2015 EDITION

CLINICAL DECISION-MAKING TOOLKIT

ACUTE CARDIOVASCULAR CARE ASSOCIATION

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Acute Cardiovascular Care Association
A Registered Branch of the ESC

EUROPEAN SOCIETY OF CARDIOLOGY®

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The Acute Cardiovascular Care Association Clinical Decision-Making TOOLKIT

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Preface

The best care of patients with acute cardiovascular syndromes relies not only on specialists but also on systems of care that involve many non-cardiologists. Several of these syndromes require immediate diagnosis and decisions on treatment, some of them life-saving. Critical decisions must often be made quickly by professionals with different backgrounds and levels of expertise with limited resources. This poses a significant clinical challenge.

Against this background, the **ACCA Clinical Decision-Making Toolkit** was created as a comprehensive resource encompassing all aspects of acute cardiovascular care but structured as an easy-to-use instrument in environments where initial acute cardiovascular care is typically initiated. Comprehensive tables, clear diagrams and algorithms, based on the ESC clinical practice guidelines as well as in clinical experience should provide diagnostic and therapeutic guidance at a glance.

The Second Edition of the ACCA Toolkit has been updated with the 2014 and 2015 ESC Guidelines, and enriched with a new chapter with up-to-date coverage of drugs most frequently used in acute cardiovascular care. However, it does not replace textbooks and other sources of information that need to be consulted to reach an optimal management of these patients.

The ACCA Toolkit is available through different platforms:
Printed booklet, available at congresses where ESC-ACCA is represented
Web-based pdf file downloadable at www.escardio.org/ACCA
Mobile application for smartphones/tablets available in both Apple & Googleplay stores

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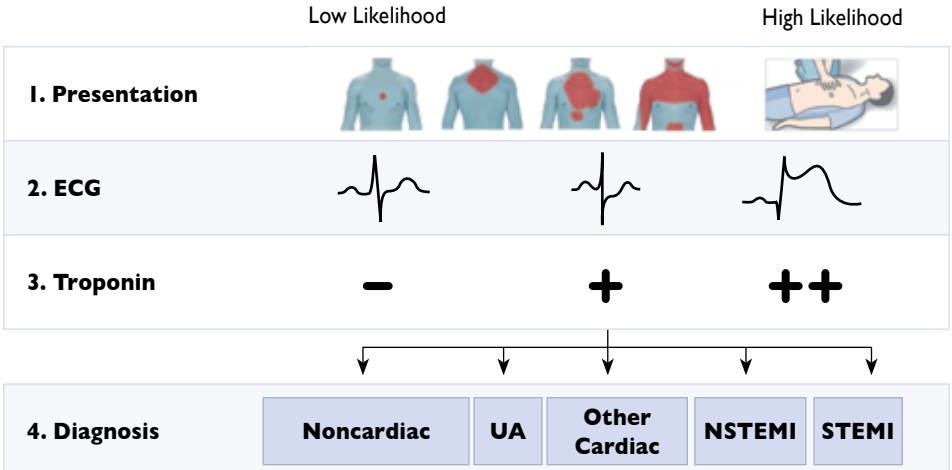
CHAPTER 1: KEY SYMPTOMS

Initial assessment of patients with CHEST PAIN

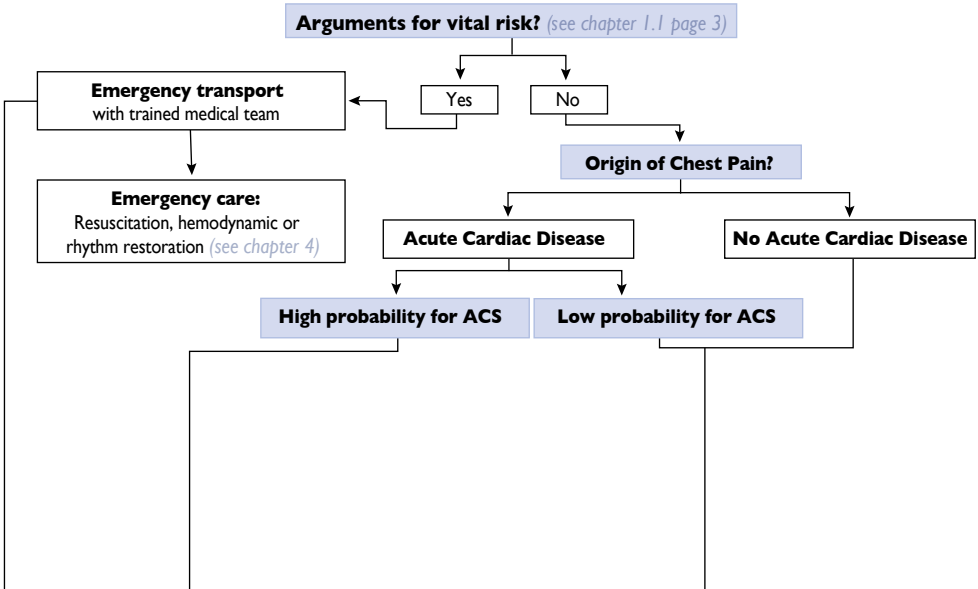


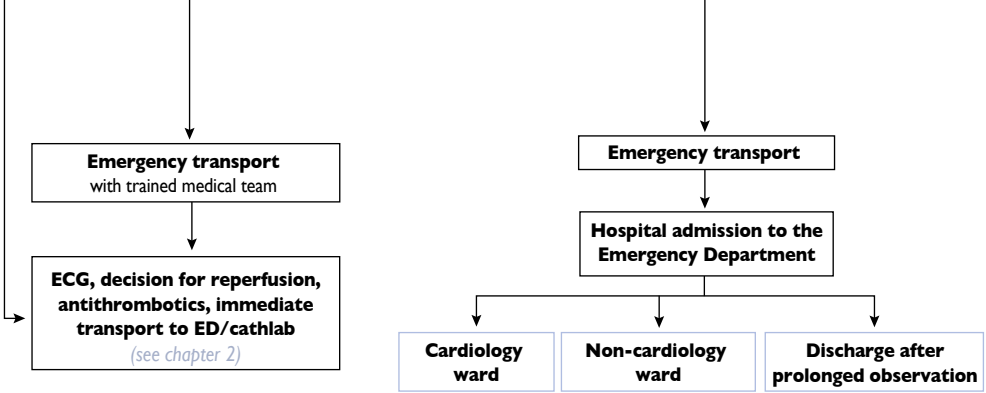
STEMI = ST-elevation myocardial infarction; NSTEMI = non-ST-elevation myocardial infarction; UA = unstable angina.
Reference: Roffi et Al. Eur Heart J 2015;eurheartj.ehv320

Factors to be considered in the evaluation after the first call for CHEST PAIN

First call for chest pain	Higher risk / probability	Lower risk / probability
Arguments for vital risk	• Cardiorespiratory arrest, syncope / loss of consciousness, neurological defect • Dyspnea • Nausea – vomiting • Arrhythmias – tachycardia	• Normal consciousness • Normal breathing *(see chapter 1.2 page 9)* • Normal heart rhythm
Context, CV risk	Age > 40 years, previous CV disease (MI, stroke, PE), modifiable CV risk factors (smoker, HTN, hypercholesterolemia, diabetes), chronic CV treatment	• Age < 40 years, • No previous CV disease • No CV risk factors • No chronic treatment
Chest Pain	Medial / lateral thoracic pain, intense, with dyspnea	• Depends on position/ palpation/ movements • Variable intensity, short duration (<1 min) • Hyperthermia
Cardiac Ischemic Pain	Retro-sternal, constriction, jaw/cervical/arm/back irradiation, spontaneous, prolonged > 20 min + dyspnea, sweating, lightheadedness, nausea	• Lateral, abdominal irradiation • No neuro-vegetative symptoms

Approach after first call for out-of-hospital CHEST PAIN

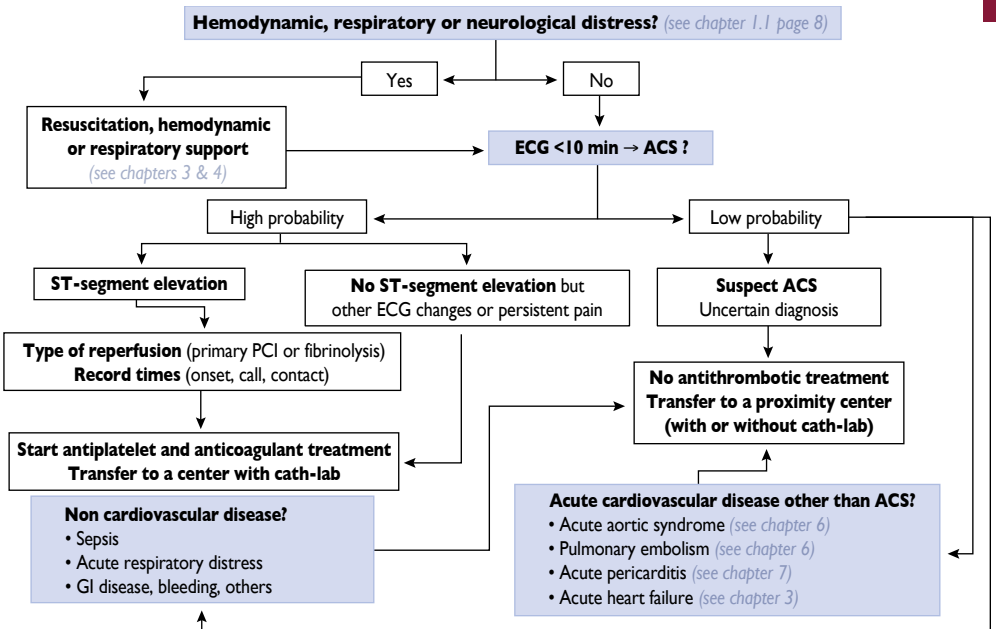



Emergency transport
with trained medical team
ECG, decision for reperfusion, antithrombotics, immediate transport to ED/cathlab
(see chapter 2)
Emergency transport
Hospital admission to the Emergency Department
Cardiology ward
Non-cardiology ward
Discharge after prolonged observation

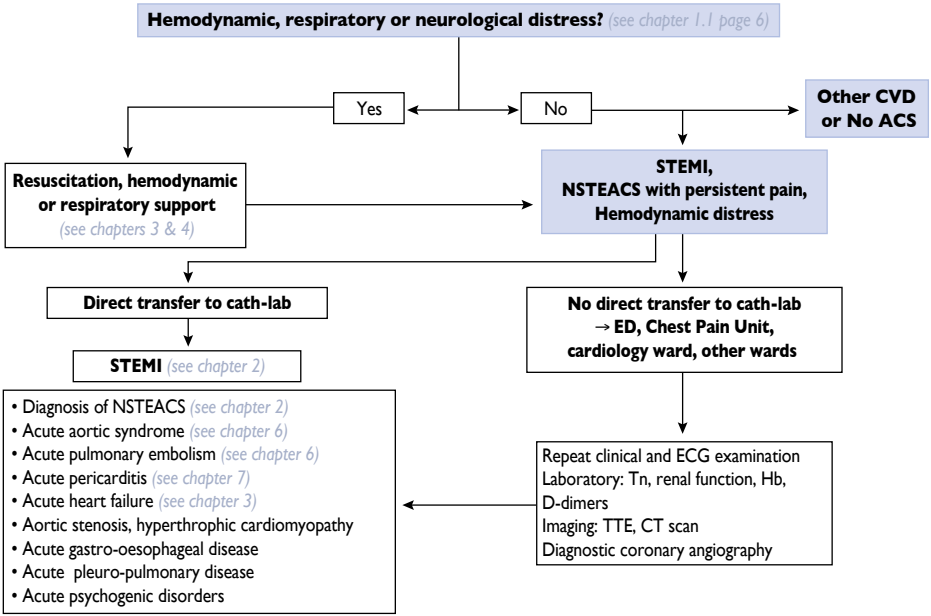
Factors to be considered in the evalutation during the first medical contact for CHEST PAIN

First medical contact	Higher risk / probability	Lower risk / probability
Hemodynamic, respiratory, neurological distress	• Cardiopulmonary arrest, hypotension, tachycardia, shock • Dyspnea, hypoxemia, lung rales (Killip class >2) • ECG: ST segment deviation	• Normal consciousness, no motion defects • Normal HR and BP • Normal breathing and SpO_2, no loss of pulse
Probability for ACS	• Context, typical symptoms consistent with myocardial ischemia • ECG changes • Bedside Tn	• No CV risk, atypical symptoms, normal ECG • Negative bedside Tn only if onset of pain >6 hours *(see chapter 2.1 page 24)*
STEMI NSTEACS Uncertain diagnosis *(see chapter 2.1 page 24)*	• ECG criteria for STEMI *(see chapter 2.3 page 35)* • ST depression or normal ECG • Normal ECG → Repeat 12-lead ECG recording	• Other ST-segment abnormalities not related to STEMI *(see chapter 2.3)*
Type of reperfusion **Time assessment**	• **Primary PCI or thrombolysis?** Primary PCI if delay <120 (preferably <90) min or <60 min if onset of pain <120 min Consider age, anterior wall location • **Times:** Onset of pain, call, first medical contact, ECG, door, balloon inflation or needle (lytic drug) administration	• No reperfusion if delay >12 h, no symptoms, no ST-segment elevation

First medical contact in patients with CHEST PAIN (home-ambulance)



Management of patients with CHEST PAIN (emergency room)



DYSPNEA: Diferential diagnosis

50% have ≥2 diagnoses, which may result in acute respiratory failure*!

Basic measures

- BP, HR, respiratory rate, SpO_2 & temperature
- Start oxygen to target SpO_2 94-98%
- Start i.v. line & monitor patient

Criteria for transfer to ICU
(despite treatment for 30 minutes)

- Respiratory rate >35/min
- SBP <90 mmHg
- SpO_2 <85%
- HR >120 bpm

Investigations:

- **ECG**
- **BNP**
- **Chest X-ray**
- **Venous BG**
- **Blood count**
- **Tn**
- **D-dimers if suspicion of PE**

Acute heart failure

Acute coronary syndrome

Pneumonia

Exacerbated COPD or other chronic lung disease

Pulmonary embolism

Other causes, including

- Asthma
- Severe sepsis
- Tumor
- Pneumothorax
- Pleural effusion/ascites
- Anxiety disorder
- Anemia
- Bronchitis
- Metabolic acidosis
- Neurologic disease

* Defined as ≥1 criterion:

- Respiratory rate ≥25/min
- PaO_2 ≤75 mmHg
- SpO_2 ≤92% in ambient air
- $PaCO_2$ ≥45 mmHg with arterial pH ≤7.35

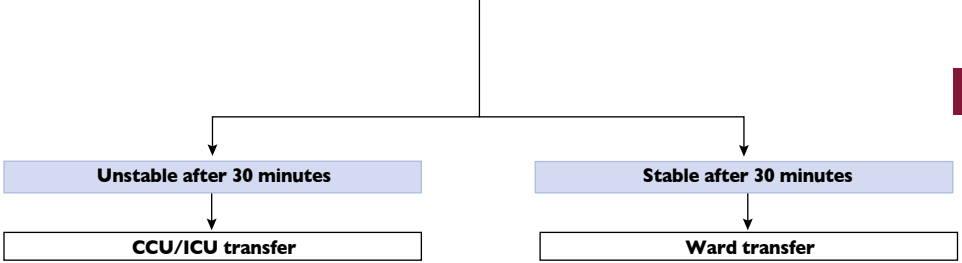
Reference: Ray P et al. Acute respiratory failure in the elderly: etiology, emergency diagnosis and prognosis. Critical Care (2006), 10 (3) :R82.

DYSPNEA: Acute heart failure *(see chapter 3.1)*

BASIC WORK-UP

- **Immediate 12-lead ECG, cardiac monitor, BP, respiratory rate, pulse oximetry**
- **Clinical findings**
  Most commonly: lower extremity edema, jugular venous distension, rales; work up for underlying cardiac disease and triggers
- **Laboratory findings**
  Complete blood count, chemistries, cardiac enzymes, BNP, TSH, ABG as needed
- **Chest X-ray (lung ultrasound)**
- **Echocardiogram**
  During admission (earlier if decompensated aortic stenosis or endocarditis are suspected)
- **Coronary angiography**
  Emergent in patients with ACS; delayed in patients with suspected coronary artery disease

• Positioning	Keep head of bed elevated above level of legs
• Oxygen	Up to 12 L/min via non-rebreather, titrate oxygen saturation to 94%
• Nitroglycerin	1-2 SL tablets or 2-3 patches 10 mg (1st choice). In pulmonary edema with severe shortness of breath: NTG drip 0.05% (100 mg in 200 ml) - Start with 25 µg/min = 3 ml/h, check BP after 5 and 10 min - Increase dose per SHO/attending recommendations by 25 µg/min at a time as long as SBP >90 mmHg - Additional BP check 5 and 10 min after each increase in dosing - Check BP every 20 min once a steady drip rate is reached
• Furosemide	40-120 mg i.v. (adjust based on kidney function and clinical findings; monitor creatinine)
• Morphine	2 mg i.v. (preceeded by 10 mg i.v. metoclopramide PRN)
• Consider digoxin	0.5 (-1.0) mg i.v. in patients with atrial fibrillation
• Anticoagulation	Therapeutic dosing in ACS and atrial fibrillation: Enoxaparin 1 mg/kg body weight as 1st dose



Reference: Ware L B and Matthay M A. Acute Pulmonary Edema. New Engl J Med (2005); 353:2788-2796.

DYSPNEA: Acute pulmonary embolism *(see chapter 6.2)*

Priorities: 1. Vital signs 2. Diagnostic screening dependent upon clinical stratification

ABG, ECG, chest X-ray plus clinical assessment of PE probability (risk factors) plus monitoring

Hemodynamically unstable

Initiate transfer to ICU

Immediate TTE (if available)

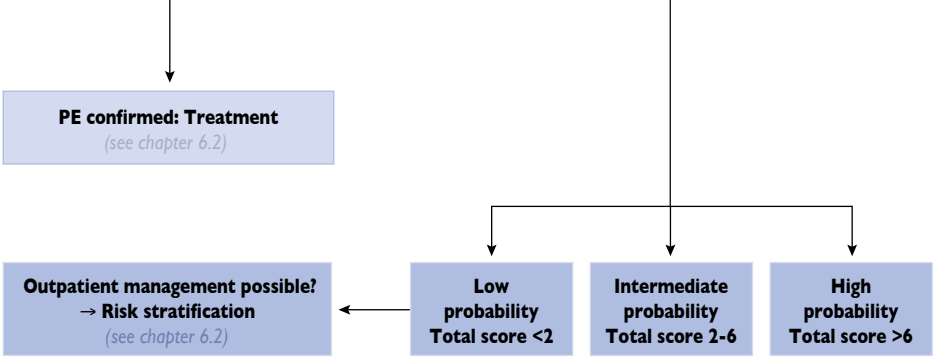
Result inconclusive → CT-angio

Right ventricular dysfunction

Hemodynamically stable

Wells criteria for PE:

	Score
• Clinical signs and symptoms of deep vein thrombosis (DVT)	+ 3.0
• No alternative diagnosis (or alternative diagnosis less likely than PE)	+ 3.0
• Heart rate >100/min	+ 1.5
• Immobilization or operation within the last 4 weeks	+ 1.5
• Previous DVT or PE	+ 1.5
• Hemoptysis	+ 1.0
• Malignant tumor with treatment within the last 6 months or palliative care	+ 1.0



DYSPNEA: COPD exacerbation

- **Verify diagnosis (DD: PE, acute heart failure, pneumothorax)**
- **Oxygen administration → SpO_2 target 88-92% (Beware of carbonarcosis: ABC after 1 h)**

Definition:
Known COPD and/or
- Progressive dyspnea and/or
- Change in quantitiy and color of sputum and/or
- Heavy coughing

→ • COPD classification (GOLD)

→ • Etiology

- History, clinical examination (blood pressure, pulse, oxygen saturation, vigilance)

↓

- Laboratory findings: Blood count, coagulation, ProCT, perhaps BNP, D-Dimers
- Chest X-ray; ECG (exclusion of differential diagnoses)
- Sputum cultures (always in case of hospitalisation or previous outpatient antibiotic treatment)

→ • Hospitalisation indicated?

→ • Evaluate ICU criteria
• NIV indicated?

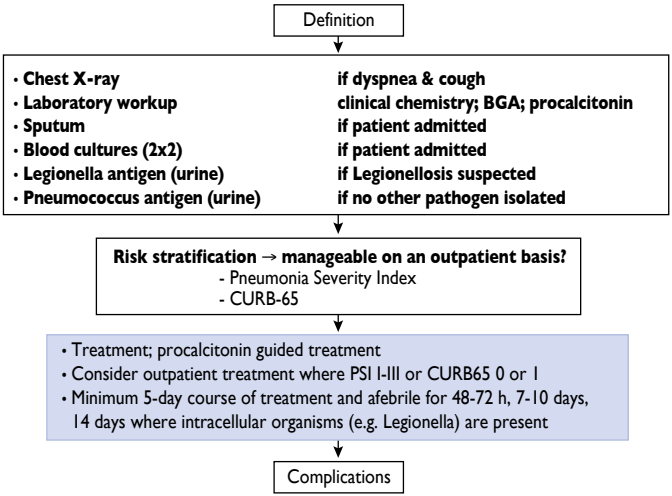
↓

- **Oxygen therapy** 2-(4) l; target saturation 90%
- **Salbutamol/ipratropium inhalations** ≥4-6 x/d, if needed long-term inhalation
- **Systemic steroids** prednisone 0.5 mg/kg of body weight for 5 days
- Antibiotic treatment should be considered; always indicated in stage Gold IV
- Physiotherapy

→ • Follow-up

DYSPNEA: Community-acquired pneumonia

Objective: diagnostics, risk stratification & empirical immediate treatment <2(-4) hrs.



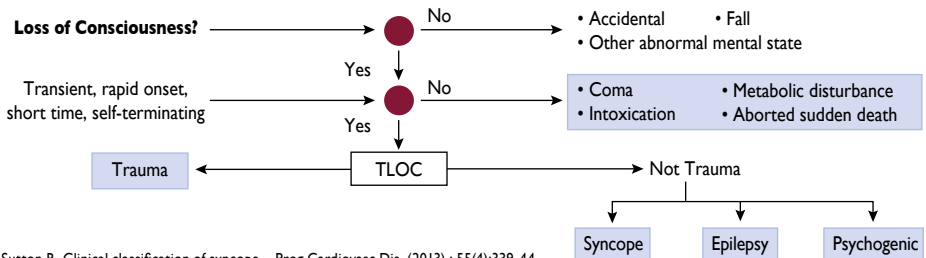
SYNCOPE: Assessment of patients with transient loss of consciousness (TLOC)

Syncope is a transient loss of consciousness due to global cerebral hypoperfusion (usually, itself due to a period of low blood pressure) characterised by rapid onset, short duration, spontaneous and complete recovery.

The differentiation between syncope and non-syncopal conditions with real or apparent LOC can be achieved in most cases with a **detailed clinical history** but sometimes can be extremely difficult. The following questions should be answered:

- Was LOC complete?
- Was LOC transient with rapid onset and short duration?
- Did the patient recover spontaneously, completely and without sequelae?
- Did the patient lose postural tone?

If the answers to these questions are positive, the episode has a high likelihood of being syncope. If the answer to one or more of these questions is negative, exclude other forms of LOC before proceeding with syncope evaluation.



Reference: Sutton R. Clinical classification of syncope. - Prog Cardiovasc Dis. (2013) ; 55(4):339-44.

SYNCOPE: Diagnostic criteria (I)
Diagnostic criteria with initial evaluation

Vasovagal syncope is diagnosed if syncope is precipitated by emotional distress or orthostatic stress and is associated with typical prodrome.

Situational syncope is diagnosed if syncope occurs during or immediately after specific triggers.

Orthostatic syncope is diagnosed when it occurs after standing up and there is documentation of orthostatic hypotension.

Arrhythmia related syncope is diagnosed by ECG when there is:

- Persistent sinus bradycardia <40 bpm in awake or repetitive sinoatrial block or sinus pauses >3 s
- Mobitz II 2nd or 3rd degree AV block
- Alternating left and right BBB
- VT or rapid paroxysmal SVT
- Non-sustained episodes of polymorphic VT and long or short QT interval
- Pacemaker or ICD malfunction with cardiac pauses

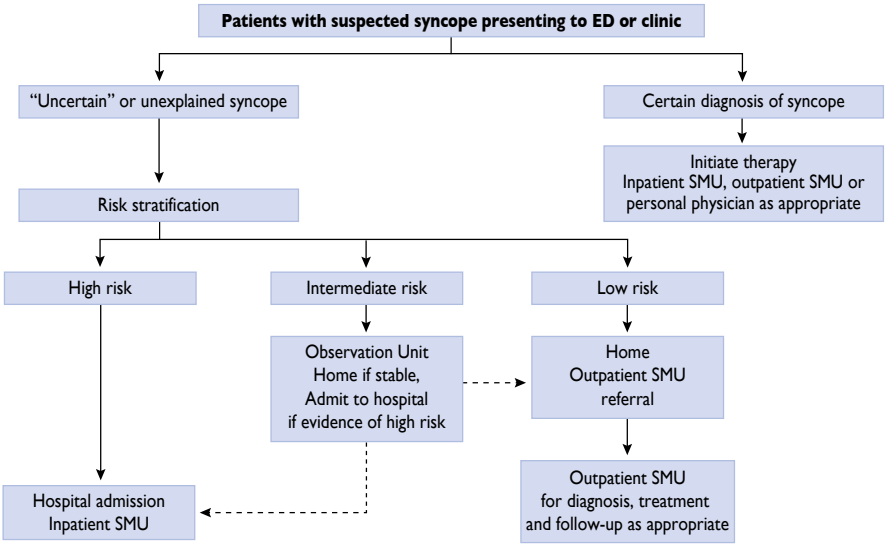
Cardiac ischemia related syncope is diagnosed when syncope presents with ECG evidence of acute ischemia with or without myocardial infarction.

Cardiovascular syncope is diagnosed when syncope presents in patients with prolapsing atrial myxoma, severe aortic stenosis, pulmonary hypertension, pulmonary embolus or acute aortic dissection.

Reference: Moya A et al. Eur Heart J(2009) 30, 2631–2671 (1).

SYNCOPE: Evaluation and risk stratification of patients with suspected syncope

Once syncope is considered to be the likely diagnosis, risk stratification is required to determine further management.



SYNCOPE: Diagnostic criteria (2)
Diagnostic criteria with provocation maneuvers

Carotid sinus massage	Orthostatic Hypotension
Indications • CSM is indicated in patients >40 years with syncope of unknown aetiology after initial evaluation; • CSM should be avoided in patients with previous MI, TIA or stroke within the past 3 months and in patients with carotid bruits (except if carotid Doppler studies excluded significant stenosis)	**Recommendations: Active standing Indications** • Manual intermittent determination with sphygmomanometer of BP supine and, when OH is suspected, during active standing for 3 min is indicated as initial evaluation; • Continuous beat-to-beat non-invasive pressure measurement may be helpful in cases of doubt
Diagnostic criteria • CSM is diagnostic if syncope is reproduced in presence of asystole longer than 3 s and/or a fall in systolic BP >50 mmHg	**Diagnostic criteria** • The test is diagnostic when there is a symptomatic fall in systolic BP from baseline value ≥20 mmHg or diastolic BP ≥10 mmHg or a decrease in systolic BP to <90 mmHg; • The test should be considered diagnostic when there is an asymptomatic fall in systolic BP from baseline value ≥20 mmHg or diastolic BP >10 mmHg or a decrease in systolic BP to <90 mmHg

Reference: Moya A et al. Eur Heart J(2009) 30, 2631–2671 (2).

Treatment according to type of SYNCOPE (I)

Treatment of reflex syncope	Treatment of orthostatic hypotension
• Explanation of the diagnosis, provision of reassurance and explanation of risk of recurrence are in all patients • Isometric PCM are indicated in patients with prodrome • Cardiac pacing should be considered in patients with dominant cardioinhibitory CSS • Cardiac pacing should be considered in patients with frequent recurrent reflex syncope, age > 40 years and documented spontaneous cardioinhibitory response during monitoring • Midodrine may be indicated in patients with VVS refractory to lifestyle measures • Tilt training may be useful for education of patients but long-term benefit depends on compliance • Cardiac pacing may be indicated in patients with tilt-induced cardioinhibitory response with recurrent frequent unpredictable syncope and age > 40 after alternative therapy has failed • Triggers or situations inducing syncope must be avoided as much as possible • Hypotensive drugs must be modified or discontinued • Cardiac pacing is not indicated in the absence of a documented cardioinhibitory reflex • Beta-adrenergic blocking drugs are not indicated • Fluid consumption and salt in the diet should be increased	• Adequate hydration and salt intake must be maintained • Midodrine should be administered as adjunctive therapy if needed • Fludrocortisone should be administered as adjunctive therapy if needed • PCM may be indicated • Abdominal binders and/or support stockings to reduce venous pooling may be indicated • Head-up tilt sleeping (>10°) to increase fluid volume may be indicated • Triggers or situations inducing syncope must be avoided as much as possible • Hypotensive drugs administered for concomitant conditions must be discontinued or reduced

Treatment according to type of SYNCOPE (2)

Treatment of arrhythmic syncope

Cardiac Pacing

- Pacing is indicated in patients with sinus node disease in whom syncope is demonstrated to be due to sinus arrest (symptom-ECG correlation) without a correctable cause
- Pacing is indicated in sinus node disease patients with syncope and abnormal CSNRT
- Pacing is indicated in sinus node disease patients with syncope and asymptomatic pauses > 3 sec. (with possible exceptions of young trained persons, during sleep and in medicated patients)
- Pacing is indicated in patients with syncope and 2nd degree Mobitz II, advanced or complete AV block
- Pacing is indicated in patients with syncope, BBB and positive EPS
- Pacing should be considered in patients with unexplained syncope and BBB
- Pacing may be indicated in patients with unexplained syncope and sinus node disease with persistent sinus bradycardia itself asymptomatic
- Pacing is not indicated in patients with unexplained syncope without evidence of any conduction disturbance

Catheter ablation

- Catheter ablation is indicated in patients with symptom/arrhythmia ECG correlation in both SVT and VT in the absence of structural heart disease (with exception of atrial fibrillation)
- Catheter ablation may be indicated in patients with syncope due to the onset of rapid atrial fibrillation

Antiarrhythmic drug therapy

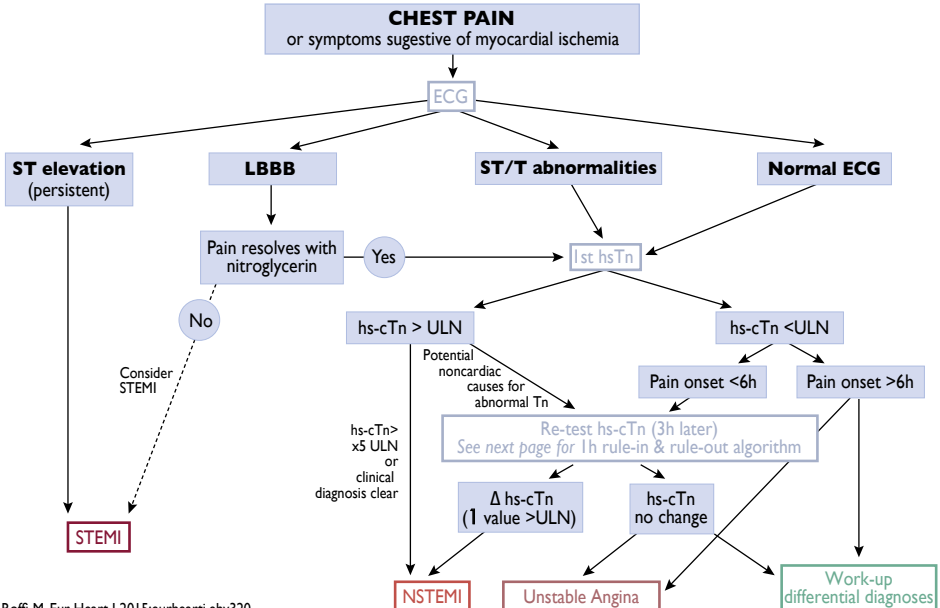
- Antiarrhythmic drug therapy, including rate control drugs, is indicated in patients with syncope due to onset of rapid atrial fibrillation
- Drug therapy should be considered in patients with symptom/arrhythmia ECG correlation in both SVT and VT when catheter ablation cannot be undertaken or has failed

Implantable Cardioverter Defibrillator (ICD)

- ICD is indicated in patients with documented VT and structural heart disease
- ICD is indicated when sustained monomorphic VT is induced at EPS in patients with previous myocardial infarction
- ICD should be considered in patients with documented VT and inherited cardiomyopathies or channelopathies

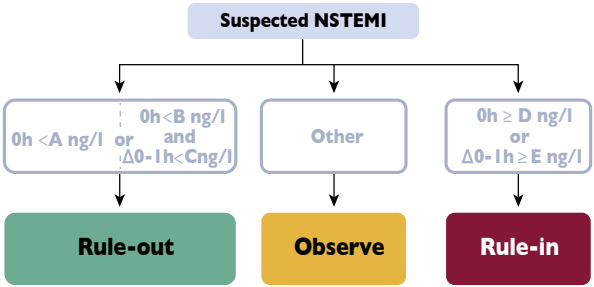
CHAPTER 2: ACUTE CORONARY SYNDROMES

ACUTE CORONARY SYNDROMES: Diagnosis (1)



Reference: Roffi M. Eur Heart J 2015;eurheartj.ehv320

ACUTE CORONARY SYNDROMES: Diagnosis (2)
0-1 H Rule-in & rule out test for NSTEMI



	A	B	C	D	E
hs-cTnT (Elecsys)*	5	12	3	52	5
hs-cTnI (Architect)*	2	5	2	52	6
hs-cTnI (Dimension Vista)*	0.5	5	2	107	19

*Cut-off levels are assay-specific.

- NSTEMI can be ruled-out at presentation, if hs-cTn concentration is very low
- NSTEMI can be ruled out by the combination of low baseline levels and the lack of a relevant increase within 1 h
- NSTEMI is highly likely if initial hs-cTn concentration is at least moderately elevated or hs-cTn concentrations show a clear rise within the first hour

Reference: Roffi M. Eur Heart J 2015;eurheartj.ehv320

ACUTE CORONARY SYNDROMES: Differential diagnosis (1)

Causes of chest pain Not related to ACS	Causes of troponin elevation Not related to ACS
Primary cardiovascular • Acute pericarditis, pericardial effusion • Acute myocarditis • Severe hypertensive crisis • Stress cardiomyopathy (Tako-Tsubo syndrome) • Hypertrophic cardiomyopathy, aortic stenosis • Severe acute heart failure • Acute aortic syndrome (dissection, hematoma) • Pulmonary embolism, pulmonary infarction • Cardiac contusion	**Primary cardiovascular** • Acute myo(peri)carditis • Severe hypertensive crisis • Pulmonary edema or severe congestive heart failure • Stress cardiomyopathy (Tako-Tsubo syndrome) • Post- tachy- or bradyarrhythmias • Cardiac contusion or cardiac procedures (ablation, cardioversion, or endomyocardial biopsy) • Aortic dissection, aortic valve disease or hypertrophic cardiomyopathy • Pulmonary embolism, severe pulmonary hypertension
Primary non-cardiovascular • Oesophageal spasm, oesophagitis, Gastro Esophageal Reflux (GER) • Peptic ulcer disease, cholecystitis, pancreatitis • Pneumonia, bronchitis, asthma attack • Pleuritis, pleural effusion, pneumothorax • Pulmonary embolism, severe pulmonary hypertension • Thoracic trauma • Costochondritis, rib fracture • Cervical / thoracic vertebral or discal damage • Herpes Zoster	**Primary non-cardiovascular** • Renal dysfunction (acute or chronic) • Critical illness (sepsis, repiratory failure…) • Acute neurological damage (i.e. stroke, subarachnoid hemorrhage) • Severe burns (affecting >30% of body surface area) • Rhabdomyolysis • Drug toxicity (chemotherapy with adriamycin, 5-fluorouracil, herceptin, snake venoms…) • Inflammatory or degenerative muscle diseases • Hypothyroidism • Infiltrative diseases (amyloidosis, hemochromatosis, sarcoidosis) • Scleroderma

ACUTE CORONARY SYNDROMES: Differential diagnosis (2)
Causes of repolarisation abnormalities in the ECG not related to ACS

ST-segment elevation

Fixed
- LV aneurysm
- LBBB, WPW, hypertrophic cardiomyopathy, LVH
- Pacemaker stimulation
- Early repolarisation (elevated J-point)

Dynamic
- Acute (myo)pericarditis
- Pulmonary embolism
- Electrolyte disturbances (hyperkalemia)
- Acute brain damage (stroke, subarachnoid haemorrhage)
- Tako Tsubo syndrome

Negative T waves

- Normal variants, i.e. women (right precordial leads), children, teenagers
- Evolutive changes post myocardial infarction
- Chronic ischemic heart disease
- Acute (myo)pericarditis, cardiomyopathies
- BBB, LVH, WPW
- Post-tachycardia or pacemaker stimulation
- Metabolic or ionic disturbances

ST-segment depression

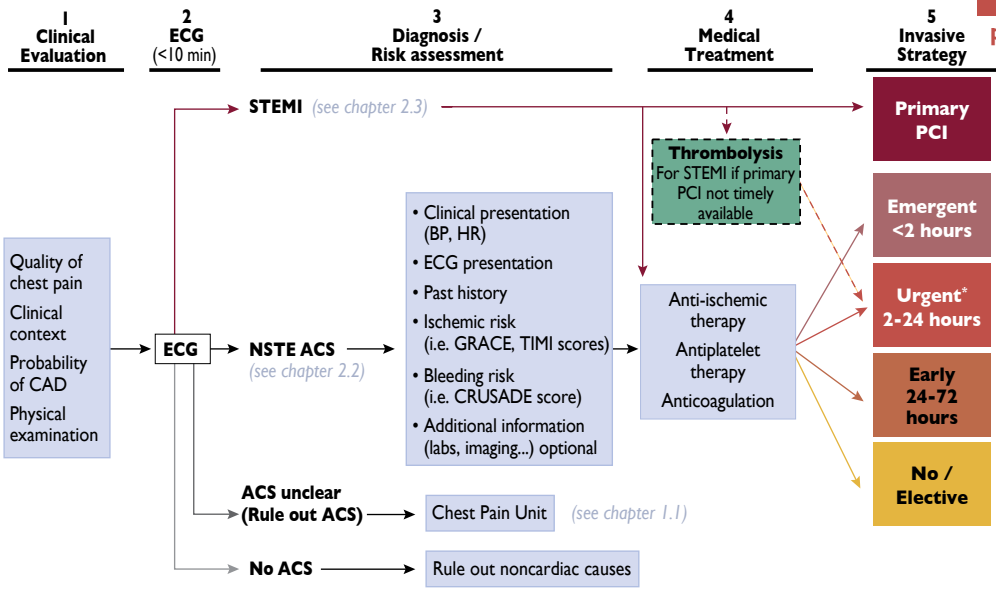
Fixed
- Abnormal QRS (LBBB, WPW, pacemaker stimulation…)
- LVH, hypertrophic cardiomyopathy
- Chronic ischemic heart disease

Dynamic
- Acute (myo)pericarditis
- Acute pulmonary hypertension
- Electrolyte disturbances (hyperkalemia)
- Intermitent LBBB, WPW, pacing
- Post-tachycardia / cardioversion
- Severe hypertensive crisis
- Drug effects (digoxin)
- Shock, pancreatitis
- Hyperventilation
- Tako Tsubo syndrome

Prominent T waves

- Normal variants, i.e. early repolarisation
- Metabolic or ionic disturbances (i.e. hyperkalemia)
- Acute neurological damage (stroke, subarachnoid haemorrhage)

General approach to the patient with chest pain/suspected ACS



* 3-12 hours after thrombolysis.

NON ST-SEGMENT ELEVATION ACS: Risk stratification (I)

Ischemic risk

Grace risk score

Predictive Factors
- Age
- HR*
- SBP*
- Creatinine (mg/dl)*
- Killip class*
- Cardiac arrest*
- ST-segment deviation
- Elevated cardiac markers

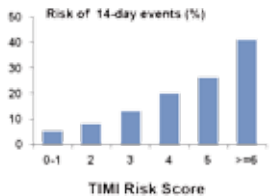
Outcomes
In-hospital, 6-month,
1-year and 3-year mortality
1-year death/MI

Risk calculation
www.gracescore.org

Timi risk score

Predictive Factors
- Age ≥ 65 years
- At least 3 risk factors for CAD
- Significant (>50%) coronary stenosis
- ST deviation
- Severe anginal symptoms (>2 events in last 24 h)
- Use of aspirin in last 7 days
- Elevated serum cardiac markers

Outcome
All-cause mortality / new or recurrent MI / severe recurrent ischemia requiring urgent revascularisation at 14 days



Risk calculation
(One point each)
www.timi.org

* At admission.

NON ST-SEGMENT ELEVATION ACS: Risk stratification (2)

Bleeding risk

Crusade risk score

Predictive Factors

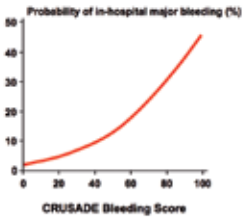
- Sex
- HR*
- SBP*
- Creatinine (mg/dl)*
- Baseline hematocrit*
- GFR: Cockcroft-Gault*
- Diabetes
- Prior vascular disease
- Signs of congestive heart failure*

Outcome

In-hospital major bleeding

Risk calculation

www.crusadebleedingscore.org



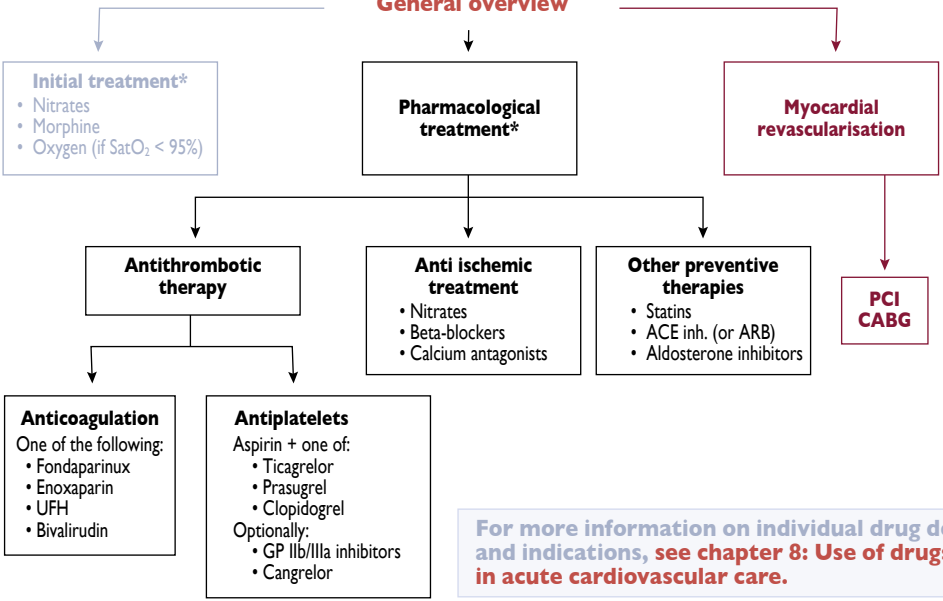
* At admission.

Antman EM, et al. The TIMI risk score for unstable angina/non-ST elevation MI: A method for prognostication and therapeutic decision making. JAMA. (2000);284(7):835-42.

Subherwal S, et al Baseline risk of major bleeding in non-ST-segment-elevation myocardial infarction: the CRUSADE (Can Rapid risk stratification of Unstable angina patients Suppress ADverse outcomes with Early implementation of the ACC/AHA Guidelines) Bleeding Score. Circulation (2009) ;119(14):1873-82.

NON ST-SEGMENT ELEVATION ACS: Treatment (I)

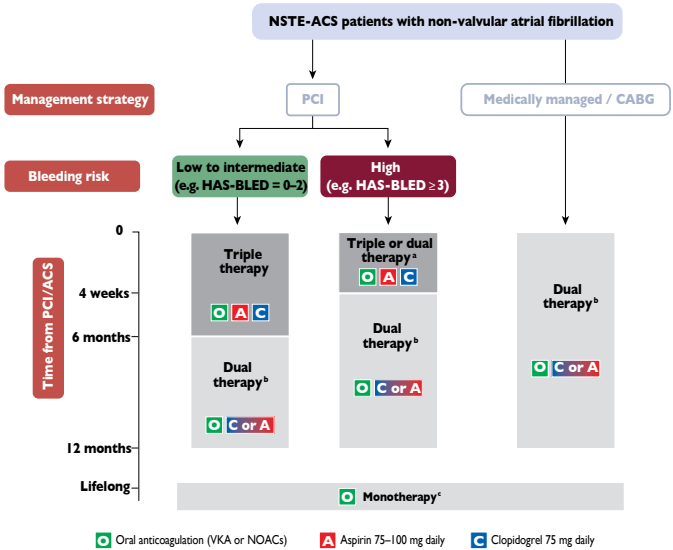
General overview



For more information on individual drug doses and indications, see chapter 8: Use of drugs in acute cardiovascular care.

NON ST-SEGMENT ELEVATION ACS: Treatment (2)

Antithrombotic strategies in patients with NSTE-ACS and non-valvular atrial fibrillation



CHA2DS2-VASc = Cardiac failure, Hypertension, Age ≥ 75 [2 points], Diabetes, Stroke [2 points] – Vascular disease, Age 65–74, Sex category.

[a] Dual therapy with oral anticoagulation and clopidogrel may be considered in selected patients (low ischaemic risk).

[b] Aspirin as an alternative to clopidogrel may be considered in patients on dual therapy (i.e., oral anticoagulation plus single antiplatelet); triple therapy may be considered up to 12 months in patients at very high risk for ischaemic events.

[c] Dual therapy with oral anticoagulation and one antiplatelet agent (aspirin or clopidogrel) beyond one year may be considered in patients at very high risk of coronary events.

[d] In patients undergoing coronary stenting, dual antiplatelet therapy may be an alternative to triple or a combination of anticoagulants and single antiplatelet therapy if the CHA2DS2-VASc score is 1 (males) or 2 (females).

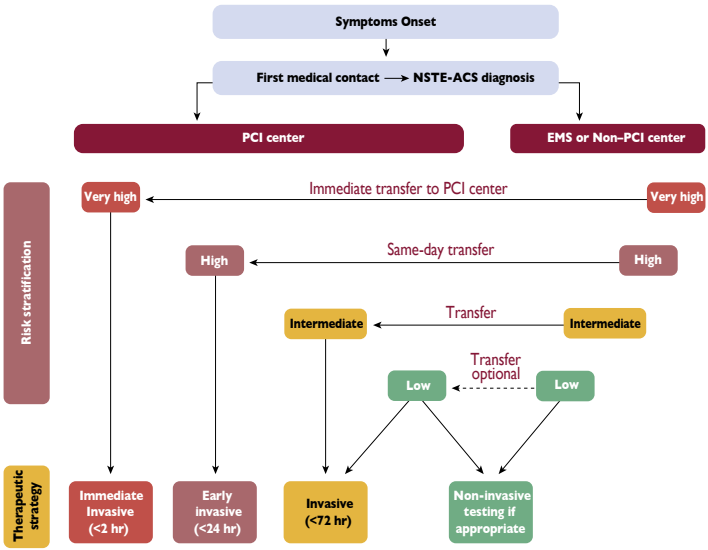
Reference: Eur Heart J 2015;eurheartj.ehv320- Figure 5.

NON ST-SEGMENT ELEVATION ACS: Treatment (3)
Risk criteria mandating invasive strategy in NSTE-ACS

Very-high-risk criteria	• Haemodynamic instability or cardiogenic shock • Recurrent or ongoing chest pain refractory to medical treatment • Life-threatening arrhythmias or cardiac arrest • Mechanical complications of MI • Acute heart failure • Recurrent dynamic ST-T wave changes, particularly with intermittent ST-elevation
High-risk criteria	• Rise or fall in cardiac troponin compatible with MI • Dynamic ST- or T-wave changes (symptomatic or silent) • GRACE score >140
Intermediate-risk criteria	• Diabetes mellitus • Renal insufficienty (eGFR <60 mL/min/1.73 m^2) • LVEF <40% or congestive heart failure • Early post-infarction angina • Prior PCI • Prior CABG • GRACE risk score >109 and <140
Low-risk criteria	• Any characteristics not mentioned above

Reference: Roffi M. Eur Heart J 2015;eurheartj.ehv320

NON ST-SEGMENT ELEVATION ACS: Treatment (4)
Timing and strategy for invasive management



Reference: Eur Heart J 2015;eurheartj.ehv320 - Figure 6.

STEMI: Electrocardiographic diagnosis

STEMI is diagnosed according to the presence of the following acute ischemic ECG changes:

In the absence of LVH and LBBB:

- New ST elevation at the J point in 2 contiguous leads with ≥ 0.2 mV in men or ≥ 0.15 mV in women in leads V_2-V_3 and/or ≥ 0.1 mV in other leads
  → Contiguous leads mean lead groups such as anterior leads (V_1-V_6), inferior leads (II, III, aVF) or lateral/apical leads (I, aVL).

In the presence LBBB or ST depression:

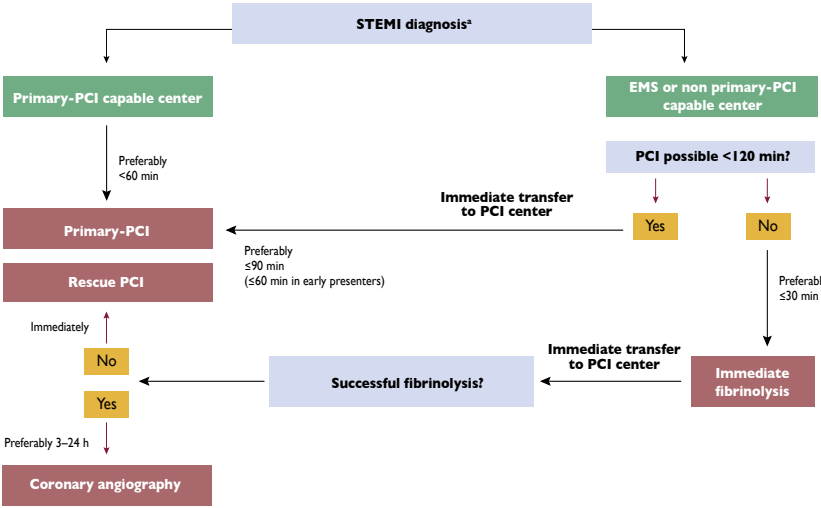
- New LBBB, and symptoms suggestive of ACS
- ST depression in leads V_1–V_3 indicate inferobasal myocardial ischemia (especially when the terminal T-wave is positive)

In suspected posterior (circumflex artery- related) or right ventricle-related infarction:

- ST elevation in V_7 (at the left posterior axillary line), V_8 (at the left midscapular line), and V_9 (at the left paraspinal border), using a cut-point > 0.05 mV
  → Capture an overlooked left dominant circumflex using posterior leads in the fifth interspace
- ST elevation in right precordial leads (V_3R and V_4R), using a cut-off point > 0.05 mV, and > 0.1 mV in men <30 years
  → Capture suspected right ventricular infarction using right precordial leads

Reference: Steg G et al. Eur Heart J. (2012);33:2569-619 (6).

STEMI: Treatment (1)
General overview of initial management



Reference: Steg G et al. Eur Heart J. (2012);33:2569-619 [6].

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

STEMI: Treatment (2)
Primary PCI - First 24 hours and days 2-7

For more information on individual drug doses and indications, see chapter 8: Use of drugs in acute cardiovascular care.

Pre hospital

Acetylicsalisylic Acid	300 mg
Heparin	70 IU/kg

Ticagrelor	180 mg
or Prasugrel	60 mg
or Clopidogrel	600 mg

PCI

Bivalirudin	
or GPI:	Eptifibatide
	Tirofiban
	Abxicimab

Follow local in-lab instruction / dosing

CCU/ICCU

Metoprolol	25 mg x 2
or carvedilol	3,25 mg x 2
or bisoprolol	2,5 mg x 2
Atorvastatin	80 mg x 1
or Rosuvastatin	40 mg x 1

Medication Titration Day 2-7

Acetylicsalisylic Acid	75 mg x 1
Ticagrelor	90 mg x 2
or Prasugrel	10/5 mg x 1
or Clopidogrel	75 mg x 1
Metoprolol	200mg x 1
or carvedilol	25 mg x 2
or bisoprolol	5 mg x 2

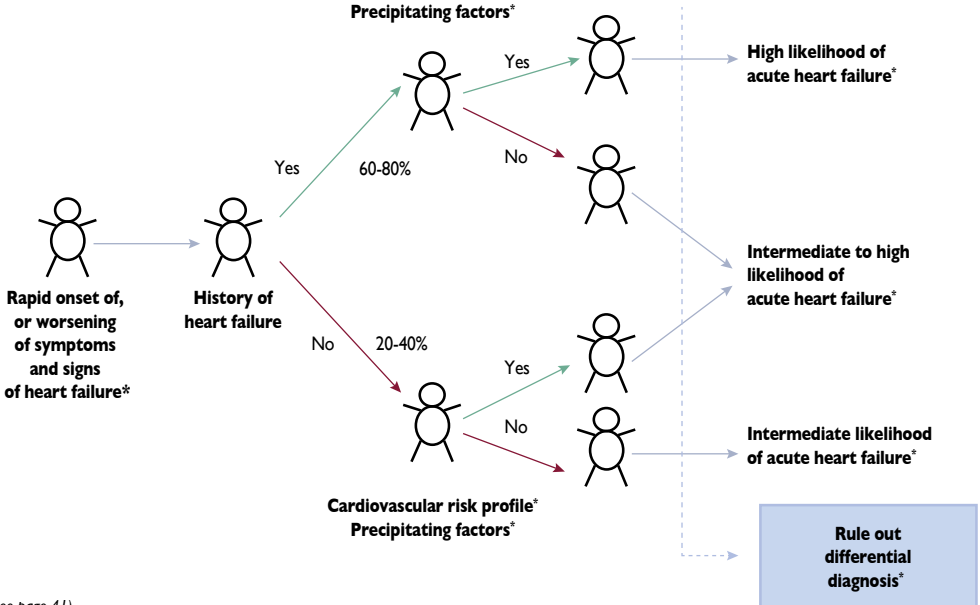
or Ca-antagonist *(see chapter 2.2)*

Start ACE-i or ARB in DM, LVSD, CHF, or to control BP
Aldosterone RB
Start or continue anti-diabetic medication

Reference: Steg G et al. Eur Heart J. (2012);33:2569-619 [7].
Pre-hospital management of patients with chest pain and/or dyspnoea of cardiac origin. A position paper of the Acute Cardiovascular Care Association (ACCA) of the ESC - European Heart Journal: Acute Cardiovascular Care August 27, 2015 2048872615604119.

CHAPTER 3: ACUTE HEART FAILURE

ACUTE HEART FAILURE: Diagnosis and causes (I)



* *(See page 41).*

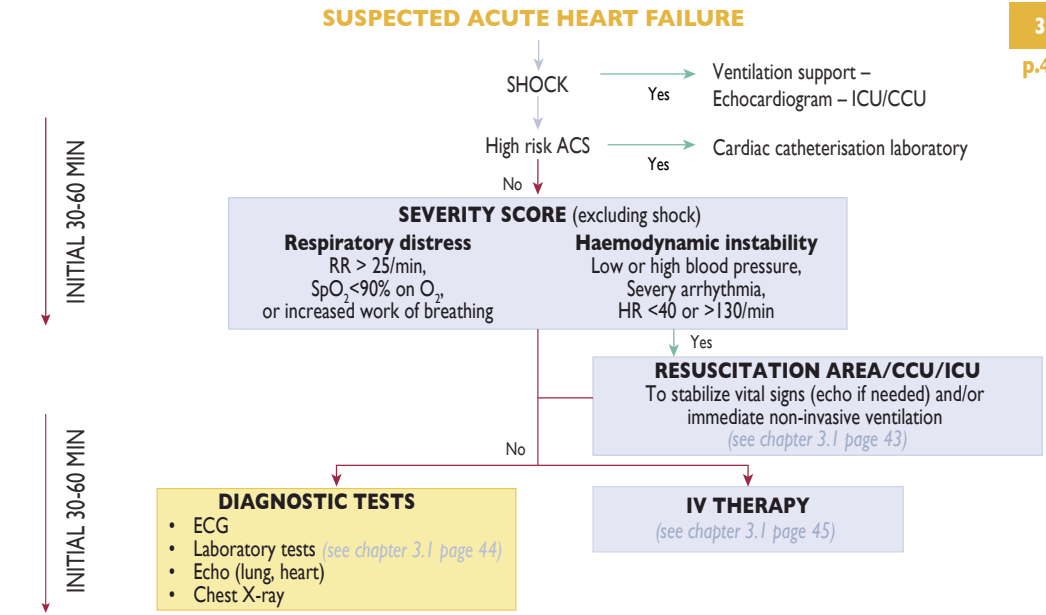
ACUTE HEART FAILURE: Diagnosis and causes (2)

1. **Symptoms:** Dyspnea (on effort or at rest)/breathlessness, fatigue, orthopnea, cough, weight gain/ankle swelling
2. **Signs:** Tachypnea, tachycardia, low or normal blood pressure, raised jugular venous pressure, 3rd/4th heart sound, rales, oedema, intolerance of the supine position
3. **Cardiovascular risk profile:** Older age, HTN, diabetes, smoking, dyslipidemia, family history, history of CVD
4. **Precipitating factors:** Myocardial ischemia, rhythm disturbances, medication (NSAID, negative inotropic agents), infection, noncompliance
5. **Differential diagnosis:** Exacerbated pulmonary disease, pneumonia, pulmonary embolism, pneumothorax, acute respiratory distress syndrome, (severe) anaemia, hyperventilation (acidosis), sepsis/septic shock, redistributive/hypovolemic shock
6. **Likelihood:** Depending on the site off presentation the underlying cause of acute heart failure is likely to differ. Cardiologists see more often worsening heart failure and physicians at the Emergency Department more often see patients with preserved systolic left ventricular function

MAIN CAUSES OF ACUTE HEART FAILURE

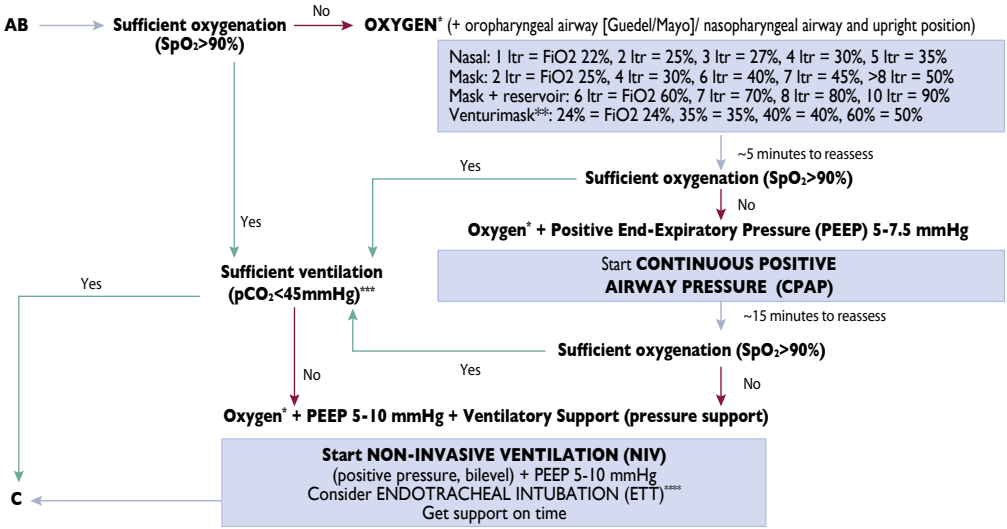
- Coronary artery disease
- Hypertension
- Cardiomyopathy (familial, acquired)
- Valvular heart disease
- Peri-/endocardial disease
- Congenital heart disease
- Arrhythmia (tachy-, brady-)
- Conduction disorder (blocks)
- Volume overload (renal, iatrogenic)
- Tumor
- Pleural effusion
- Anxiety disorder
- Neurologic disease

Reference: McMurray JJ et al, Eur Heart J (2012) ;33(14):1787-847 (19).



Algorithm for the management of acute heart failure. Depicted from Mebazaa A et al. Eur J Heart Fail. (2015);17(6):544-58.

ACUTE HEART FAILURE: Initial diagnosis and treatment Airway (A) & Breathing (B)



* Goal SpO_2 94-98%.
** Use the predefined liters of oxygen. When using higher flows the FiO_2 will drop.
*** For a patient with COPD, a pCO_2 of 45-50 mmHg may be optimal. Aim for a normal pH.
**** Consider if the above fails or when patient is fatigued.

ACUTE HEART FAILURE: Initial diagnosis (CDE)

C - CIRCULATION* HR (bradycardia [<60/min], normal [60-100/min], tachycardia [>100/min]), rhythm (regular, irregular), SBP (very low [<90t mmHg], low, normal [110-140 mmHg], high [>140 mmHg]), and elevated jugular pressure should be checked

INSTRUMENTATION & INVESTIGATIONS:

Consider intravenous (central) & arterial line (BP monitoring)

Laboratory measures

- Cardiac markers (troponin, (BNP/NT-proBNP, MR-proANP)
- Complete blood count, electrolytes, creatinine, urea, glucose, inflammation, TSH

Standard 12-lead ECG

- Venous blood gases, D-dimer (suspicion of acute pulmonary embolism)
- Rhythm, rate, conduction times?
- Signs of ischemia/myocardial infarction? Hypertrophy?

Echocardiography

- Ventricular function (systolic and diastolic)?
- Presence of valve dysfunction (severe stenosis/insufficiency)?
- Pericardial effusion/tamponade?

ACTIONS:

Rule in/out diagnosis of acute heart failure as diagnosis for symptoms and signs

Establish cause of disease

Determine severity of disease

Start treatment as soon as possible, i.e. both heart failure and the factors identified as triggers

D – DISABILITY DUE TO NEUROLOGICAL DETERIORATION

Normal consiousness/altered mental status? Measurement of mental state with AVPU (alert, visual, pain or unresponsive) Glasgow Coma Scale: EMV score <8 → Consider ETT

Anxiety, restlessness? → Consider morphine 2.0-5 mg i.v. bolus (diluted in normal saline), preceded by metoclopramide 10 mg i.v. PRN

E – EXPOSURE & EXAMINATION

Temperature/fever : central and peripheral

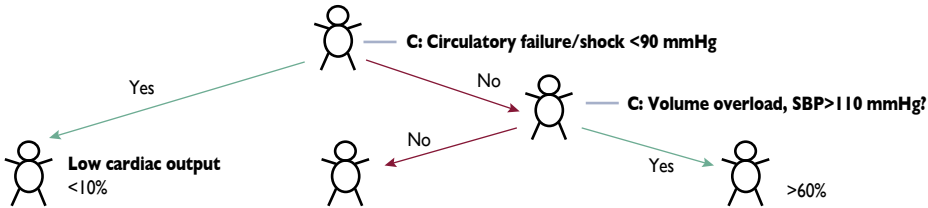
Weight

Skin/extremities: circulation (e.g. capilary refill), color

Urinary output (<0.5ml/kg/hr) → Insert indwelling catheter; the benefits should outweigh the risks of infection and long-term complications

References: Mebazaa A et al. Intensive Care Med. (2015) Sep 14. [Epub ahead of print]; Mueller C et al. Eur Heart J Acute Cardiovasc Care. (2015) Jun 29.

ACUTE HEART FAILURE: Initial treatment (C) IV therapy



1 Inotropic drugs
- Dobutamine 2.5 µg/kg/min
- Milrinone bolus 25 µg/kg in10-20 min, continuous 0.375 µg/kg/min

2 Vasopressor i.v.
- Norepinephrine 0.2 µg/kg/min

3 Diuretics i.v.
- Furosemide 20-40 mg bolus, continuous 100 mg/6 h

4 Consider hypertonic saline + diuretic

5 Consider mechanical circulatory support

1 Diuretics i.v.
- Furosemide 20-40 mg bolus, continuous 100 mg/6 h*

2 Inotropic drugs
- Dobutamine continuous 2.5 µg/kg/min
- Milrinone bolus 25 µg/kg in 10-20 min, continuous 0.375 µg/kg/min
- Levosimendan bolus 12 µg/kg in 10 min, continuous 0.1 µg/kg/min

3 Consider to start ACE-I/ARB, beta-blocker, MRA.

***See chapter 8: Use of drugs in acute cardiovascular care.**

(See table page 47-48)

1 Vasodilators
- Nitroglycerine spray 400 µg sublingual, repeat ~5-10 min
- Nitroglycerine i.v. continuously ~10 µg/min, increase ~5 µg/min
- Nitroprusside 0.3 µg/kg/min increase to 5 microg/kg/min

2 Diuretics i.v.
- Furosemide 20-40 mg bolus, continuous 100 mg/6 h

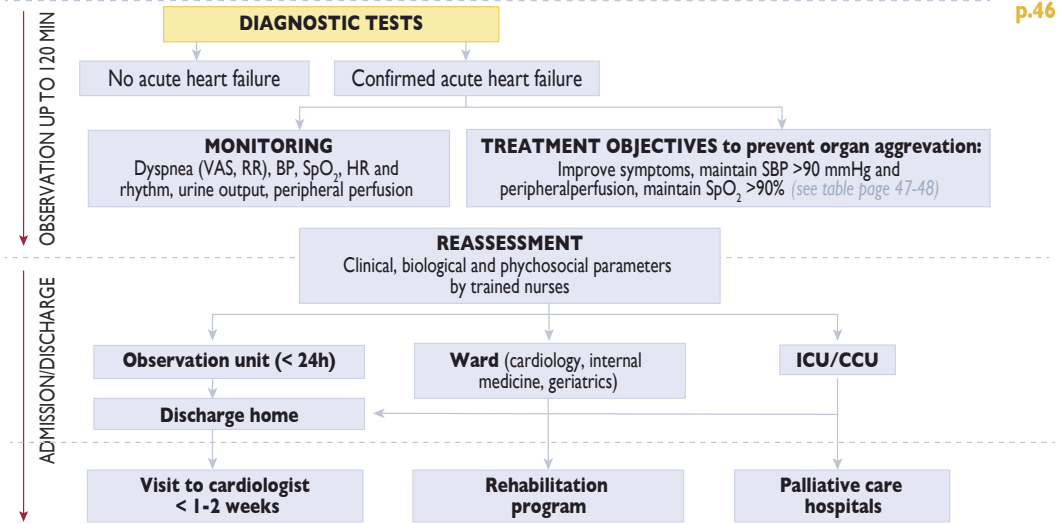
3 Consider to start ACE-I/ARB, beta-blocker, MRA.

***See chapter 8: Use of drugs in acute cardiovascular care.**

(See table page 47-48)

*Use higher dose in patients on chonic diuretic treatment for HF (i.e. 2.5 times normal dose).

MANAGEMENT OF ACUTE HEART FAILURE



Algorithm for the management of acute heart failure. Depicted from Mebazaa A et al.
Eur J Heart Fail. (2015);17(6):544-58

Management of oral therapy in AHF in the first 48 hours

	Normotension/ Hypertension	Hypotension		Low Heart rate		Potassium		Renal impairment	
		<100 >85 mmHg	<85 mmHg	<60 ≥50 bpm	<50 bpm	≤3.5 mg/dL	>5.5 mg/dL	Cr < 2.5, eGFR > 30	Cr > 2.5, eGFR < 30
ACE-I/ARB	Review/increase	Reduce/ stop	Stop	No change	No change	Review/ increase	Stop	Review	Stop
Beta-blocker	No change	Reduce/ stop	Stop	Reduce	Stop	No change	No change	No change	No change
MRA	No change	No change	Stop	No change	No change	Review/ increase	Stop	Reduce	Stop
Diuretics	Increase	Reduce	Stop	No change	No change	Review/ No change	Review/ increase	No change	Review

CCB, calcium channel blockers (mg/dL); Cr, creatinine blood level (mg/dL); eGFR, estimated glomerular filtration rate ml/min/1.73 m2; MRA, mineralocorticoid receptor antagonist; (*) amiodarone. - Depicted from Mebazaa A et al. Eur J Heart Fail. (2015);17(6):544-58.

Management of oral therapy in AHF in the first 48 hours

	Normotension/ Hypertension	Hypotension		Low Heart rate		Potassium		Renal impairment	
		<100 >85 mmHg	<85 mmHg	<60 ≥50 bpm	<50 bpm	≤3.5 mg/dL	>5.5 mg/dL	Cr < 2.5, eGFR > 30	Cr > 2.5, eGFR < 30
Other vasodilators (Nitrates)	Increase	Reduce/ stop	Stop	No change	No change	No change	No change	No change	No change
Other heart rate slowing drugs (amiodarone, CCB, Ivabradine)	Review	Reduce/ stop	Stop	Reduce/ stop	Stop	Review/ stop (*)	No change	No change	No change

Thrombosis prophylaxis should be started in patients not anticoagulated (enoxaparin 1 mg/kg as first dose)
Maintain an adequate nutritional status with a nutritional support of 20-25 kcal/kg/day within the first 48 hours

CCB, calcium channel blockers (mg/dL); Cr, creatinine blood level (mg/dL); eGFR, estimated glomerular filtration rate ml/min/1.73 m2; MRA, mineralocorticoid receptor antagonist; (*) amiodarone. - Depicted from Mebazaa A et al. Eur J Heart Fail. (2015);17(6):544-58.

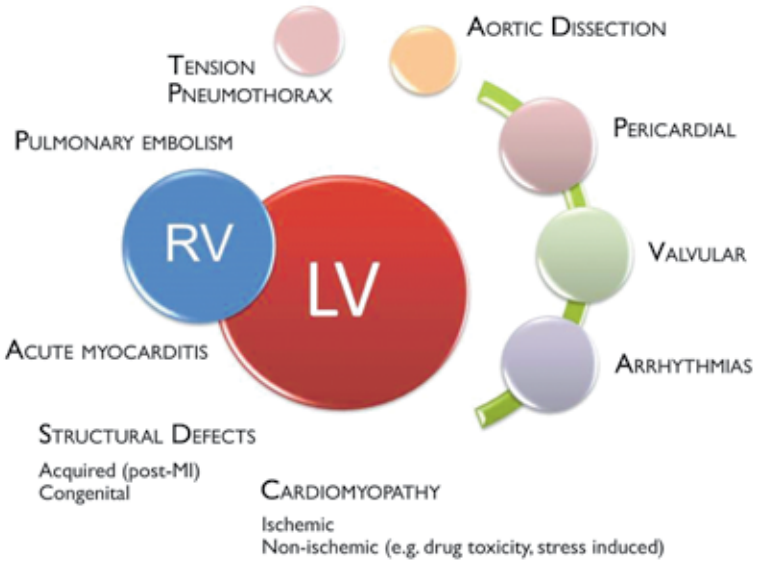
CARDIOGENIC SHOCK: Definition

Clinical condition defined as the inability of the heart to deliver an adequate amount of blood to the tissues to meet resting metabolic demands as a result of impairment of its pumping function.

Hemodynamic criteria to define cardiogenic shock
• Systolic blood pressure <80 to 90 mmHg or mean arterial pressure 30 mmHg lower than baseline
• Severe reduction in cardiac index: <1.8 L/min/m^2 without support or <2.0 to 2.2 L/min/m^2 with support
• Adequate or elevated filling pressure: Left ventricular end-diastolic pressure >18 mmHg or Right ventricular end-diastolic pressure >10 to 15 mmHg

CARDIOGENIC SHOCK: Causes

LV pump failure is the primary insult in most forms of CS, but other parts of the circulatory system contribute to shock with inadequate compensation or additional defects.



CARDIOGENIC SHOCK: Initial triage and management

This protocol should be initiated as soon as cardiogenic shock/end organ hypoperfusion is recognised and should not be delayed pending intensive care admission.

EMERGENCY DEPARTMENT

0 min

EARLY TRIAGE & MONITORING

Start high flow O_2
Establish i.v. access

- Age: 65–74, ≥75
- Heart rate >100 beats per minute
- Systolic blood pressure <100 mmHg
- Proportional pulse pressure ≤25 % (CI <2.2l/min/m^2)
- Orthopnea (PCWP >22 mmHg)
- Tachypnea (>20/min), >30/min (!)
- Killip class II-IV
- Clinical symptoms of tissue hypoperfusion/hypoxia:
  - cool extremities,
  - decreased urine output (urine output <40 ml/h)
  - decreased capillary refill or mottling
  - alteration in mental status

5 min

INITIAL RESUSCITATION

- Arterial and a central venous catheterization with a catheter capable of measuring central venous oxygen saturation
- Standard transthoracic echocardiogram to assess left (and right) ventricular function and for the detection of potential mechanical complications following MI
- Early coronary angiography in specialized myocardial intervention center when signs and/or symptoms of ongoing myocardial ischemia (e.g. ST segment elevation myocardial infarction).

- CORRECT: hypoglycemia & hypocalcemia,
- TREAT: sustaned arrhythmias: brady- or tachy-
- Isotonic saline-fluid challenge of 20 to 30 ml per kilogram of body weight over a 30-minute period to achieve a central venous pressure of 8 to 12 mmHg or until perfusion improves (with a maximum of 500 ml)
- CONSIDER NIVmechanical ventilation for comfort (fatigue, distress) or as needed:
  - To correct acidosis
  - To correct hypoxemia
- INOTROPIC SUPPORT (dobutamine and/or vasopressor support)

15 min

60 min

TREATMENT GOALS

- a mean arterial pressure of 60 mmHg or above,
- a mean pulmonary artery wedge pressure of 18 mmHg or below,
- a central venous pressure of 8 to 12 mmHg,
- a urinary ouput of 0,5 ml or more per hour per kilogram of body weight
- an arterial pH of 7.3 to 7.5
- a central venous saturation ($ScvO_2$) ≥70% (provided SpO_2 ≥93% and Hb level ≥9 g/dl)

CARDIAC INTENSIVE CARE UNIT

In persistent drug-resistant cardiogenic shock, consider mechanical circulatory support

For more informations on individual drug doses and indications:

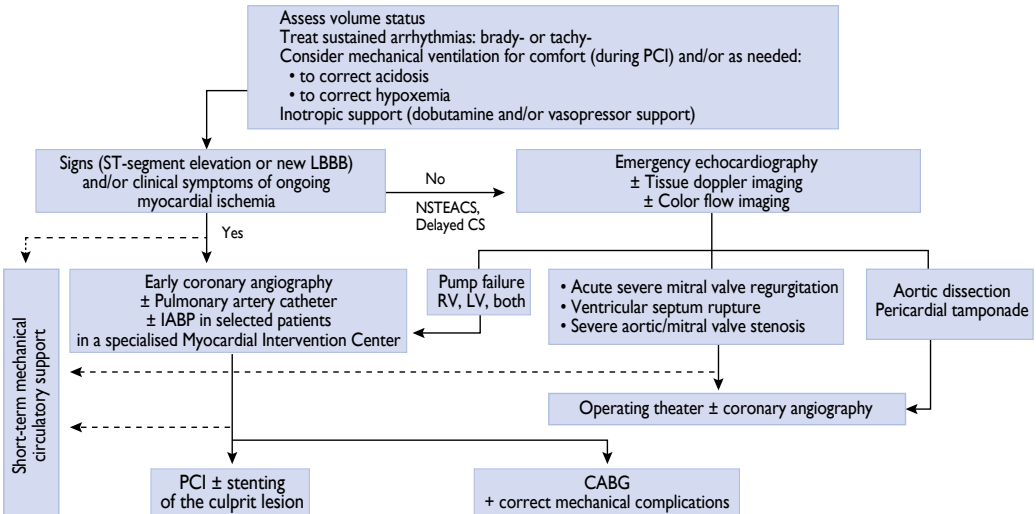
*See chapter 8: Use of drugs in acute cardiovascular care.

Ventilator mode	Pressure assist/control
Tidal Volume goal	Reduce tidal volume to 6-8 ml/kg lean body weight
Plateau Pressure goal	≤ 30 cm H_2O
Anticipated PEEP levels	5-10 cm H_2O
Ventilator rate and pH goal	12-20, adjusted to achieve a pH ≥ 7.30 if possible
Inspiration: Expiration time	1:1 to 1:2
Oxygenation goal:	
• PaO_2	50-80 mmHg
• SpO_2	> 90%

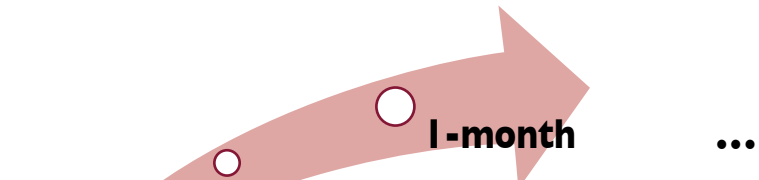
Predicted body weight calculation:
- Male: 50 + 0.91 (height in cm - 152.4)
- Female: 45.5 + 0.91 (height in cm - 152.4)

Some patients with CS will require increased PEEP to attain functional residual capacity and maintain oxygenation, and peak pressures above 30 cm H2O to attain effective tidal volumes of 6-8ml/kg with adequate CO2 removal.

CARDIOGENIC SHOCK: Management following STEMI



CARDIOGENIC SHOCK:
Mechanical circulatory support, basic characteristics



IABP	Impella 2,5	Impella 5,0	Tandem-heart	Levitronix	ECMO	Implantable
Left ventricular support					BiVentricular support	
Partial support			Full support			
				Pulmonary support		

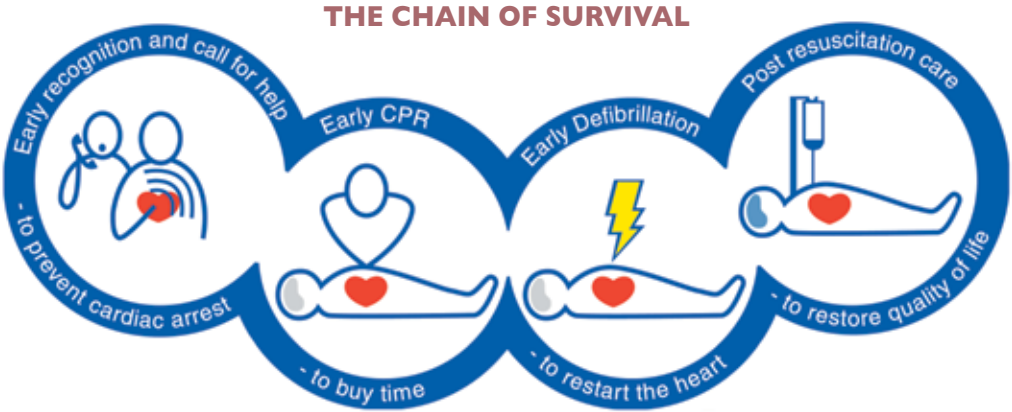
Level of support

	Type	Support		Access
Intra-aortic balloon pump	Balloon counterpulsation	Pulsatile flow	<0.5 L	Arterial: 7.5 French
Impella Recover	Axial flow	Continuous flow		
LP 2.5			<2.5 L	Arterial: 12 French
CP			<4,0 L	Arterial: 14 French
LP 5.0			<5.0 L	Arterial: 21 French
Tandemheart	Centrifugal flow	Continuous flow	<5.0 L	Venous: 21 French Arterial: 15-17 French
Cardiohelp			<5.0 L	Venous: 15-29 French Arterial: 15-29 French

Different systems for mechanical circulatory support are available to the medical community. The available devices differ in terms of the insertion procedure, mechanical properties, and mode of action. A minimal flow rate of 70 ml/kg/min, representing a cardiac index of at least 2.5 L/m², is generally required to provide adequate organ perfusion. This flow is the sum of the mechanical circulatory support output and the remaining function of the heart.

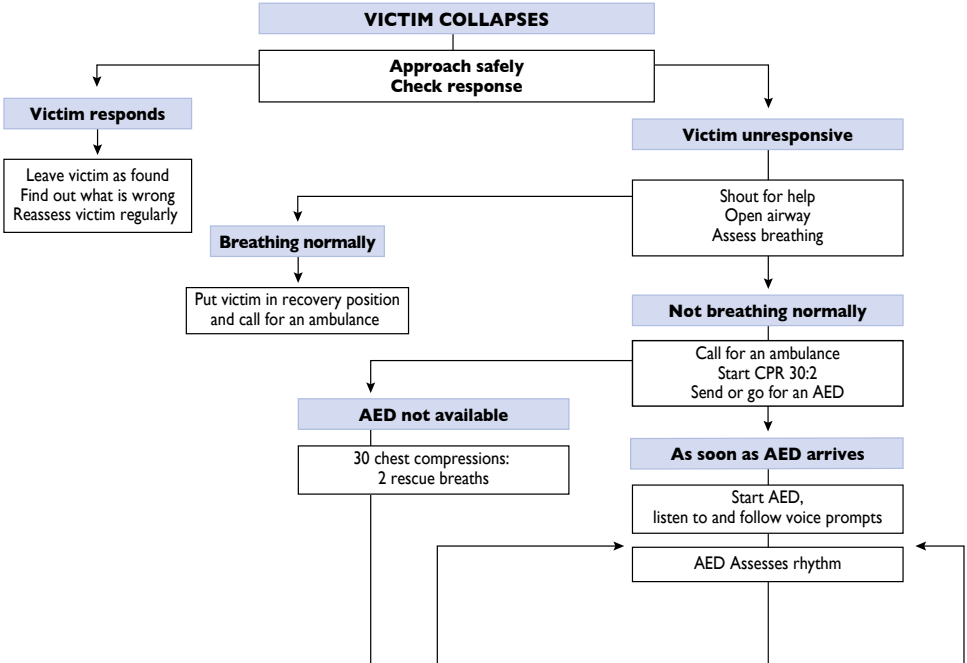
The SAVE-score may be a tool to predict survival for patients receiving ECMO for refractory cardiogenic shock (www.save-score.com).

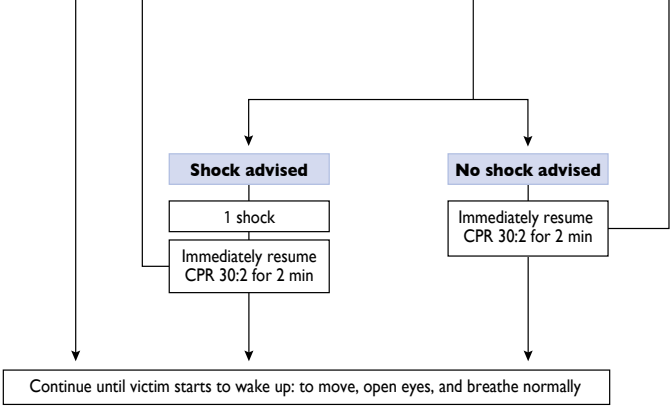
CHAPTER 4: CARDIAC ARREST AND CARDIOPULMONARY RESUSCITATION



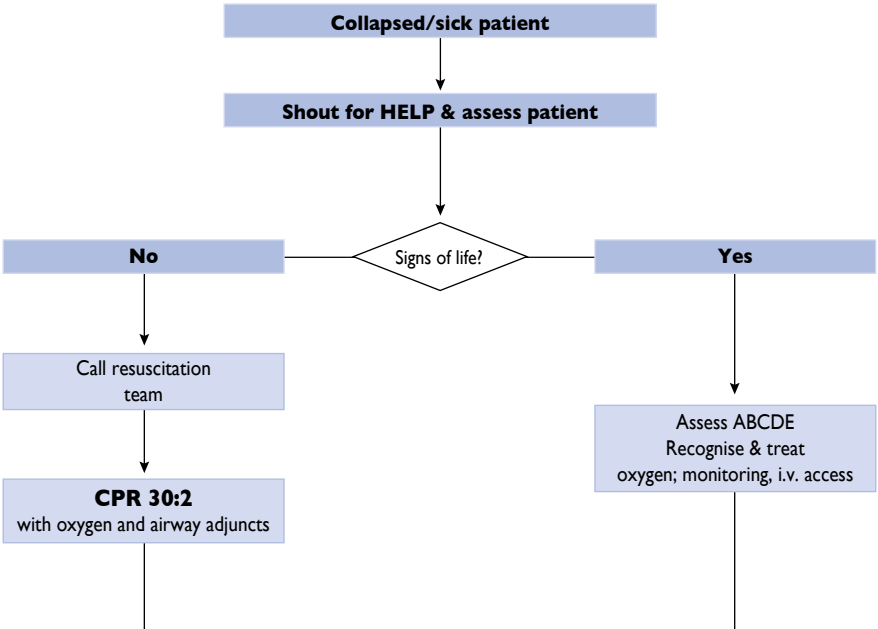
Monsieurs KG, et al. European Resuscitation Council Guidelines for Resuscitation 2015. Section 1. Executive Summary. Resuscitation 2015; 95C:1-80, DOI:10.1016/j.resuscitation.2015.07.038

OUT OF HOSPITAL CARDIAC ARREST:
Assessment of a collapsed victim and initial treatment



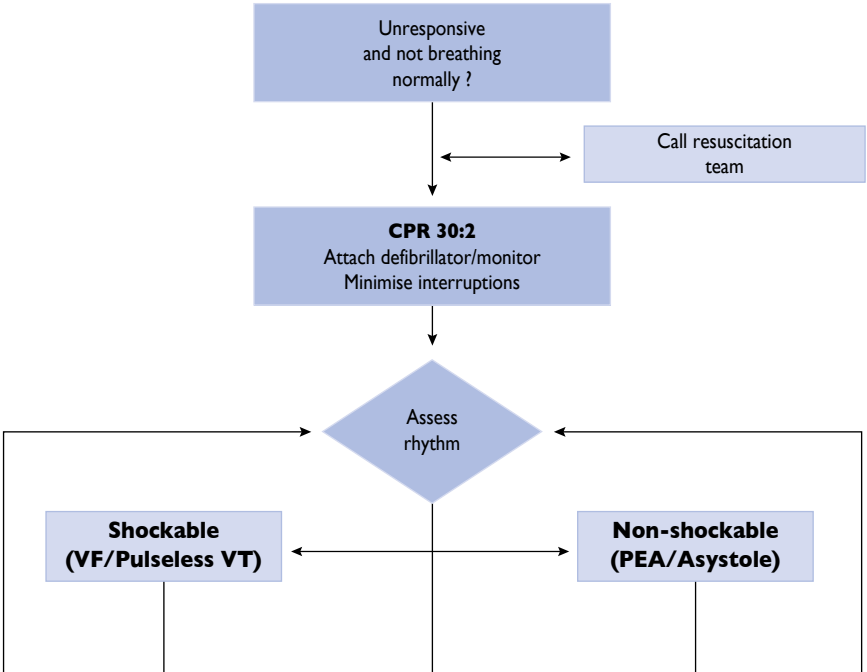

Shock advised
No shock advised
1 shock
Immediately resume CPR 30:2 for 2 min
Immediately resume CPR 30:2 for 2 min
Continue until victim starts to wake up: to move, open eyes, and breathe normally

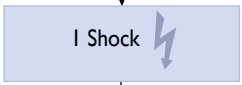
IN-HOSPITAL CARDIAC ARREST:
Assessment of a collapsed victim and initial treatment




Apply pads/monitor
Attempt defibrillation
if appropriate
Advanced Life Support
when resuscitation team arrives
Call resuscitation team
if appropriate
Handover to resuscitation team

IN-HOSPITAL CARDIAC ARREST: Advanced life support





Immediately resume:
CPR for 2 min
Minimise interruptions

DURING CPR
- Ensure high-quality chest compressions
- Minimise interruptions to compressions
- Give Oxygen
- Use waveform capnography
- Continuous chest compressions when advanced airway in place
- Vascular access (intravenous, intraosseous)
- Give adrenaline every 3-5 min
- Give amiodarone after 3 shocks
- Correct reversible causes

Return of spontaneous circulation

IMMEDIATE POST CARDIAC ARREST TREATMENT
- Use ABCDE approach
- Aim for SaO_2 94-98%
- Aim for normal $PaCO_2$
- 12-lead ECG
- Treat precipitating cause
- Temperature control / Therapeutic hypothermia

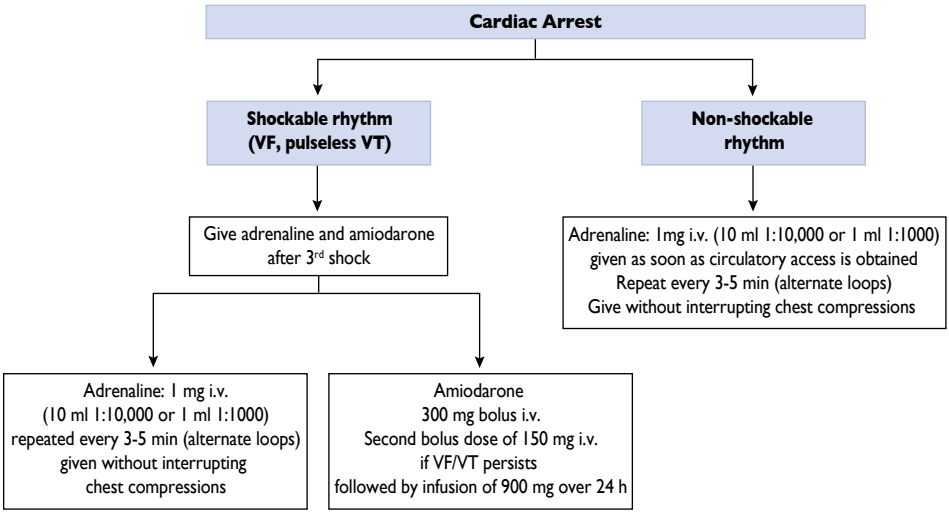
CONSIDER
- Ultrasound imaging
- Mechanical chest compressions to facilitate transfer/treatment
- Coronary angiography and PCI
- Extracorporeal CPR

Immediately resume:
CPR for 2 min
Minimise interruptions

REVERSIBLE CAUSES
- Hypoxia
- Hypovolaemia
- Hypo-/hyperkalaemia/metabolic
- Hypothermia

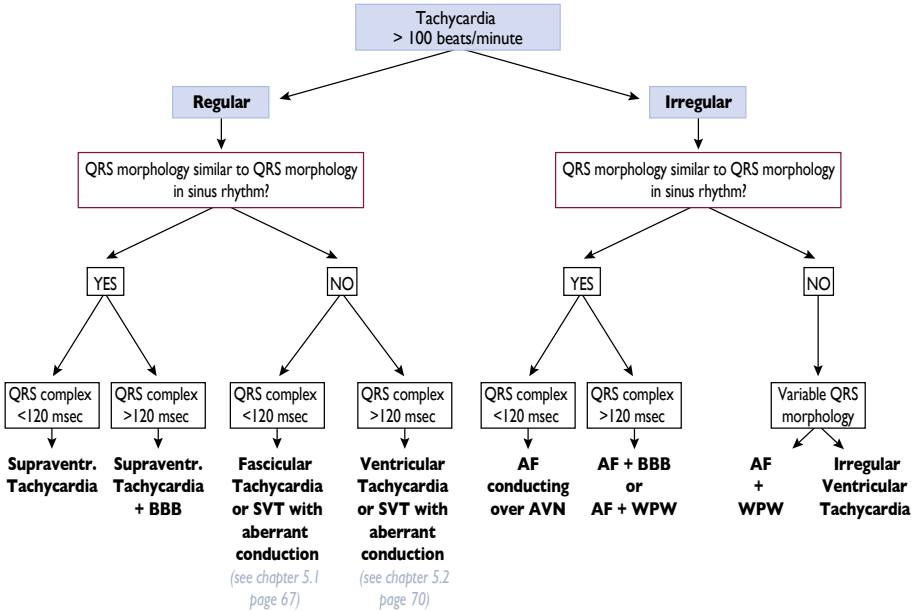
- Thrombosis
- Tamponade - cardiac
- Toxins
- Tension pneumothorax

IN-HOSPITAL CARDIAC ARREST: Drug therapy during advanced life support

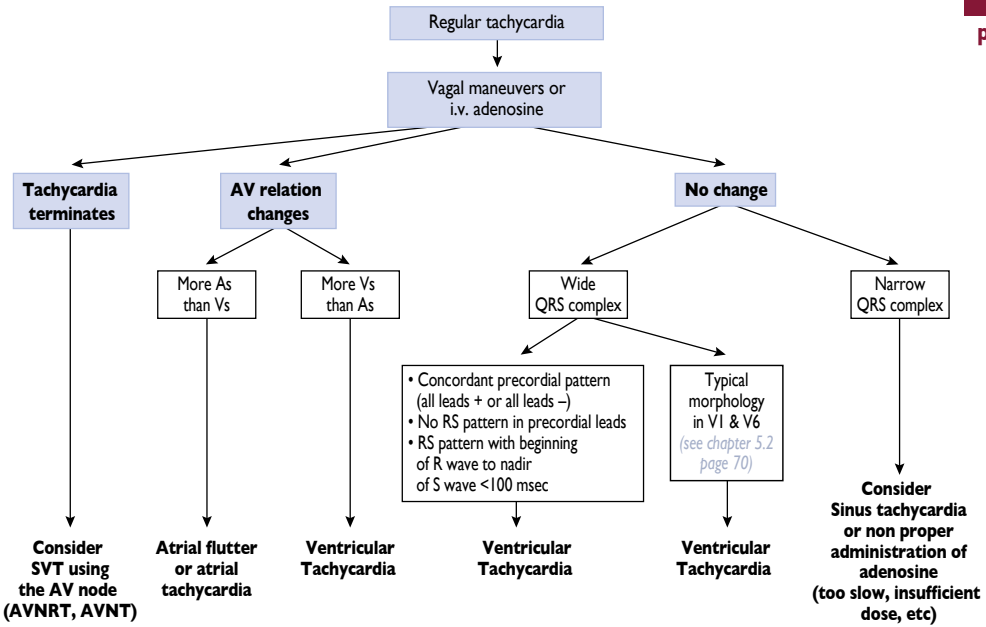


CHAPTER 5: RHYTHM DISTURBANCES

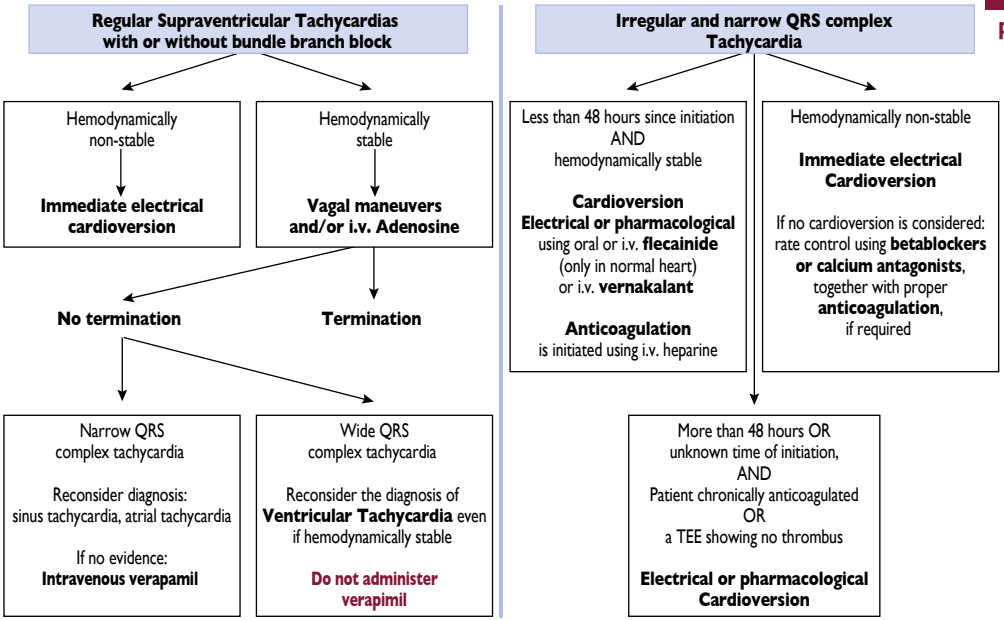
TACHYARRHYTHMIAS: Diagnostic criteria



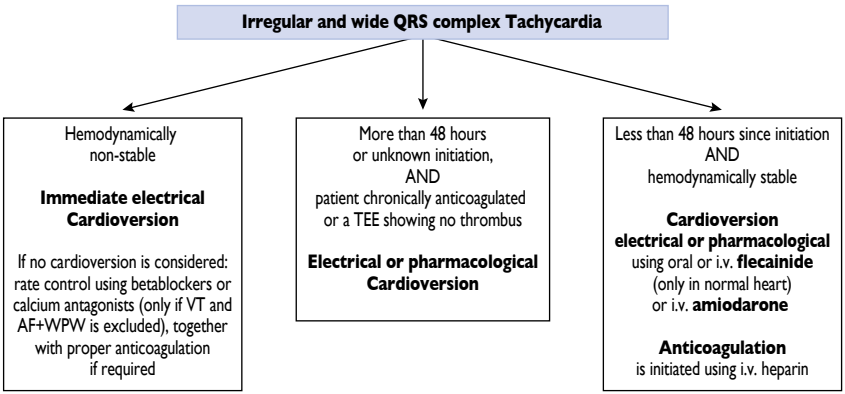
TACHYARRHYTHMIAS: Diagnostic maneuvers



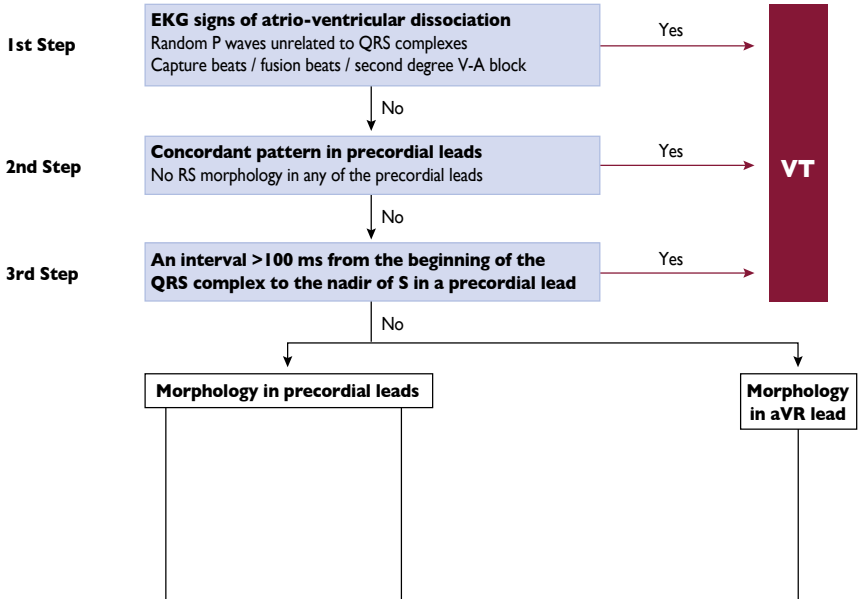
TACHYARRHYTHMIAS: Therapeutic algorithms (1)

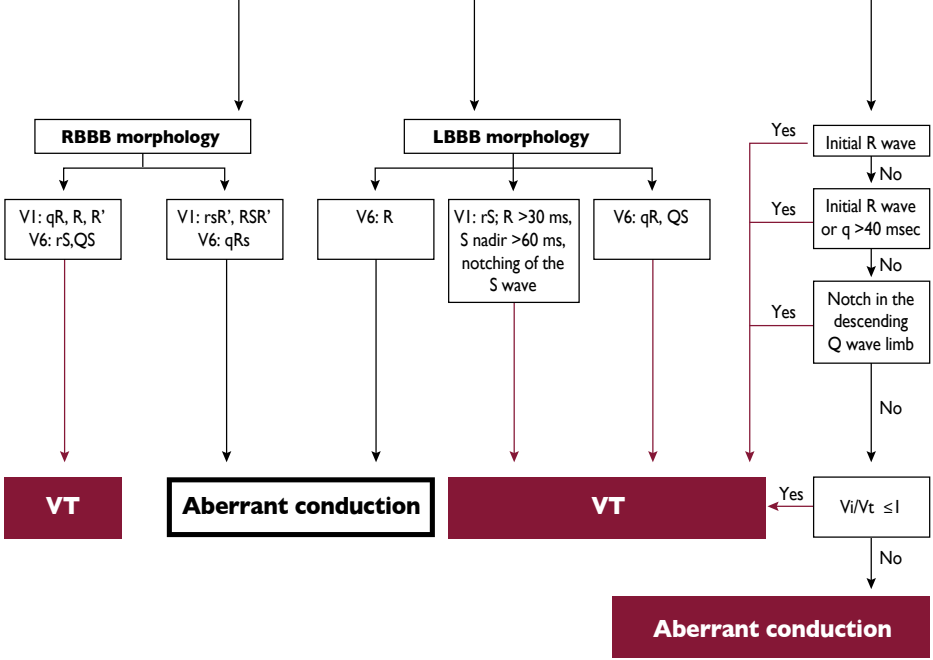


TACHYARRHYTHMIAS: Therapeutic algorithms (2)

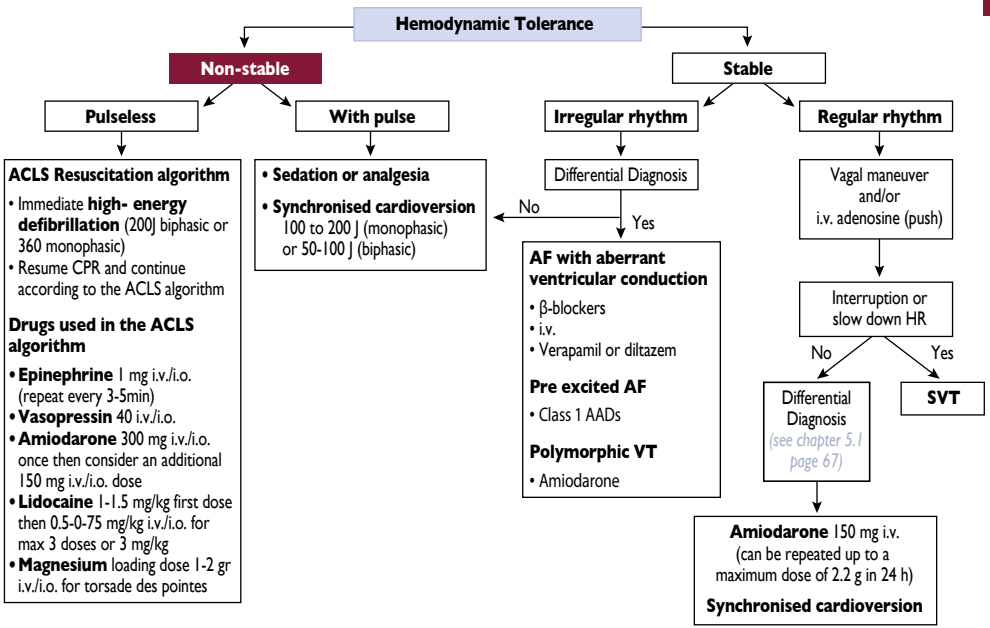


VENTRICULAR TACHYSCARDIAS:
Diferential diagnosis of wide QRS tachyscardias



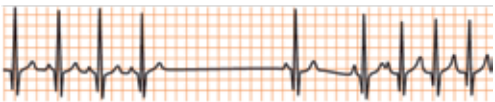

RBBB morphology
LBBB morphology
Yes
Initial R wave
No
V1: qR, R, R'
V6: rS,QS
V1: rsR', RSR'
V6: qRs
V6: R
V1: rS; R >30 ms,
S nadir >60 ms,
notching of the
S wave
V6: qR, QS
Yes
Initial R wave
or q >40 msec
No
Yes
Notch in the
descending
Q wave limb
No
VT
Aberrant conduction
VT
Yes
Vi/Vt ≤1
No
Aberrant conduction

Management of wide QRS TACHYSCARDIAS



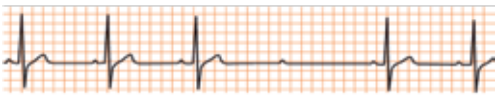
BRADYARRHYTHMIAS: Definitions and diagnosis

Sinus node dysfunction



- **Sinus bradycardia.** It is a rhythm that originates from the sinus node and has a rate of under 60 beats per minute
- **Sinoatrial exit block.** The depolarisations that occur in the sinus node cannot leave the node towards the atria
- **Sinus arrest.** Sinus pause or arrest is defined as the transient absence of sinus P waves on the ECG

Atrioventricular (AV) blocks



- **First degree AV block.** Atrioventricular impulse transmission is delayed, resulting in a PR interval longer than 200 msec
- **Second degree AV block.** Mobitz type I (Wenckebach block): Progressive PR interval prolongation, which precedes a nonconducted P wave
- **Second degree AV block.** Mobitz type II: PR interval remains unchanged prior to a P wave that suddenly fails to conduct to the ventricles
- **Third degree (complete) AV block.** No atrial impulses reach the ventricle

BRADYARRHYTHMIAS: Treatment (I)

- Rule out and treat any underlying causes of bradyarrhythmia
- Treat symptomatic patients only

For more information on individual drug doses and indications, see chapter 8: Use of drugs in acute cardiovascular care.

Temporary transvenous pacing

Be Careful!

- Complications are common!
- Shall not be used routinely
- Use only as a last resource when chronotropic drugs are insufficient
- Every effort should be made to implant a permanent pacemaker as soon as possible, if the indications are established.

Indications limited to:

- High-degree AV block without escape rhythm
- Life threatening bradyarrhythmias, such as those that occur during interventional procedures, in acute settings such as acute myocardial infarction, drug toxicity.

BRADYARRHYTHMIAS: Treatment (2)
Pacemaker therapies in sinus node dysfunction

Permanent pacemaker is indicated in the following settings:

- Documented symptomatic bradycardia, including frequent sinus pauses that produce symptoms
- Symptomatic chronotropic incompetence
- Symptomatic sinus bradycardia that results from required drug therapy for medical conditions

Permanent pacemaker is not recommended in the following settings:

- Asymptomatic patients
- Patients for whom the symptoms suggestive of bradycardia have been clearly documented to occur in the absence of bradycardia
- Symptomatic bradycardia due to nonessential drug therapy

BRADYARRHYTHMIAS: Treatment (3)
Pacemaker therapies in atrioventricular blocks

Permanent pacemaker therapy is indicated in the following settings regardless of associated symptoms:

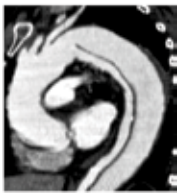
- Third-degree AV block
- Advanced second-degree AV block
- Symptomatic Mobitz I or Mobitz II second-degree AV block
- Mobitz II second-degree AV block with a wide QRS or chronic bifascicular block
- Exercise-induced second- or third-degree AV block
- Neuromuscular diseases with third- or second-degree AV block
- Third- or second-degree (Mobitz I or II) AV block after catheter ablation or valve surgery when block is not expected to resolve

Permanent pacemaker is not recommended in the following settings:

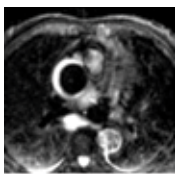
- Asymptomatic patients
- Patients for whom the symptoms suggestive of bradycardia have been clearly documented to occur in the absence of bradycardia
- Symptomatic bradycardia due to nonessential drug therapy

CHAPTER 6: ACUTE VASCULAR SYNDROMES

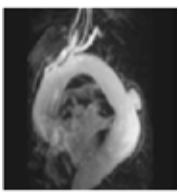
ACUTE AORTIC SYNDROMES: Concept and classification (I)
Types of presentation



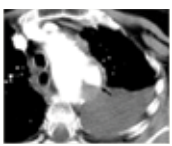
Classic aortic dissection
Separation of the aorta media with presence of extraluminal blood within the layers of the aortic wall. The intimal flap divides the aorta into two lumina, the true and the false



Intramural hematoma (IMH)
Aortic wall hematoma with no entry tear and no two-lumen flow



Penetrating aortic ulcer (PAU)
Atherosclerotic lesion penetrates the internal elastic lamina of the aorta wall



Aortic aneurysm rupture
(contained or not contained)

ACUTE AORTIC SYNDROMES: Concept and classification (2)
Anatomic classification and time course

DeBakey's Classification

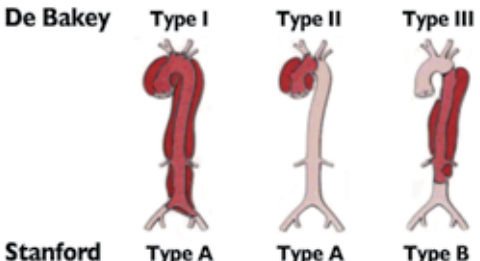
- Type I and type II dissections both originate in the ascending aorta
  - In type I, the dissection extends distally to the descending aorta
  - In type II, it is confined to the ascending aorta
- Type III dissections originate in the descending aorta

Stanford Classification

- Type A includes all dissections involving the ascending aorta regardless of entry site location
- Type B dissections include all those distal to the brachiocephalic trunk, sparing the ascending aorta

Time course

- Acute: < 14 days
- Subacute: 15-90 days
- Chronic: > 90 days



ACUTE AORTIC SYNDROME: Clinical suspicion and differential diagnosis

SYMPTOMS AND SIGNS SUGGESTIVE OF AAS

- Abrupt and severe chest/back pain with maximum intensity at onset
- Pulse/pressure deficit
  - Peripheral or visceral ischemia
  - Neurological deficit
- Widened mediastinum on chest X -ray
- Risk factors for dissection
- Other
  - Acute aortic regurgitation
  - Pericardial effusion
  - Hemomediastinum/hemothorax

DIFFERENTIAL DIAGNOSIS

- Acute coronary syndrome (with/without ST-segment elevation)
- Aortic regurgitation without dissection
- Aortic aneurysms without dissection
- Musculoskeletal pain
- Pericarditis
- Pleuritis
- Mediastinal tumours
- Pulmonary embolism
- Cholecystitis
- Atherosclerosis or cholesterol embolism

General approach to the patient with suspected ACUTE AORTIC SYNDROME

Consider acute aortic dissection in all patients presenting with:

- Chest, back or abdominal pain
- Syncope
- Symptoms consistent with perfusion deficit (central nervous system, visceral myocardial or limb ischemia)

Pre-test risk assessment for acute aortic dissection

High-risk conditions

- **Marfan's syndrome**
- **Connective tissue disease**
- **Family history of aortic disease**
- **Aortic valve disease**
- **Thoracic aortic aneurysm**

High-risk pain features

Chest, back or abdominal pain described as:

Abrupt at onset, severe in intensity, and ripping/sharp or stabbing quality

High-risk exam features

- **Perfusion deficit:**
  - Pulse deficit
  - SBP differential
  - Focal neurological deficit
- **Aortic regurgitation murmur**
- **Hypotension or shock**

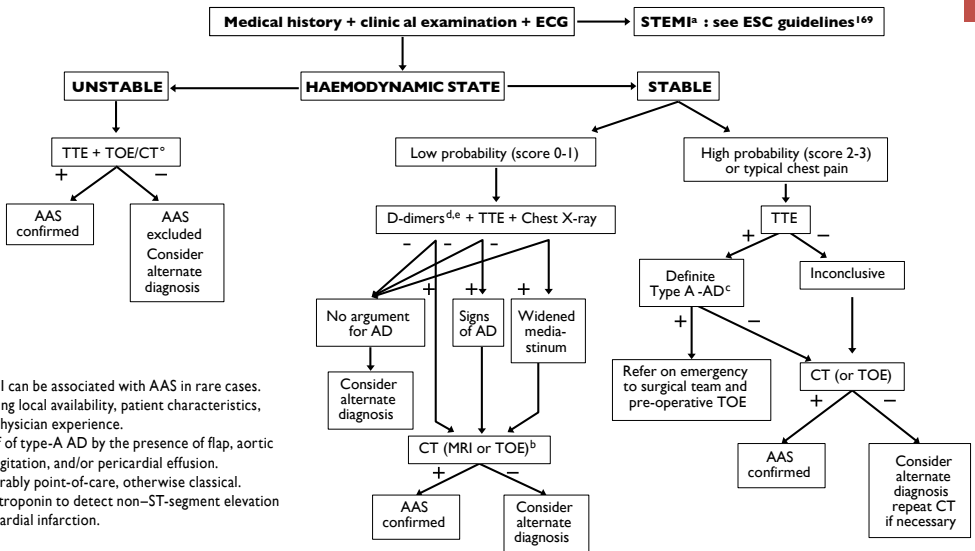
Laboratory tests required for patients with ACUTE AORTIC dissection

Laboratory tests	To detect signs of:
Red blood cell count	Blood loss, bleeding, anaemia
White blood cell count	Infection, inflammation (SIRS*)
C-reactive protein	Inflammatory response
ProCalcitonin	Differential diagnosis between SIRS* and sepsis
Creatine kinase	Reperfusion injury, rhabdomyolysis
TroponinIorT	Myocardial ischaemia, myocardial infarction
D-dimer	Aortic dissection, pulmonary embolism, thrombosis
Creatinine	Renal failure (existing or developing)
Aspartate transaminase/ alanine aminotransferase	Liver ischaemia, liver disease
Lactate	Bowel ischaemia, metabolic disorder
Glucose	Diabetes mellitus
Blood gases	Metabolic disorder, oxygenation

*SIRS = systemic inflammatory response syndrome.

Reference: Eur Heart J 2014;eurheartj.ehu281.

ACUTE CHEST PAIN



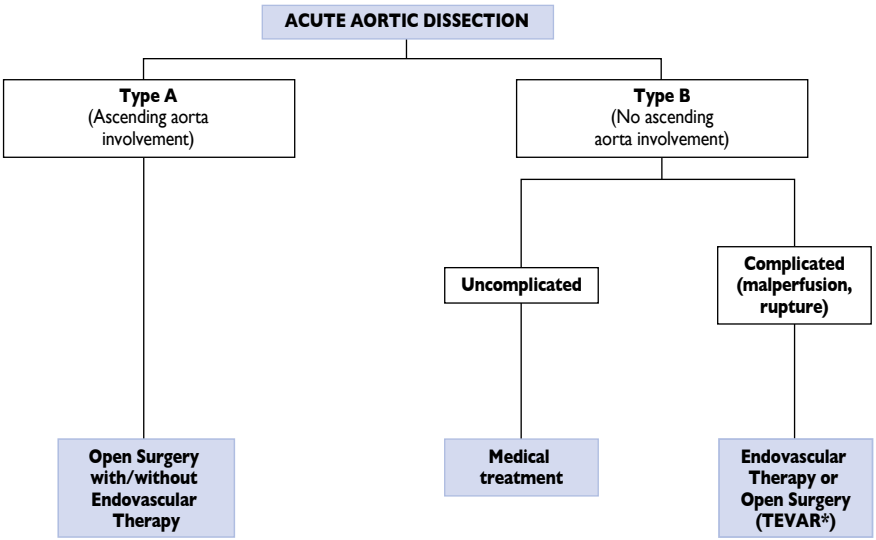
[a] STEMI can be associated with AAS in rare cases.
[b] Pending local availability, patient characteristics, and physician experience.
[c] Proof of type-A AD by the presence of flap, aortic regurgitation, and/or pericardial effusion.
[d] Preferably point-of-care, otherwise classical.
[e] Also troponin to detect non–ST-segment elevation myocardial infarction.

Flowchart for decision-making based on pre-test sensitivity of acute aortic syndrome.
Reference: Eur Heart J 2014;eurheartj.ehu281.

Details required from imaging in ACUTE AORTIC dissection

Aortic dissection	• Visualization of intimal flap • Extent of the disease according to the aortic anatomic segmentation • Identification of the false and true lumens (if present) • Localization of entry and re-entry tears (if present) • Identification of antegrade and/or retrograde aortic dissection • Identification grading, and mechanism of aortic valve regurgitation • Involvement of side branches • Detection of malperfusion (low flow or no flow) • Detection of organ ischaemia (brain, myocardium, bowels, kidneys, etc.) • Detection of pericardial effusion and its severity • Detection and extent of pleural effusion • Detection of peri-aortic bleeding • Signs of mediastinal bleeding
Intramural haematoma	• Localization and extent of aortic wall thickening • Co-existence of atheromatous disease (calcium shift) • Presence of small intimal tears
Penetrating aortic ulcer	• Localization of the lesion (length and depth) • Co-existence of intramural haematoma • Involvement of the peri-aortic tissue and bleeding • Thickness of the residual wall
In all cases	• Co-existence of other aortic lesions: aneurysms, plaques, signs of inflammatory disease, etc.

ACUTE AORTIC SYNDROMES MANAGEMENT: General approach



*TEVAR Thoracic Endovascular Aortic Repair.

ACUTE AORTIC SYNDROMES: Initial management

1 • Detailed **medical history** and complete **physical examination** (when possible)

2 • **Standard 12-lead ECG:** Rule-out ACS, documentation of myocardial ischemia

3 • **Intravenous line, blood sample** (CK, Tn, myoglobin, white blood count, D-dimer, hematocrit, LDH)

4 • **Monitoring:** HR and BP

5 • **Pain relief** (morphine sulphate) *(see chapter 3)*

6 • **Noninvasive imaging** *(see previous page)*

7 • **Transfer to ICU**

For more information on individual drug doses and indications, see chapter 8: Use of drugs in acute cardiovascular care.

ACUTE AORTIC SYNDROMES: Surgical management

TYPE A ACUTE AORTIC DISSECTION

URGENT SURGERY (<24h)

Graft replacement of ascending aorta +/- arch with/without aortic valve or aortic root replacement/repair (depending on aortic regurgitation and aortic root involvement)

Emergency Surgery

- Haemodynamic instability (hypotension/shock)
- Tamponade
- Severe acute aortic regurgitation
- Impending rupture
- Flap in aortic root
- Malperfusion syndrome

Elective/individualised Surgery

- Non-complicated intramural hematoma
- Comorbidities
- Age >80 years

TYPE B ACUTE AORTIC DISSECTION

Definitive diagnosis

by clinical presentation and imaging

Yes / No

COMPLICATED

defined as:

- Impending rupture
- Malperfusion
- Refractory HTN
- SBP <90 mmHg)
- Shock

MEDICAL MANAGEMENT and TEVAR

MEDICAL MANAGEMENT and OPEN SURGERY REPAIR

if TEVAR contraindicated

UNCOMPLICATED

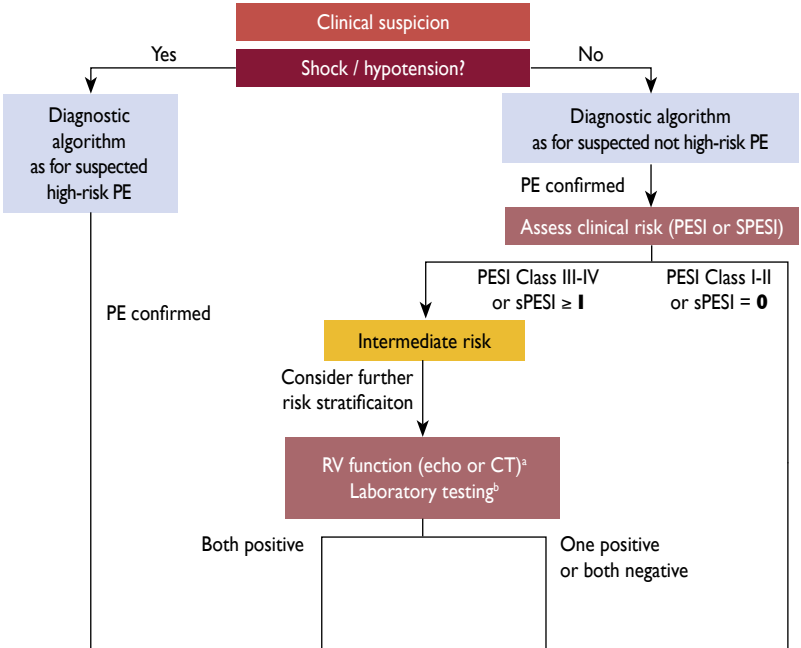
defined as:

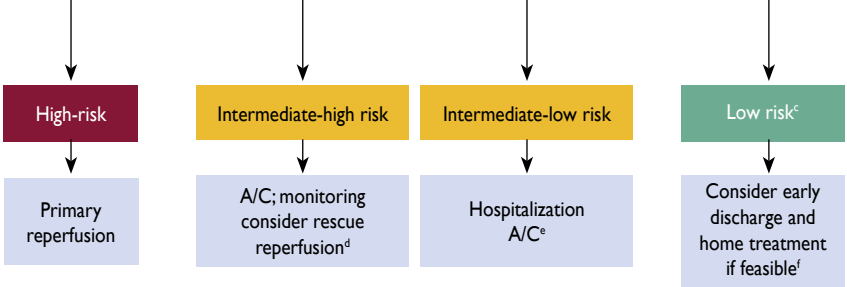
No features of complicated dissection

MEDICAL MANAGEMENT and imaging surveillance protocol

- On admission
- At 7 days
- At discharge
- Every 6 months thereafter

Risk-adjusted management strategies in ACUTE PULMONARY EMBOLISM





[a] If echocardiography has already been performed during diagnostic work-up for PE and detected RV dysfunction, or if the CT already performed for diagnostic work–up has shown RV enlargement (RV/LV (left ventricular) ratio ≥0.9, a cardiac troponin test should be performed except for cases in which primary reperfusion is not a therapeutic option (e.g. due to severe comorbidity or limited life expectancy of the patient).

[b] Markers of myocardial injury (e.g. elevated cardiac troponin I or T concentrations in plasma), or of heart failure as a result of (right) ventricular dysfunction (elevated natriuretic peptide concentrations in plasma). If a laboratory test for a cardiac biomarker has already been performed during initial diagnostic work-up (e.g. in the chest pain unit) and was positive, then an echocardiogram should be considered to assess RV function, or RV size should be (re)assessed on CT.

[c] Patients in the PESI Class I-II, or with sPESI of 0, and elevated cardiac biomarkers or signs of RV dysfunction on imaging tests, are also to be classified into the intermediate-low risk category. This might apply to situations in which imaging or biomarker results become available before calculation of the clinical severity index. These patients are probably no candidates for home treatment.

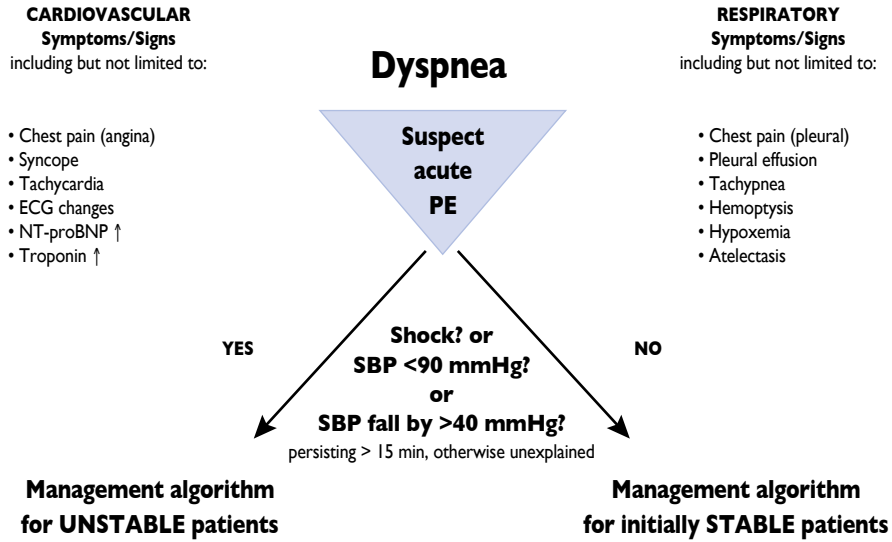
[d] Thrombolysis, if (and as soon as) clinical signs of haemodynamic decompensation appear; surgical pulmonary embolectomy or percutaneous catheter-directed treatment may be considered as alternative options to systemic thrombolysis, particularly if the bleeding risk is high.

[e] Monitoring should be considered for patients with confirmed PE and a positive troponin test, even if there is no evidence of RV dysfunction on echocardiography or CT.

[f] The simplified version of the PESI has not been validated in prospective home treatment trials; inclusion criteria other than the PESI were used in two single-armed (non-randomized) management studies.

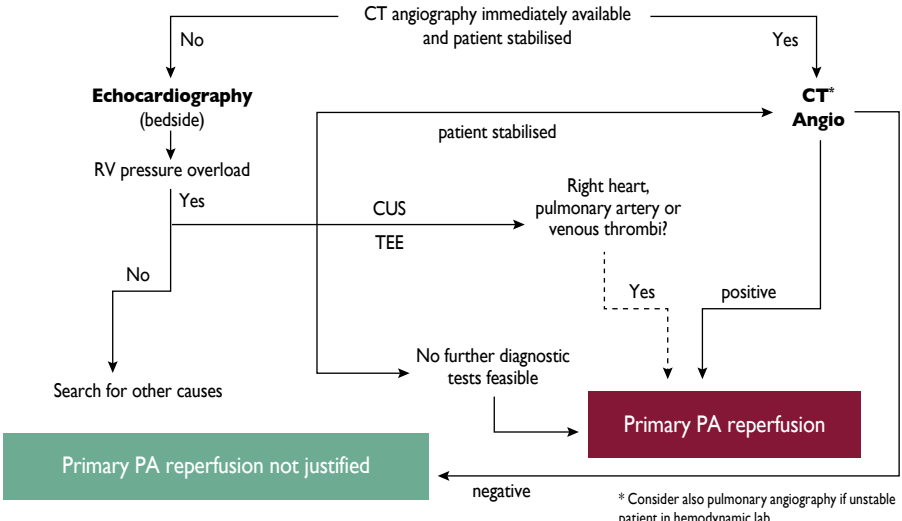
Reference: Eur Heart J 2014;35:3033-3073.

ACUTE PULMONARY EMBOLISM: Diagnosis



Reference: IACC Textbook (2015) chapter 66 Pulmonary embolism - page 638 - figure 66.1

Management algorithm for unstable patients with suspected ACUTE PULMONARY EMBOLISM

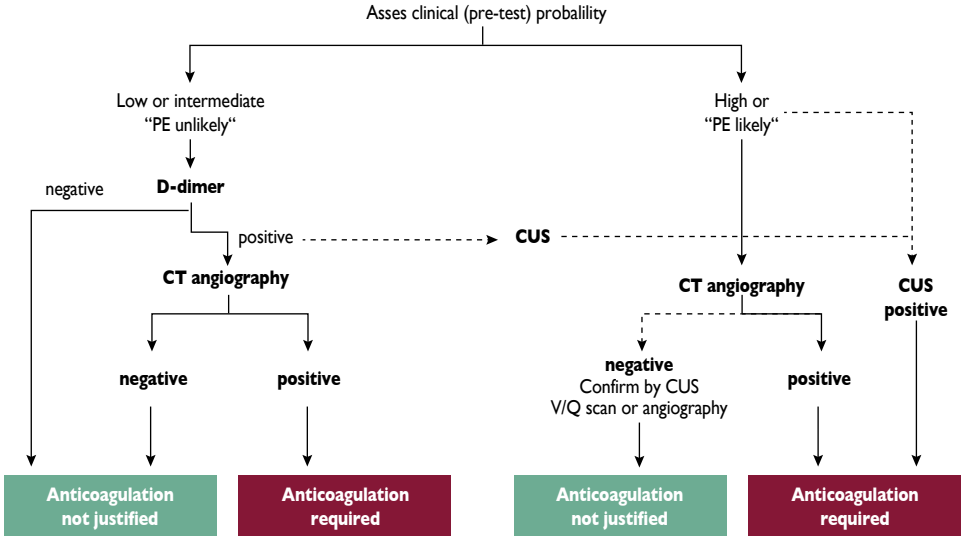


Reference: IACC Textbook (2015) chapter 66 Pulmonary embolism - page 639 - figure 66.2

ACUTE PE: Management strategy for initially unstable patients with confirmed high risk pulmonary embolism

Shock or hypotension	**YES**		
Contraindications for thrombolysis	No	Relative	Absolute
Primary PA reperfusion strategy	**Thrombolysis**	**Low-dose transcatheter thrombolysis / clot fragmetation**	**Surgical or Percutaneous catheter embolectomy (availability/experience)**
Supportive treatment	**i.v. UFH, STABILISE SYSTEMIC BLOOD PRESSURE, CORRECT HYPOXEMIA**		

Management algorithm for initially stable patients with suspected ACUTE PULMONARY EMBOLISM



Reference: IACC Textbook (2015) chapter 66 Pulmonary embolism - page 640 - figure 66.3

Suggested management strategy for initially stable patients with (non-high risk) confirmed PE

Markers for myocardial injury	Positive	Positive	Negative
Markers for RV overload	Positive	Positive	Negative
Clinical risk assessment score (PESI)	Positive (class III-V)	Positive (class III-V)	Negative (class I-II)
Suggested initial anticoagulation	**UFH i.v /LMWH s.c.**	**LMWH/Fonda/ apixaban/ rivaroxaban**	**apixaban/rivaroxaban**
STRATEGY	**Monitoring (ICU)* rescue thrombolysis**	**Hospitalisation** (telemonitoring)**	**Early discharge*** **

* When all markers are positive.

** When at least one marker is positive.

*** When all markers are negative.

For more information on individual drug doses and indications, see chapter 8: Use of drugs in acute cardiovascular care.

PULMONARY EMBOLISM: Pharmacological treatment

Key drugs for initial treatment of patients with confirmed PE

For more information on individual drug doses and indications, see chapter 8: Use of drugs in acute cardiovascular care.

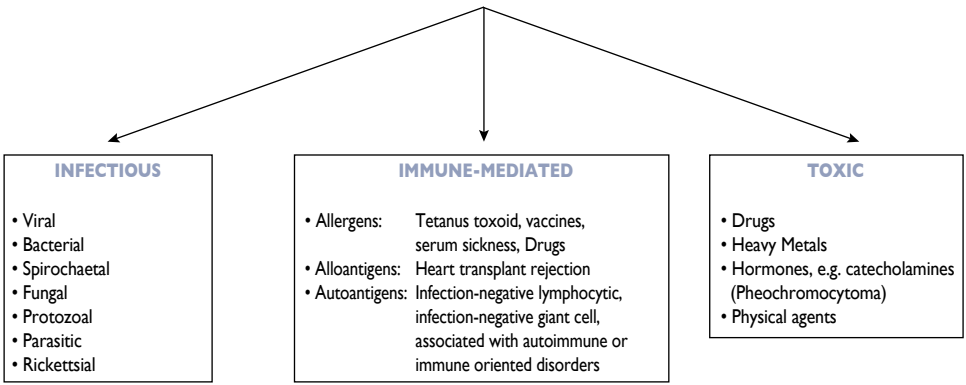
Unstable	Alteplase (rtPA) (intravenous)	100 mg/2 h or 0.6 mg/kg/15 min (max 50 mg)
	Urokinase (intravenous)	3 million IU over 2 h
	Streptokinase (intravenous)	1.5 million IU over 2 h
	Unfractionated heparin (intravenous)	80 IU/kg bolus + 18 IU/kg/h
Stable	Enoxaparine (subcutaneous)	1.0 mg/kg BID or 1.5 mg/kg QD
	Tinzaparin (subcutaneous)	175 U/kg QD
	Fondaparinux (subcutaneous)	7.5 mg (50-100 Kg of body weight) 5 mg for patients <50 kg, 10 mg for patients >100 kg
	Rivaroxaban (oral)	15 mg BID (for 3 weeks, then 20 mg QD)
	Apixaban (oral)	10mg bid (for 7 days, than 5mg bid)

CHAPTER 7: ACUTE MYOCARDIAL / PERICARDIAL SYNDROMES

ACUTE MYOCARDITIS: Definition and causes

MYOCARDITIS (WHO /ISFC): Inflammatory disease of the myocardium diagnosed by established histological, immunological and immunohistochemical criteria.

CAUSES OF MYOCARDITIS



ACUTE MYOCARDITIS: Diagnostic criteria (I)

Diagnostic criteria for clinically suspected myocarditis

Clinical presentations with or without ancillary findings	Diagnostic criteria
• Acute chest pain (pericarditic or pseudo-ischemic) • New-onset (days up to 3 months) or worsening dyspnea or fatigue, with or without left/right heart failure signs • Palpitation, unexplained arrhythmia symptoms, syncope, aborted sudden cardiac death • Unexplained cardiogenic shock and/or pulmonary oedema	**I. ECG/Holter/stress test features:** Newly abnormal ECG and/or Holter and/or stress testing, any of the following: • I to III degree atrioventricular block, or bundle branch block, ST/T wave changes (ST elevation or non ST elevation, T wave inversion), • Sinus arrest, ventricular tachycardia or fibrillation and asystole, atrial fibrillation, frequent premature beats, supraventricular tachycardia • Reduced R wave height, intraventricular conduction delay (widened QRS complex), abnormal Q waves, low voltage
Ancillary findings which support the clinical suspicion of myocarditis	**II. Myocardiocytolysis markers:** Elevated TnT/TnI
• Fever ≥38.0°C within the preceding 30 days • A respiratory or gastrointestinal infection • Previous clinically suspected or biopsy proven myocarditis • Peri-partum period • Personal and/or family history of allergic asthma • Other types of allergy • Extra-cardiac autoimmune disease • Toxic agents • Family history of dilated cardiomyopathy, myocarditis	**III. Functional/structural abnormalities on echocardiography** • New, otherwise unexplained LV and/or RV structure and function abnormality (including incidental finding in apparently asymptomatic subjects): regional wall motion or global systolic or diastolic function abnormality, with or without ventricular dilatation, with or without increased wall thickness, with or without pericardial effusion, with or without endocavitary thrombi **IV. Tissue characterisation by CMR:** Edema and/or LGE of classical myocarditic pattern

Reference: Caforio ALP et al. Eur Heart J. (2013) Jul 3 (15).

ACUTE MYOCARDITIS: Diagnostic criteria (2)

Acute myocarditis should be clinically suspected in the presence of:

One or more of the clinical presentations shown in the Diagnostic Criteria*
with or without Ancillary Features*
AND
One or more Diagnostic Criteria from different categories (I to IV)*

OR

when the patient is asymptomatic, two or more diagnostic criteria from different categories (I to IV)*

in the absence of:

1) angiographically detectable coronary artery disease
2) known pre-existing cardiovascular disease or extra-cardiac causes that could explain the syndrome (e.g. valve disease, congenital heart disease, hyperthyroidism, etc.)

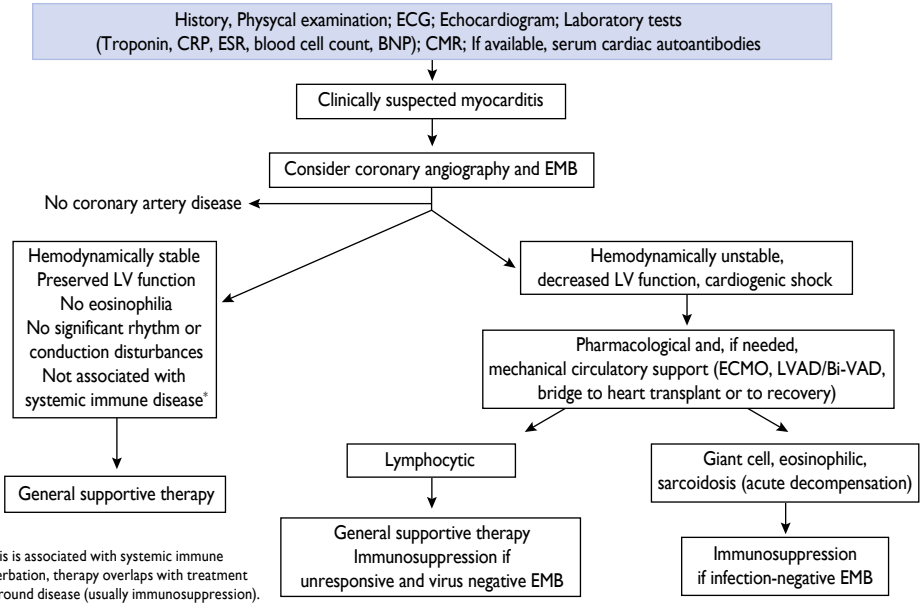
Suspicion is higher with higher number of fulfilled criteria*

Endomyocardial biopsy is necessary to: 1) confirm the diagnosis of clinically suspected myocarditis, 3) identify the type and aetiology of inflammation, and 2) provide the basis for safe immunosuppression (in virus negative cases).

*See chapter 7.1 page 99.

Reference: Caforio ALP et al. Eur Heart J. (2013) Jul 3 (16).

ACUTE MYOCARDITIS: Diagnostic and management protocol



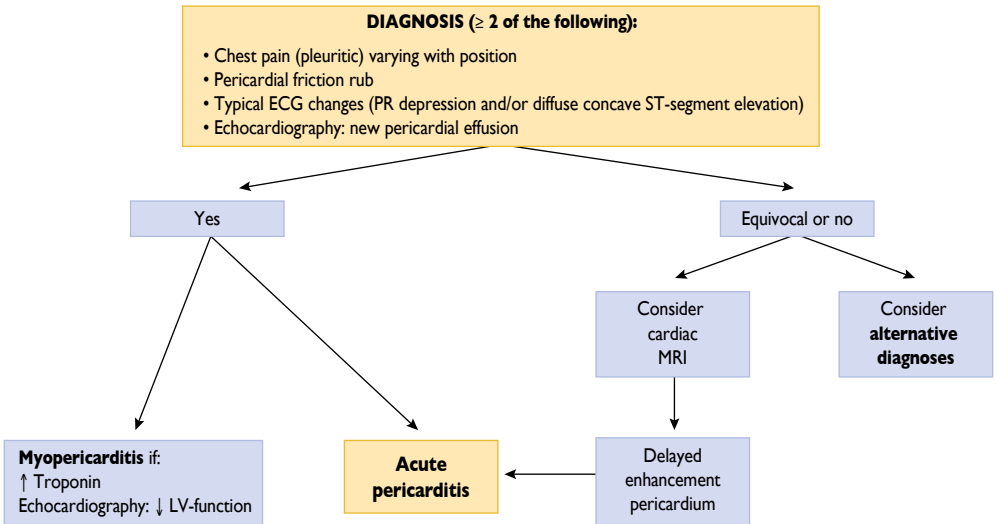
*If myocarditis is associated with systemic immune disease exacerbation, therapy overlaps with treatment of the background disease (usually immunosuppression).

Management of patients with life-threatening ACUTE MYOCARDITIS

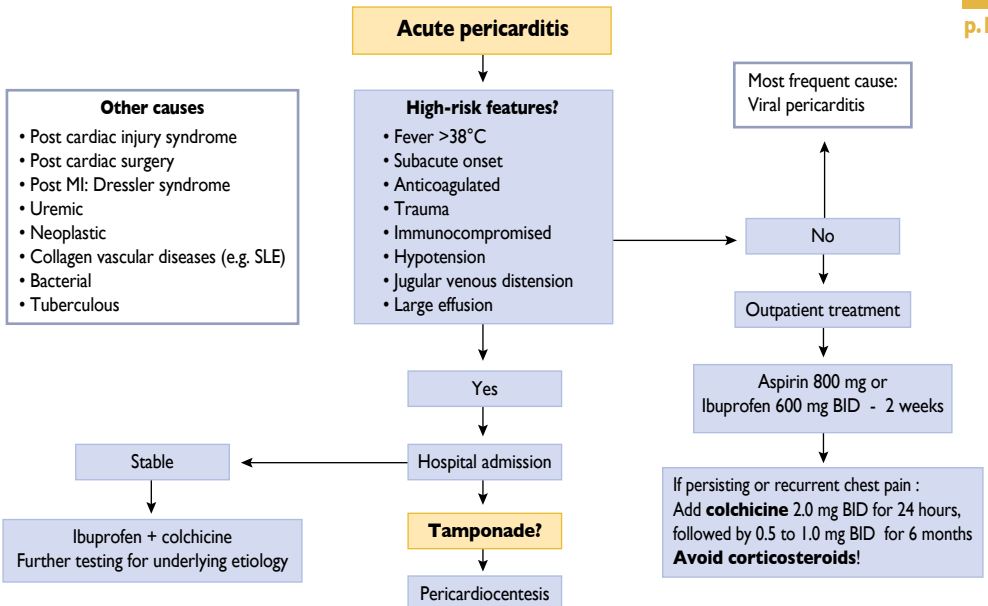
- Patients with a life-threatening presentation should be sent to specialised units with capability for hemodynamic monitoring, cardiac catheterisation and expertise in endomyocardial biopsy.
- In patients with hemodynamic instability a **mechanical cardio-pulmonary assist device** may be needed as a bridge to recovery or to heart transplantation.
- **Heart transplant** should be deferred in the acute phase, because recovery may occur, but can be considered for hemodynamically unstable myocarditis patients, including those with giant cell myocarditis, if optimal pharmacological support and mechanical assistance cannot stabilise the patient
- **ICD implantation** for complex arrhythmias should be deferred until resolution of the acute episode, with possible use of a lifevest during the recovery period.

Reference: Caforio ALP et al. Eur Heart J. 2013 Jul 3 (18).

ACUTE PERICARDITIS: Diagnosis



ACUTE PERICARDITIS: Management



CARDIAC TAMPONADE: Diagnosis and management

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Physical examination
- Distended neck veins
- Shock
- Pulsus paradoxus
- Muffled heart sounds

ECG
- Sinus tachycardia
- Microvoltage QRS
- Electrical alternans

Tamponade ?

Echocardiography
with respirometer

- Presence of a moderate to large pericardial effusion
- Diastolic collapses of right atrium and right ventricle
- Ventricular interdependence
- Increased tricuspid and pulmonary flow velocities (>50%) with decreased mitral and aortic flow velocities (>25%) during inspiration (predictive value >90%)

Not performed in routine

Cardiac catheterization
Early
- Right atrial pressure ↑
- Loss of X-descent

Late
- Aortic pressure ↓
- Pulsus paradoxus
- Intracardiac diastolic pressure equilibration

Tamponade

Percutaneous pericardiocentesis & drainage
Consider surgical drainage
Avoid PEEP ventilation

CHAPTER 8: DRUGS USED IN ACUTE CARDIOVASCULAR CARE

Ana de Lorenzo

Oral antiplatelets

Drug	Indications	Dose	Dose adjustments	Comments
Aspirin	Primary (not universally approved) and secondary cardiovascular disease prevention	LD (if ACS): 150-300 mg oral MD: 75-100 mg oral QD	-	Major contraindications: GI bleeding-active peptic ulcer
Ticagrelor	ACS (all patients at moderate-to-high risk of ischaemic events, e.g. elevated cardiac troponins)	LD: 180 mg oral MD: 90 mg oral BID	-	Major contraindications: previous intracerebral hemorrhage
	Secondary prevention 1-3 years post-MI	MD: 60 mg oral BID	-	Major contraindications: previous intracerebral hemorrhage
Prasugrel	ACS with planned PCI	LD: 60 mg oral MD: 10 mg oral QD	MD: 5 mg QD weight < 60 kg	Contraindication: previous stroke/TIA Prasugrel is generally not recommended in elderly, and if positive benefit/risk 5 mg is recommended
Clopidogrel	ACS + PCI or medical management (patients who cannot receive ticagrelor or prasugrel) and in ACS patients at high bleeding risk (e.g. patients who require oral anticoagulation)	LD: 300-600 mg oral MD: 75 mg oral QD	-	-

Oral antiplatelets (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Clopidogrel	STEMI + fibrinolysis < 75 years	LD: 300 mg oral MD: 75 mg oral QD	-	Prasugrel and ticagrelor have not been studied as adjuncts to fibrinolysis and oral anticoagulants
	STEMI + fibrinolysis ≥ 75 years	LD: 75mg oral. MD: 75 mg oral QD	-	
	Secondary prevention >12 months post coronary stenting	MD: 75 mg oral QD	-	
Vorapaxar	Co-administered with aspirin and, where appropriate, clopidogrel, in patients with a history of MI or peripheral artery disease	2.08 mg oral QD	-	Initiated at least 2 weeks after a MI and preferably within the first 12 months Major contraindications: active pathologic bleeding or increased risk of bleeding, history of stroke / TIA or intracranial bleeding, severe hepatic dysfunction

Intravenous Antiplatelets

Drug	Indications	Dose	Dose adjustments	Comments
Abciximab	Adjunct to PCI for bailout situations or thrombotic complications	LD: 0.25 mg/Kg i.v. MD: 0.125 μg/Kg/min i.v. (max: 10 μg/min) for 12h	-	Contraindications: Active internal bleeding - History of CVA within 2 years - Bleeding diathesis - Preexisting thrombocytopenia - Recent (within 2 months) intracranial or intraspinal surgery or trauma - Recent (within 2 months) major surgery - Intracranial neoplasm, arteriovenous malformation, or aneurysm - Severe uncontrolled hypertension - Presumed or documented history of vasculitis - Severe hepatic failure or severe renal failure requiring haemodialysis - Hypertensive retinopathy
Eptifibatide	ACS treated medically or with PCI	LD: 180 μg/Kg i.v. (at a 10 min interval) If STEMI and PCI: add a second 180 mcg/kg i.v. bolus at 10 min MD: 2 μg/Kg/min i.v. infusion	Reduce infusion dose to1 μg/kg/min if CrCl 30-50ml/min	Contraindications: Bleeding diathesis or bleeding within the previous 30 days - Severe uncontrolled hypertension - Major surgery within the preceding 6 weeks - Stroke within 30 days or any history of hemorrhagic stroke - Coadministration of another parenteral GP IIb/IIIa inhibitor - Dependency on renal dialysis - Known hypersensitivity to any component of the product

Intravenous Antiplatelets (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Tirofiban	ACS treated medically or with PCI	LD: 25 µg/Kg i.v. over 5 min MD: 0.15 µg/Kg/min i.v. Infusion to 18 hour	CrCl < 30ml/min: decrease 50% bolus and infusion dose	Contraindications: Severe hypersensitivity reaction to tirofiban A history of thrombocytopenia following prior exposure Active internal bleeding or a history of bleeding diathesis, major surgical procedure or severe physical trauma within the previous month
Cangrelor	All patients undergoing PCI (elective + ACS) immediate onset + rapid offset (platelet recovery in 60 min)	IV Bolus of 30 µg/Kg + IV infusion of 4 µg/kg/min For at least 2 hours from start of PCI	-	Major contraindications: significant active bleeding or stroke Transition to oral P2Y12 inhibitors variable according to type of agent

Drug	Indications	Dose	Dose adjustments	Comments
Warfarin Acenocoumarol	Treatment and prophylaxis of thrombosis	INR goal of 2-3 (INR: 2.5-3.5 for mechanical mitral valve prostheses or double valve replacement)	Assessing individual risks for thromboembolism and bleeding	-
Dabigatran	Prevention of stroke and systemic embolism in NVAF	150 mg oral BID	110 mg BID (if age ≥ 80, increased bleeding risk or concomitant use of verapamil)	Contraindicated if CrCl < 30ml/min or severe hepatic impairment Active pathological bleeding Idarucizumab: specific antidote (not yet available)
	Treatment of DVT and PE in patients who have been treated with a parenteral anticoagulant for 5-10 days and prevention of recurrent DVT and PE in patients who have been previously treated	150 mg oral BID		

Oral Anticoagulants (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Rivaroxaban	Prevention of stroke and systemic embolism in NVAF	20 mg oral QD	CrCl < 50ml/min: 15 mg QD	Contraindicated if CrCl < 15ml/min or hepatic disease associated with coagulopathy and clinically relevant bleeding risk
	Treatment of DVT and PE and prevention of recurrent DVT and PE	15 mg oral BID for the first 3 weeks followed by 20 mg QD	Reduce the maintenance dose to 15 mg QD if bleeding risk outweighs the risk for recurrent DVT and PE (not formally approved)	
	Prevention of atherothrombotic events after an ACS	2.5 mg oral BID	-	
Apixaban	Prevention of stroke and systemic embolism in NVAF	5 mg oral BID	2.5 mg oral BID 1) when at least 2 of the following characteristics: age ≥ 80, Cr > 1.5 mg/dl or weight < 60Kg 2) when CrCl 15-29 mL/min	Contraindicated if CrCl < 15ml/min or severe hepatic impairment
	Treatment of DVT and PE	10 mg oral BID for the first 7 days followed by 5 mg oral BID	-	
	Prevention of recurrent DVT and PE	2.5 mg oral BID	-	

Intravenous/Subcutaneous Anticoagulants

Drug	Indications	Dose	Dose adjustments	Comments
UFH	NSTE-ACS	LD: 4000 IU i.v. MD: 1000 IU/h i.v.	Target aPTT: 50-70s or 1.5 to 2.0 times that of control to be monitored at 3, 6, 12 and 24h	Monitoring for heparin-induced thrombocytopenia (HIT) Dose-independent reaction
	STEMI	Primary PCI: 70-100 IU/Kg i.v. when no GP-IIb/IIIa inhibitor is planned. 50-60 IU/Kg i.v. bolus with GP-IIb/IIIa inhibitors - Fibrinolysis/No reperfusion: 60 IU/kg i.v. bolus (max: 4000 IU) followed by an i.v. infusion of 12 IU/kg (max: 1000 IU/h) for 24-48h	Target aPTT: 50-70s or 1.5 to 2.0 times that of control to be monitored at 3, 6, 12 and 24h	
	Treatment of DVT and PE	80 IU/Kg i.v. bolus followed by 18 IU/Kg/h	According to aPTT, thromboembolic and bleeding risk	
Fondaparinux	NSTE-ACS	2.5 mg QD s.c.	-	Severe hepatic impairment: caution advised Contraindicated if CrCl < 20ml/min Contraindicated for DVT/PE treatment if CrCl < 30ml/min
	STEMI	Fibrinolysis/No reperfusion: 2.5 mg i.v. bolus followed by 2.5 mg QD s.c. up to 8 days or hospital discharge	-	
	Treatment of DVT and PE	5 mg QD s.c. (< 50 kg); 7.5 mg QD s.c. (50-100 kg); 10 mg QD s.c.(> 100 kg)	If > 100Kg and CrCl 30-50ml/min: 10 mg followed by 7.5 mg/24h s.c.	
	Prevention of VTE	2.5 mg QD s.c.	CrCl 20-50ml/min: 1.5 mg QD s.c.	

Drug	Indications	Dose	Dose adjustments	Comments
Bivalirudin	PCI for NSTE-ACS	0.75 mg/kg i.v. bolus followed immediatelly by 1.75 mg/kg/h infusion which may be continued for up to 4h post PCI as clinically warranted and further continued at a reduced infusion dose of 0.25 mg/kg/h for 4-12h as clinically necessary	Patients undergoing PCI with CrCl 30-50ml/min should receive a lower infusion rate of 1.4 mg/kg/h. No change for the bolus dose.	Contraindicated if CrCl < 30ml/min
	PCI for STEMI	0.75 mg/kg i.v. bolus followed immediatelly by 1.75 mg/kg/h infusion which should be continued for up to 4h after the procedure After cessation of the 1.75 mg/kg/h infusion, a reduced infusion dose of 0.25 mg/kg/h may be continued for 4-12h		
	PCI for elective cases	0.75 mg/kg i.v. bolus followed immediatelly by 1.75 mg/kg/h infusion which may be continued for up to 4h post PCI as clinically waranted		

Intravenous/Subcutaneous Anticoagulants (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Enoxaparin	NSTE-ACS	30 mg i.v. + 1 mg/kg s.c. BID	If > 75 years: no LD and MD 0.75 mg/Kg BID s.c. CrCl < 30ml/min: no LD and MD 1 mg/Kg QD s.c. If > 75 years and CrCl < 30ml/min: no LD and 0.75 mg/Kg QD s.c.	Monitoring for HIT - Anti Xa monitoring during treatment with LMWH might be helpful in pregnancy, extreme body weights and renal impairment.
	STEMI	Primary PCI: 0.5 mg/Kg i.v. bolus Fibrinolysis/No reperfusion: a) Age < 75y: 30 mg i.v. bolus followed by 1 mg/Kg BID s.c. until hospital discharge for a max of 8 days - The first two doses should not exceed 100 mg b) Age > 75y: no bolus; 0.75 mg/Kg BID s.c. - The first two doses should not exceed 75 mg	In patients with CrCl < 30 ml/min: regardless of age, the s.c. doses are given once daily	
	Treatment of DVT and PE	1 mg/Kg s.c. BID or 1.5 mg/Kg s.c. QD	CrCl < 30ml/min: 1 mg/Kg/24h s.c.	
	Prevention of VTE	40 mg s.c. QD	CrCl < 30ml/min: 20 mg s.c. QD	

Intravenous/Subcutaneous Anticoagulants (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Tinzaparin	Prevention of VTE	3500 IU s.c. QD (moderate risk) 4500 IU s.c. QD (high risk)	-	Monitoring for HIT - Anti Xa monitoring during treatment with LMWH might be helpful in pregnancy, extreme body weights and renal impairment - Dalteparin: In cancer patients, dose of 200 IU/kg (max: 18000 IU)/24h for 1 month, followed by 150 IU/kg/24h for 5 months - After this period, vitamin K antag or a LMWH should be continued indefinitely or until the cancer is considered cured
	Treatment of DVT and PE	175 IU/Kg s.c. QD	-	
Dalteparin	Prevention of VTE	2500 IU s.c. QD (moderate risk) 5000 IU s.c. QD (high risk)	-	
	Treatment of DVT and PE	200 IU/Kg QD or 100 IU/Kg BID s.c.	Anti Xa monitoring if renal impairment	
Argatroban	Anticoagulant in patients with HIT	Initial i.v. infusion dose: 2 µg/kg/min (not to exceed 10 µg/kg/min) Patients undergoing PCI: 350 µg/kg i.v. followed by 25 µg/kg/min i.v.	Renal and hepatic impairment: caution advised	Monitored using aPTT goal: 1.5 to 3.0 times the initial baseline value PCI: ACT goal: 300-450s

Drug	Indications	Dose	Dose adjustments	Comments
Streptokinase (SK)	STEMI	1.5 million units over 30-60min i.v.	-	**Absolute contraindications to fibrinolytics:** Previous intracranial haemorrhage or stroke of unknown origin at any time Ischaemic stroke in the preceding 6 months Central nervous system damage or neoplasms or atrioventricular malformation Recent major trauma/surgery/head injury (within the preceding 3 weeks) Gastrointestinal bleeding within the past month Known bleeding disorder (excluding menses) Aortic dissection Non-compressible punctures in the past 24h (e.g. liver biopsy, lumbar puncture)
	Treatment of PE	250000 IU as a LD over 30min, followed by 100000 IU/h over 12-24h	-	
Alteplase (tPA)	STEMI	15 mg i.v. bolus: 0.75 mg/kg over 30 min (up to 50 mg) then 0.5 mg/kg over 60 min i.v. (up to 35 mg)	-	
	Treatment of PE	Total dose of 100 mg: 10 mg i.v. bolus followed by 90 mg i.v. for 2h	If weight < 65 Kg: max dose < 1.5 mg/kg	

Fibrinolytics (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Reteplase (rt-PA)	STEMI	10 units + 10 units i.v. bolus given 30 min apart	Renal and hepatic impairment: caution advised	**Absolute contraindications to fibrinolytics:** Previous intracranial haemorrhage or stroke of unknown origin at any time Ischaemic stroke in the preceding 6 months Central nervous system damage or neoplasms or atrioventricular malformation Recent major trauma/surgery/head injury (within the preceding 3 weeks) Gastrointestinal bleeding within the past month Known bleeding disorder (excluding menses) Aortic dissection Non-compressible punctures in the past 24h (e.g. liver biopsy, lumbar puncture)
Tenecteplase (TNK-tPA)	STEMI	Over 10 seconds; Single i.v. bolus: 30 mg if < 60 kg 35 mg if 60 to < 70 kg 40 mg if 70 to < 80 kg 45 mg if 80 to < 90 kg 50 mg if ≥ 90 kg	-	

Antiischemic drugs

Drug	Indications	Dose	Dose adjustments	Comments
Beta-blockers: Preferred over calcium channel blockers - Contraindicated if coronary spasm, severe bradycardia, AV block, severe bronchospasm				
Atenolol	NSTE-ACS	LD: 25-100 mg oral MD: 25-100 mg QD	Elderly: start at a lower dose CrCl: 15-35ml/min: max dose 50 mg/day; CrCl < 15ml/min: max dose 25 mg/day	Only if normal LVEF
	STEMI	25-100 mg QD, titrate as tolerated up to 100 mg QD only if no LVSD or CHF		
Carvedilol	NSTE-ACS	LD: 3.125-25 mg oral MD: 3.125-25 mg BID	Caution in elderly and hepatic impairment	Preferred if LVSD/HF
	STEMI	3.125-6.25 mg BID, titrated as tolerated up to 50 mg BID		
Bisoprolol	NSTE-ACS	LD: 1.25-10 mg oral MD: 1.25-10 mg QD	Caution in renal or hepatic impairment	Preferred if LVSD/HF
	STEMI	1.25-5 mg QD, titrate as tolerated up to 10 mg QD		

Antiischemic drugs (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Beta-blockers: Preferred over calcium channel blockers - Contraindicated if coronary spasm, severe bradycardia, AV block, severe bronchospasm				
Metoprolol	NSTE-ACS	LD: 25-100 mg oral MD: 25-100 mg BID	Caution in hepatic impairment	Preferred if LVSD/HF
	STEMI	5-25 mg BID, titrate as tolerated up to 200 mg QD		
Calcium antagonists: Consider if beta-blockers are contraindicated. First option in vasospastic angina				
Verapamil	ACS	LD: 80-120 mg oral MD: 80-240 mg TID-QD	Caution in elderly, renal or hepatic impairment	Contraindicated if bradycardia, HF, LVSD
Diltiazem	ACS	LD: 60-120 mg oral MD: 60-300 mg TID-QD	Caution in elderly and hepatic impairment	Contraindicated if bradycardia, HF, LVSD

Antiischemic drugs (Cont.)

Drug		Indications	Dose	Dose adjustments	Comments
Calcium antagonists: Consider if beta-blockers are contraindicated. First option in vasospastic angina					
Amlodipine		ACS	LD: 5-10 mg oral, MD: 5-10 mg QD	Caution in hepatic impairment	Contraindicated if hypotension
Nitrates					
Nitroglycerin	**i.v.**	ACS	If intolerant or unresponsive to nitroglycerin s.l. 5 µg/min - Increase by 5 mcg/min q3-5min up to 20 µg/min - If 20 mcg/min is inadequate, increase by 10 to 20 µg/min every 3 to 5min - Max dose: 400 µg/min	-	Contraindicated if severe hypotension and co-administration with phosphodiesterase inhibitors The most common adverse effects are headache and dizziness Use glass bottles for nitroglycerin i.v. administration
	spray	Angina	1-2 puff s.l. every 5min as needed, up to 3 puff in 15min	-	
	sublingual tablet	Angina	0.3 to 0.6 mg s.l. or in the buccal pouch every 5min as needed, up to 3 doses in 15min	-	

Antiischemic drugs (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Isosorbide mononitrate	Angina	5-10 mg BID with the two doses given 7h apart (8am and 3pm) to decrease tolerance development - then titrate to 10 mg BID in first 2-3 days **Extended release tablet:** Initial: 30-60 mg given in the morning as a single dose Titrate upward as needed, giving at least 3 days between increases Max daily single dose: 240mg	-	Contraindicated if severe hypotension and co-administration with phosphodiesterase inhibitors The most common adverse effects are headache and dizziness
Isosorbide dinitrate	Angina	Initial dose: 5 to 20 mg orally 2 or 3 times/day MD: 10 to 40 mg orally 2 or 3 times a day Extended release: 40 to 160 mg/day orally	-	
Nitroglycerin transdermal patch	Angina	0.2 to 0.4 mg/h patch applied topically once a day for 12 to 14h per day; titrate as needed and tolerated up to 0.8 mg/h	-	

Antiischemic drugs (Cont.)

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Drug	Indications	Dose	Dose adjustments	Comments
Other antiischemic drugs				
Ivabradine	Stable angina	5-7.5 mg oral BID	Caution in elderly and CrCl < 15ml/min	Contraindicated if severe hepatic impairment
Ranolazine	Stable angina	Initial dose: 375 mg oral BID After 2-4 weeks, the dose should be titrated to 500 mg BID and, according to the patient's response, further titrated to a recommended max dose of 750 mg BID	Use with caution in renal and hepatic impairment, CHF, elderly, low weight	Contraindicated if CrCl < 30ml/min, concomitant administration of potent CYP3A4 inhibitors, moderate or severe hepatic impairment
Trimetazidine	Stable angina	Modified-release: 35 mg oral BID	Caution in elderly and 30 < CrCl < 60ml/min	Contraindicated in parkinson disease, parkinsonian symptoms, tremors, restlessleg syndrome, movement disorders, severe renal impairment

Drug	Indications	Dose				Dose adjustments	Comments
Statins: Secondary prevention of cardiovascular disease: start with high doses and down titrate if side effects Target LDL-C levels < 70 mg/dl initiated early after admission							
Atorvastatin		**LDL-C reduction**				-	Contraindicated in patients with active liver disease or with unexplained elevation of liver function enzyme levels
Rosuvastatin		**<30%**	**30-40%**	**40-50%**	**>50%**	CrCl < 30ml/min: start 5 mg QD, max: 10 mg QD	
Pitavastatin		Simva 10 mg	Simva 20-40 mg	Simva 40 mg	Ator 80 mg	CrCl 30-59ml/min: start 1 mg QD, max 2 mg/day; CrCl 10-29ml/min: not defined	
Simvastatin		Lova 20 mg	Ator 10 mg	Ator 20-40 mg	Simva/ezet 40/10 mg	Severe renal impairment: start 5 mg QPM	
Fluvastatin		Prava 20-40 mg	Prava 40 mg	Rosu 10-20 mg	Rosu 40 mg	Caution in severe renal impairment	
Pravastatin		Fluva 40 mg	Fluva 80 mg	Pita 4 mg		Significant renal impairment: start 10 mg QD	
Lovastatin		Pita 1 mg	Rosu 5 mg	Simva/ezet 20/10 mg		CrCl < 30ml/min: caution if dose > 20 mg QD	
			Pita 2 mg				

Hypolipidemic drugs (Cont.)

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Drug	Indications	Dose	Dose adjustments	Comments
Others				
Ezetimibe	Hyperlipidemia	10 mg oral QD	Avoid use if moderate-severe hepatic impairment	-
Fenofibrate	Hyperlipidemia	48-160 mg oral QD May adjust dose q4-8 weeks	CrCl 50-90ml/min: start 48-54 mg QD	Contraindicated if CrCl < 50ml/min or hepatic impairment
Gemfibrozil	Hyperlipidemia	900-1200 mg/day oral		Contraindicated if severe renal impairment or hepatic dysfunction Statins may increase muscle toxicity: avoid concomitant use
Evolocumab	PCSK9 inhibitor (not yet available). Most common side effects: nasopharyngitis, upper respiratory tract infection, headache and back pain			

Drug	Indications	Dose	Dose adjustments	Comments
ACEI				
Captopril	HF	Start: 6.25 mg oral TID Target dose: 50 mg TID	CrCl > 50 ml/min: 75-100% of the normal dose CrCl 10-50ml/min: 25-50% CrCl < 10ml/min: 12.5%	Check renal function, electrolytes, drug interactions Major contraindications: History of angioedema, known bilateral renal artery stenosis, pregnancy (risk)
	HTN	Start: 12.5 mg oral BID Target dose: 25-50 mg TID Max 450 mg/day		
Enalapril	HF, HTN	Start: 2.5 mg oral BID Target dose: 10-20 mg BID	CrCl 30-80ml/min: start 5 mg/day CrCl 10-30ml/min: start 2.5 mg/day	
Lisinopril	HF	Start: 2.5-5.0 mg oral QD Target dose: 20-35 mg QD	CrCl 31-80ml/min: start 5-10 mg/day CrCl 10-30ml/min: start 2.5-5 mg/day CrCl < 10ml/min: start 2.5 mg/day	
	HTN	10-20 mg oral QD Max: 80 mg QD		

Drug	Indications	Dose	Dose adjustments	Comments
Perindopril	HF	Start: 2.5 mg oral QD Max: 5mg QD	CrCl > 60ml/min: start 5 mg/day CrCl 31-60ml/min: start 2.5 mg/day CrCl 15-30ml/min: start 2.5 mg alternate days CrCl < 15ml/min: start 2.5 mg/day on the day of dialysis	Check renal function, electrolytes, drug interactions Major contraindications: History of angioedema, known bilateral renal artery stenosis, pregnancy (risk)
	HTN	Start: 2.5-5 mg QD Target dose: 10 mg QD		
Ramipril	HF, HTN	Start: 2.5 mg oral QD Target dose: 5 mg BID	CrCl < 40ml/min: start 1.25 mg QD, max 5 mg/day Caution in elderly and hepatic impairment	
Trandolapril	HF	Start: 0.5 mg oral QD Target dose: 4 mg QD	CrCl < 30ml/min or severe hepatic impairment: start 0.5 mg	
	HTN	2-4 mg oral QD	CrCl < 30ml/min or severe hepatic impairment: start 0.5 mg	

Drug	Indications	Dose	Dose adjustments	Comments
ARB				
Candesartan	HF, HTN	Start: 4-8 mg oral QD Target dose: 32 mg QD	If renal or hepatic impairment: start 4 mg/day	If ACEI is not tolerated. Check renal function, electrolytes, drug interactions Major contraindications: History of angioedema, known bilateral renal artery stenosis, pregnancy (risk)
Losartan	HF	Start: 50 mg oral QD Target dose: 150 mg QD	CrCl < 20ml/min: 25 mg QD Caution if hepatic impairment	
	HTN	50-100 mg oral QD	CrCl < 20ml/min: 25 mg QD Caution if hepatic impairment	
Valsartan	HF	Start: 40 mg oral BID Target dose: 160 mg BID	If mild-moderate hepatic impairment: max dose 80 mg/day	
	HTN	80-160 mg QD	If mild-moderate hepatic impairment: max dose 80 mg/day	

Drug		Indications	Dose	Dose adjustments	Comments
Beta-blockers: Check 12- lead ECG					
Cardioselective	**Atenolol**	HTN	Start: 25 mg oral QD Usual dose: 50-100 mg QD	CrCl 10-50ml/min: decrease dose 50% CrCl < 10ml/min: decrease dose 75%	Major contraindications: asthma, 2nd or 3rd degree AV block
	Bisoprolol	HF	Start: 1.25 mg oral QD Target dose: 10 mg QD	CrCl < 20ml/min: max dose 10 mg QD Hepatic impairment: avoid use	
		HTN	Start: 2.5-5 mg oral QD Usual dose: 5-10 mg QD Max dose: 20 mg QD		
	Metoprolol	HF	Start: 12.5-25 mg oral QD Target dose: 200 mg QD	Hepatic impairment: start with low doses and titrate gradually	
		HTN	100-400 mg QD Max dose: 400 mg QD		

Drug		Indications	Dose	Dose adjustments	Comments
Beta-blockers: Check 12- lead ECG					
Cardioselective	**Nebivolol**	HF	Start: 1.25 mg oral QD Target dose: 10 mg QD	Renal impairment or elderly: start dose 2.5 mg QD, titrate to 5 mg QD Hepatic impairment: contraindicated	Major contraindications: asthma, 2nd or 3rd degree AV block
		HTN	Start: 2.5 mg oral QD Usual dose: 5 mg QD		
Non-cardioselective	**Carvedilol**	HF	Start: 3.125 mg oral BID Target dose: 25-50 mg BID	Caution in elderly Contraindicated if hepatic impairment	
		HTN	Start: 12.5 mg oral QD Usual dose: 25 mg QD and max dose: 25 mg BID or 50 mg QD		

Drug	Indications	Dose	Dose adjustments	Comments
Other vasodilators				
Amlodipine	HTN	Start: 5 mg oral QD, increase after 1-2 weeks Max: 10 mg/day	Elderly or secondary agent: start 2.5 mg QD Hepatic impairment: start 2.5 mg QD	Contraindicated if cardiogenic shock, 2nd or 3rd degree AV block, severe hypotension
Nifedipine	HTN	Extended-release form: Start 20 mg oral BID or TID Max: 60 mg BID	Renal and hepatic impairment: caution advised	
Clevidipine	HTN	Initiate the IV infusion at 4 ml/h (2 mg/h); the dose may be doubled every 90 seconds Uptitration until desired BP range is achieved Half life of 1-2min	The desired therapeutic response for most patients occurs at doses of 8-12 ml/h (4-6 mg/h) The max recommended dose is 64 ml/h (32 mg/h)	Hypersensitivity to soy, peanut, or egg products Critical Aortic stenosis, mitral stenosis, HOCM

Drug	Indications	Dose	Dose adjustments	Comments
Other vasodilators				
Verapamil	HTN	**Immediate-release form:** Dose: 80-120 mg oral TID; Start: 80 mg TID; Max: 480 mg/day	Start 40 mg oral TID in elderly or small stature patients	Contraindicated if bradycardia, HF, LVSD
Loop diuretics				
Furosemide	HF	20-40 mg i.v. bolus, continuous 100 mg/6h (adjust based on kidney function and clinical findings; monitor creatinine)	Anuria: contraindicated Cirrhosis/ascites: caution advised	-
	HTN	10-40 mg oral BID		
Torsemide	HF	10-20 mg oral or i.v. QD	Hepatic impairment: initial dose should be reduced by 50% and dosage adjustments made cautiously	-
	HTN	5 mg oral or i.v. QD Max 10 mg QD		

Drug	Indications	Dose	Dose adjustments	Comments
Thiazides				
Chlorthalidone	HF	50-100 mg oral QD MD: 25-50 mg QD	Elderly: max dose 25 mg/day CrCl < 25ml/min: avoid use	-
	HTN	Start 12.5-25 mg oral QD; Max: 50 mg/day	Elderly: max dose 25 mg/day CrCl < 25ml/min: avoid use	-
Hydrochlorothiazide	HF	25-200 mg oral/day	CrCl < 25 ml/min: avoid use Hepatic impairment: caution advised	-
	HTN	Start 12.5-25 mg oral QD MD: may increase to 50 mg oral as a single or 2 divided doses	CrCl < 25 ml/min: avoid use Hepatic impairment: caution advised	-

Drug	Indications	Dose	Dose adjustments	Comments
Thiazides				
Indapamide	HTN	Start 1.25 mg PO QAM x4weeks, then increase dose if no response Max: 5 mg/day	CrCl < 25 ml/min: avoid use Hepatic impairment: caution advised	-
Aldosterone-antagonists				
Spironolactone	HF	Start 25 mg oral QD Target dose: 25-50 mg QD	CrCl < 10ml/min, anuria or acute renal impairment: contraindicated Severe hepatic impairment and elderly: caution advised	Check renal function, electrolytes, drug interactions Produces gynecomastia
	HTN	50-100 mg/day oral		

Drug	Indications	Dose	Dose adjustments	Comments
Aldosterone-antagonists				
Eplerenone	HF	Start 25 mg oral QD Target dose: 50 mg QD	Elderly: caution advised CrCl < 50ml/min: contraindicated	Check renal function, electrolytes, drug interactions Major contraindications: strong CYP3A4 inhibitors
	HTN	50 mg oral QD-BID Max: 100 mg/day		
Others				
Ivabradine	HF	5-7.5 mg oral BID	Caution in elderly and CrCl < 15ml/min	Contraindicated if severe hepatic impairment

Drug	Indications	Dose	Dose adjustments	Comments
Levosimendan	HF/cardiogenic shock	LD: 6 to 12 µg/kg i.v. over 10 min (given only if immediate effect is needed) followed by 0.05 to 0.2 µg/kg/min as a continuous infusion for 24h	Avoid use if CrCl < 30ml/min or severe hepatic impairment	Calcium sensitizer and ATP-dependent potassium channel opener
Milrinone	HF/cardiogenic shock	50 µg/kg i.v. in 10-20 min, continuous 0.375-0.75 µg/kg/min	Renal: Same bolus. Adjust infusion: CrCl 50ml/min: start 0.43 µg/kg/min CrCl 40ml/min: start 0.38 µg/kg/min CrCl 30ml/min: start 0.33 µg/kg/min CrCl 20ml/min: start 0.28 µg/kg/min CrCl 10ml/min: start 0.23 µg/kg/min CrCl 5ml/min: start 0.20 µg/kg/min	Phosphodiesterase inhibitor Caution if atrial flutter Hypotensive drug
Isoprenaline/ Isoproterenol	Cardiogenic shock	0.5-5 µg/min (0.25-2.5 ml of a 1:250,000 dilution) i.v. infusion	-	ß1, ß2 agonist. Contraindicated in patients with tachyarrhythmia, tachycardia or heart block caused by digitalis intoxication, ventricular arrhythmias which require inotropic therapy, angina pectoris, recent ACS, hyperthyroidism
	Bradyarrhythmias	Bolus: 20-40 µg i.v. Infusion: 0.5 µg/min of 2 mg/100 ml normal saline		

Inotropics & vasopressors (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Dobutamine	Cardiogenic shock	2-20 µg/kg/min i.v.	-	ß1, α1/ß2 agonist. Increases contractility with little effect on heart rate and blood pressure. Reduces pulmonary and systemic VR, PCP
Dopamine	Cardiogenic shock	Dopaminergic effect: 2-5 µg/Kg/min i.v. ß effect : 5-15 µg/Kg/min i.v. α effect : 15-40 µg/Kg/min i.v.	-	ß, α, dopaminergic agonist Increases BP, PAP, heart rate, cardiac output and pulmonary and systemic VR More arrhythmogenic than dobutamine and noradrenaline
Noradrenaline	Cardiogenic shock	0.05-0.2 µg/kg/min i.v. titrate to effect	-	α 1, ß1 agonist Increases BP and PAP Little arrhythmogenic

Drug	Indications	Dose	Dose adjustments	Comments
Group I				
Procainamide i.v.	AF (termination); stable VT (with a pulse)	15-18 mg/kg i.v. over 60 min, followed by infusion of 1-4 mg/min	Reduce LD to 12 mg/kg in severe renal impairment Reduce MD by one-third in moderate renal impairment and by two-thirds in severe renal impairment Caution in elderly and asthma	Hypotension (negative inotropic agent) Lupus-like syndrome Contraindicated if myasthenia gravis, AV block, severe renal impairment
Lidocaine i.v.	Pulseless VT/VF	1-1.5 mg/kg i.v./i.o. bolus (can give additional 0.5-0.75 mg/kg i.v./i.o. push every 5-10 min if persistent VT/VF, max cumulative dose = 3 mg/kg), followed by infusion of 1-4 mg/min	1-2 mg/min infusion if liver disease or HF	Contraindicated if advanced AV block, bradycardia, hypersensitivity to local anesthetics Caution in HF, renal impairment and elderly May cause seizures, psychosis. Stop if QRS widens > 50%
	Stable VT (with a pulse)	1-1.5 mg/kg i.v. bolus (can give additional 0.5-0.75 mg/kg i.v. push every 5-10min if persistent VT, max cumulative dose = 3 mg/kg), followed by infusion of 1-4 mg/min	1-2 mg/min infusion if liver disease or HF	

Antiarrhythmics (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Group I				
Flecainide i.v.	SVT, ventricular arrhythmias	2 mg/kg (max 150 mg) i.v. over 30min This may be followed by an infusion at a rate of 1.5 mg/kg/h for 1 h, reduced to 0.1-0.25 mg/kg/h for up to 24h, max cumulative dose = 600 mg	Severe renal impairment: caution advised	Contraindicated if cardiogenic shock, recent MI, 2nd or 3rd degree AV block
Propafenone i.v.	PSVT, ventricular arrhythmias	LD: 0.5-2 mg/kg i.v. direct over a minimum of 3-5min MD: 0.5-2.5 mg/kg i.v. direct q8h (max 560 mg/day) or continuous infusion up to 23 mg/h	May need to reduce dose in renal or hepatic failure	Contraindicated if unstable HF, cardiogenic shock, AV block, bradycardia, myasthenia gravis severe hypotension, bronchospastic disorders, Brugada syndrome

Antiarrhythmics (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Group II				
Atenolol i.v.	Arrhythmias	2.5 mg i.v. over 2.5 min every 5 min (max 10 mg)	Caution in elderly and/or severe renal impairment	Contraindicated if cardiogenic shock, bradycardia and greater than first-degree block, unstable HF
Metoprolol i.v.	Arrhythmias	2.5-5mg i.v. over 5 min, may repeat every 5 min (max 15mg)	Caution if severe hepatic impairment	Contraindicated if cardiogenic shock, bradycardia and greater than first-degree block, unstable HF
Propranolol i.v.	Arrhythmias	Initially given as slow i.v. boluses of 1 mg, repeated at 2 min intervals (max: 10 mg in conscious patients and 5 mg if under anesthesia)	-	Contraindicated if cardiogenic shock, bradycardia and greater than first-degree block, asthma, unstable HF

Antiarrhythmics (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Group III				
Amiodarone i.v.	AF (termination)	5 mg/Kg i.v. over 30 min, followed by infusion of 1 mg/min for 6h, then 0.5 mg/min	-	Reduce infusion rate if bradycardia, AV block, hypotension Bolus should be avoided if hypotension or severe LV dysfunction Highly vesicant agent
	Stable VT (with a pulse)	150 mg i.v. over 10 min followed by infusion of 1 mg/min for 6h, then 0.5 mg/min	-	
	Pulseless VT/VF	300 mg bolus i.v. (can give additional 150 mg i.v. bolus if VF/VT persists) followed by infusion of 900 mg over 24h	-	
Dronedarone	Paroxysmal or persistent AF prevention	400 mg oral BID	-	Contraindicated if severe renal or liver dysfunction, LVSD, symptomatic HF, permanent AF, bradycardia… (multiple contraindications)

Antiarrhythmics (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Group IV				
Diltiazem i.v.	PSVT;AF (rate control)	0.25 mg/kg i.v. over 2 min (may repeat with 0.35 mg/kg i.v. over 2 min), followed by infusion of 5-15 mg/h	Hepatic impairment: caution advised	-
Verapamil i.v.	PSVT;AF (rate control)	2.5-5 mg i.v. over 2 min (may repeat up to max cumulative dose of 20 mg); can follow with infusion of 2.5-10 mg/h	-	Contraindicated if AF+WPW, tachycardias QRS (except RVOT-VT), fascicular VT, bronchospasm, age>70 Antidote: - LVD: Calcium gluconate, dobutamine - Bradycardia/AV block: Atropine, Isoproterenol
Adenosine i.v.	Rapid conversion to a normal sinus rhythm of PSVT including those associated with accessory by-pass tracts (WPW syndrome)	Rapid i.v. boluses separated by 2 min: 6 mg → 6 mg → 12 mg	-	Contraindicated if sick sinus syndrome, second or third degree Atrio-Ventricular (AV) block (except in patients with a functioning artificial pacemaker), chronic obstructive lung disease with evidence of bronchospasm (e.g. asthma bronchiale), long QT syndrome, severe hypotension; decompensated states of heart failure - Adenosine can cause AF

Antiarrhythmics (Cont.)

Drug	Indications	Dose	Dose adjustments	Comments
Others				
Magnesium sulfate	VT-Torsades de Pointes	Bolus: 1-2 g i.v./i.o. over 5 min Perfusion: 5-20 mg/min i.v.	Caution if severe renal failure	Contraindicated if myasthenia gravis
Vernakalant	Acute atrial fibrillation	3 mg/kg i.v. over 10 min. If AF persists, a second 10-min-infusion of 2 mg/kg, 15 min later may be administered	-	Contraindicated if ACS within the last 30 days, severe aortic stenosis, SBP < 100mmHg, HF class NYHA III/IV, severe bradycardia, sinus node dysfunction or 2nd or 3rd degree heart block

APTT = Activated partial thromboplastin time
AB = Airway and breathing
ABG = Arterial blood gas
AADs = Antiarrhythmic drugs
AAS = Acute aortic syndrome
ACEI = Angiotensin converting enzyme inhibitor
ACLS = Advanced cardiovascular life support
ACS = Acute coronary syndrome
ACT = Activated clotting time
AD = Aortic Dissection
AED = Automated external defibrillator
AF = Atrial fibrillation
Ao = Aortic
aPRR = Activated partial thromboplastin time
ARB = Angiotensin receptor blockers
AS = Aortic stenosis
AV = Atrioventricular
AVN = Atrioventricular node
AVNRT = Atrioventricular nodal re-entrant tachycardia
AVNT = Atrioventricular nodal tachycardia
BID = Twice a day
BBB = Bundle branch block
BLS = Basic life support
BNP = Brain natriuretic peptide
BP = Blood pressure
CABG = Coronary artery bypass grafting
CAD = Coronary artery disease
Cath Lab = Catheterisation laboratory
CCU = Coronary care unit
CHF = Congestive heart failure
CMR = Cardiovascular magnetic resonance
COPD = Chronic obstructive pulmonary disease
CPAP = Continuous positive airway pressure
CPR = Cardiopulmonary resuscitation
CrCl = Creatinine clearance
CS = Cardiogenic shock
CSM = Carotid sinus massage
CSNRT = Corrected sinus node recovery time
CSS = Carotid sinus syndrome
CT = Computed tomography
CT-angio = Computed tomography angiography
CUS = Compression venous ultrasound

CV = Cardiovascular
CXR = Chest X-ray
DD = Dyastolic dysfunction
DM = Diabetes mellitus
DVT = Deep vein thrombosis
ECG = Electrocardiogram
ED = Emergency department
EG = Electrograms
EMB = Endomyocardial biopsy
EMS = Emergency medical services
EPS = Electrophysiological study
ERC = European Resuscitation Council
ESR = Erythrocyte sedimentation rate
ETT = Exercice treadmill testing
FMC = First medical contact
GER = Gastroesophageal reflux
GFR = Glomerular flow rate
GI = Gastrointestinal
GP = Glycoprotein
HF = Heart failure
HTN = Hypertension
HR = Heart rate
hsTn = High-sensitive troponin
IABP = Intra-aortic balloon pump
ICC = Intensive cardiac care
ICCU = Intensive cardiac care unit
ICD = Implantable cardioverter defibrillator
IHD = Ischemic heart disease
IMH = Intramural hematoma
ISFC = International Society and Federation of Cardiology
i.o. = Intraosseous
IV = Invasive ventilation
i.v. = Intravenous
KD = Kidney disease
LBBB = Left bundle branch block
LD = Loading dose
LGE = Late gadolinium enhancement
LMWH = Low-molecular weight heparin
LOC = Loss of consciousness
LV = Left ventricular
LVD = Left ventricular dysfunction
LVEF = Left ventricular ejection fraction

LVH = Left ventricular hypertrophy
LVSD = Left ventricular systolic dysfunction
MCS = Mechanical circulatory support
MD = Maintenance dose
MDCT = Computed tomography with >4 elements
MI = Myocardial infarction
MRI = Magnetic resonance imaging
Mvo = Microvascular obstruction
NIV = Non-invasive ventilation
NOAC = New oral anticoagulants
NSAID = Non-steroidal anti-inflammatory drugs
NSTEACS = Non-ST-elevation ACS
NSTEMI = Non ST-segment elevation myocardial infarction
NTG = Nitroglycerin
NT-proBNP = N-terminal pro brain natriuretic peptide
NVAF = Non-valvular atrial fibrillation
NYHA = New York Heart Association
OH = Orthostatic hypotension
PAP = Pulmonary arterial pressure
PAU = Penetrating aortic ulcer
PCI = Percutaneous coronary intervention
PCM = Physical counter-measures
PCP = Pulmonary capillary pressure
PE = Pulmonary embolism
PEA = Pulmonary endarterectomy
PEEP = Positive end expiratory pressure
PR = Pulmonary regurgitation
ProCT = Procalcitonin
PRN = Pro re nata
PSVT = Paroxysmal supraventricular tachycardia
QD = Once a day
QPM = Every evening
rtPA = Recombinant tissue plasminogen activator
RV = Right ventricular
RVOT-VT = Right ventricular outflow tract ventricular tachycardia
SBP = Systemic blood pressure
s.c = Subcutaneous
SLE = Systemic lupus erythematosus
SMU = Syncope management units
STE-ACS = ST-segment elevation acute coronary syndrome
STEMI = ST-segment elevation myocardial infarction

SVT = Supraventricular tachycardia
SpO_2 = Oxygen saturation
TEE = Transesophageal echocardiography
TEVAR = Thoracic endovascular aortic aneurysm repair
TIA = Transient ischemic attack
TID = Three times a day
TLOC = Transient loss of consciousness
Tn = Troponin
TOE = Transoesopageal echocardiography
TSH = Thyroid-stimulating hormone
TTE = Transthoracic echocardiography
UFH = Unfractionated heparin
ULN = Upper limit of normal
VF = Ventricular fibrillation
VR = Vascular resistance
VT = Ventricular tachycardia
VTE = Venous thromboembolism
VVS = Vasovagal syncope
WHO = World Health Organization
WPW = Wolff-Parkinson-White

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Clinical Decision-Making
TOOLKIT

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