uncertain. <ul style="list-style-type: none"> • Expert opinion • No direct research evidence • One or more studies with very severe limitations

GRADE (Grading of Recommendations Assessment, Development and Evaluation) Working Group 2007 (modified by the EBM Guidelines Editorial Team).

CLINICAL ALGORITHM(S)

A clinical algorithm, "Diagnostic Classification of Acute Coronary Syndromes," is available in the original guideline document.

EVIDENCE SUPPORTING THE RECOMMENDATIONS

REFERENCES SUPPORTING THE RECOMMENDATIONS

[References open in a new window](#)

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

Concise summaries of scientific evidence attached to the individual guidelines are the unique feature of the Evidence-Based Medicine Guidelines. The evidence summaries allow the clinician to judge how well-founded the treatment recommendations are. The type of supporting evidence is identified and graded for select recommendations (see the "Major Recommendations" field).

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

- Appropriate diagnosis and treatment of myocardial infarction (MI)
- Reduction in morbidity and mortality
- Improved long-term prognosis after MI

POTENTIAL HARMS

Antiplatelet and thrombolytic therapies increase the risk of bleeding.

CONTRAINDICATIONS

CONTRAINDICATIONS

- *Aspirin*. Contraindications include active ulcer, hypersensitivity to aspirin, anticoagulation.
- *Beta-blockers*. Contraindications include asthma, hypotension, heart insufficiency, conduction disturbance, and bradycardia.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

IMPLEMENTATION TOOLS

Clinical Algorithm

For information about [availability](#), see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better

IOM DOMAIN

Effectiveness
Patient-centeredness
Timeliness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

Finnish Medical Society Duodecim. Myocardial infarction. In: EBM Guidelines. Evidence-Based Medicine [Internet]. Helsinki, Finland: Wiley Interscience. John Wiley & Sons; 2008 Apr 2 [Various]. [6 references]

ADAPTATION

Not applicable: The guideline was not adapted from another source.

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GUIDELINE DEVELOPER(S)

Finnish Medical Society Duodecim - Professional Association

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GUIDELINE COMMITTEE

Editorial Team of EBM Guidelines

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Primary Author: Helena Kervinen

FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

Not stated

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Finnish Medical Society Duodecim. Myocardial infarction. In: EBM Guidelines. Evidence-Based Medicine [Internet]. Helsinki, Finland: Wiley Interscience. John Wiley & Sons; 2006 Apr 26 [Various].

GUIDELINE AVAILABILITY

This guideline is included in "EBM Guidelines. Evidence-Based Medicine" available from Duodecim Medical Publications, Ltd, PO Box 713, 00101 Helsinki, Finland; e-mail: info@ebm-guidelines.com; Web site: www.ebm-guidelines.com.

AVAILABILITY OF COMPANION DOCUMENTS

None available

PATIENT RESOURCES

None available

NGC STATUS

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