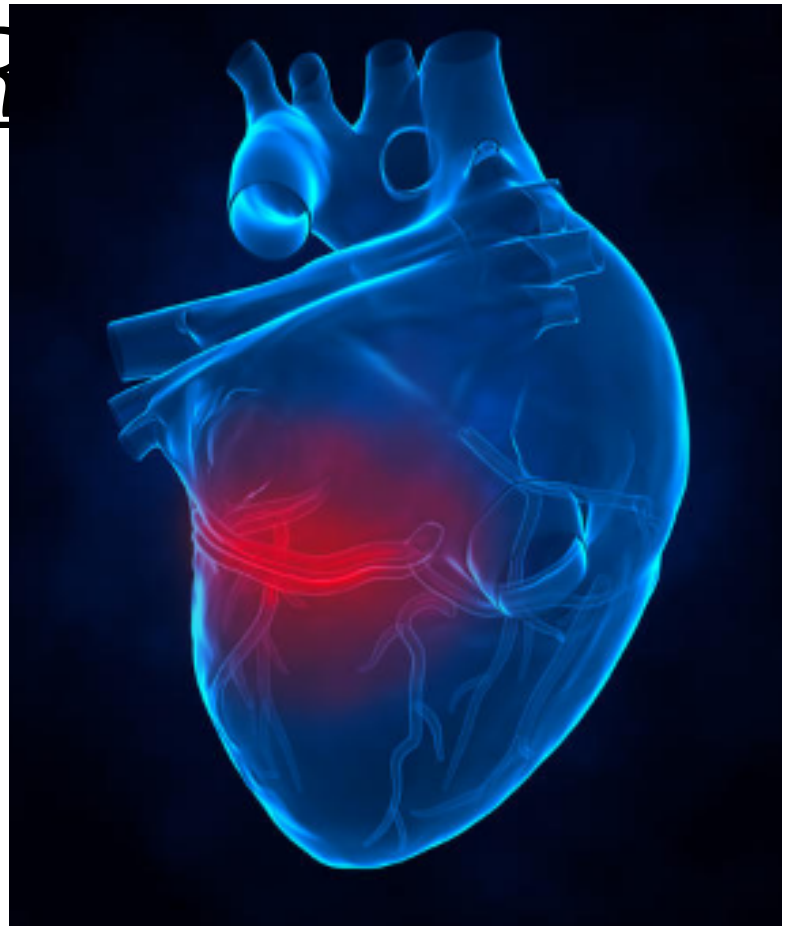
ACUTE CORONAR
SYNDROME

DR CHEVAAN HENDRICKSE

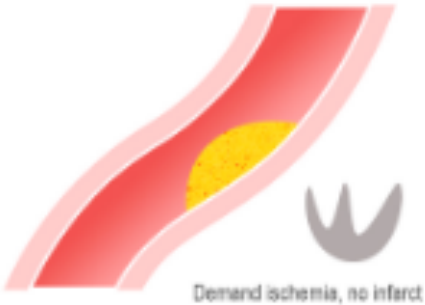
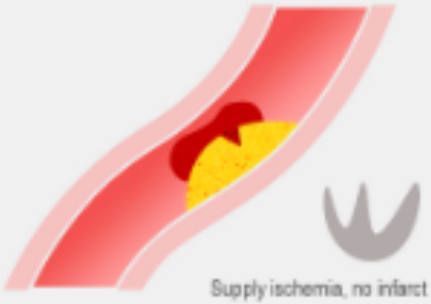
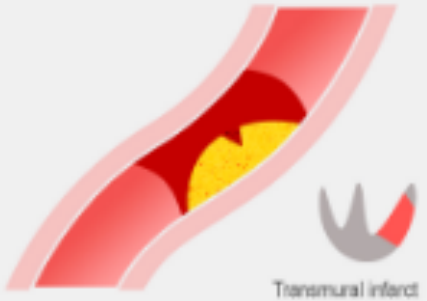
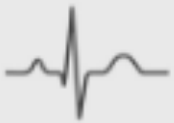
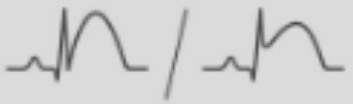
INTERVENTIONAL CARDIOLOGIST



Conflicts of interest

None

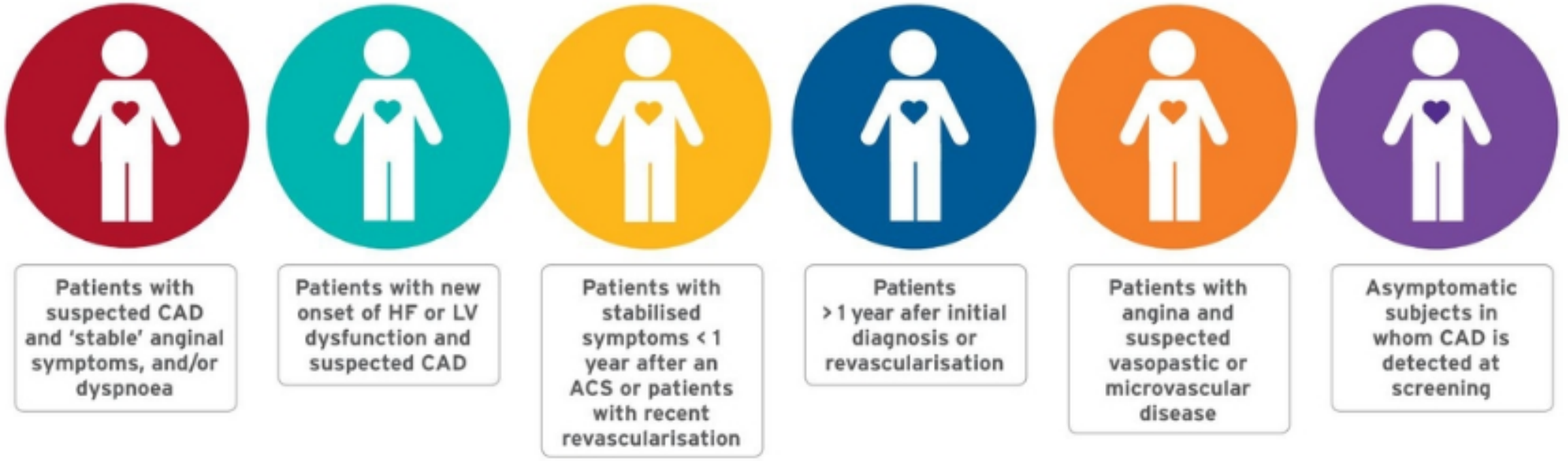
ACUTE CORONARY SYNDROMES

ACUTE CORONARY SYNDROME	1 STABLE ANGINA	2 UNSTABLE ANGINA	3 NSTEMI	4 STEMI
	Angina pain develops when there is increased demand in the setting of a stable atherosclerotic plaque. The vessel is unable to dilate enough to allow adequate blood flow to meet the myocardial demand.	The plaque ruptures and a thrombus forms around the ruptured plaque, causing partial occlusion of the vessel. Angina pain occurs at rest or progresses rapidly over a short period of time.	During an NSTEMI, the plaque rupture and thrombus formation causes partial occlusion to the vessel that results in injury and infarct to the subendocardial myocardium.	A STEMI is characterized by complete occlusion of the blood vessel lumen, resulting in transmural injury and infarct to the myocardium, which is reflected by ECG changes and a rise in troponins.
	 Demand ischemia, no infarct	 Supply ischemia, no infarct	 Subendocardial infarct	 Transmural infarct
ECG	 Normal	 Normal, Inverted T waves, or ST depression	 Normal, Inverted T waves, or ST depression	 Hyperacute T waves or ST elevation
TROPONINS	Normal	Normal	Elevated	Elevated

This infographic was created by Paula Sneath and Leah Zhao for the Sirens to Scrubs series of CanadiEM.org.

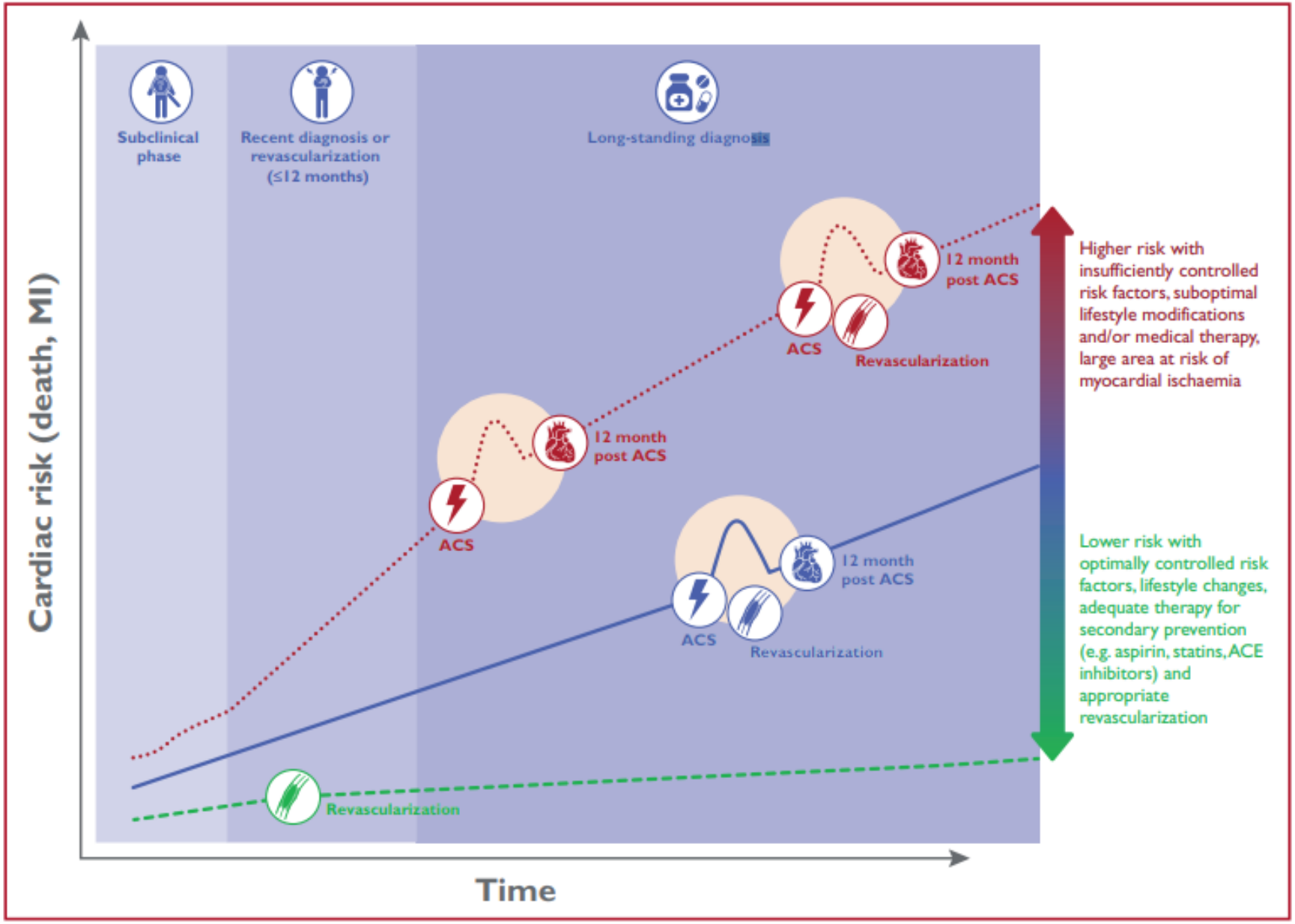
CHRONIC CORONARY SYNDROMES (2019)

Figure 2. Chronic Coronary Syndromes: 6 Common Scenarios at Outpatient Clinics



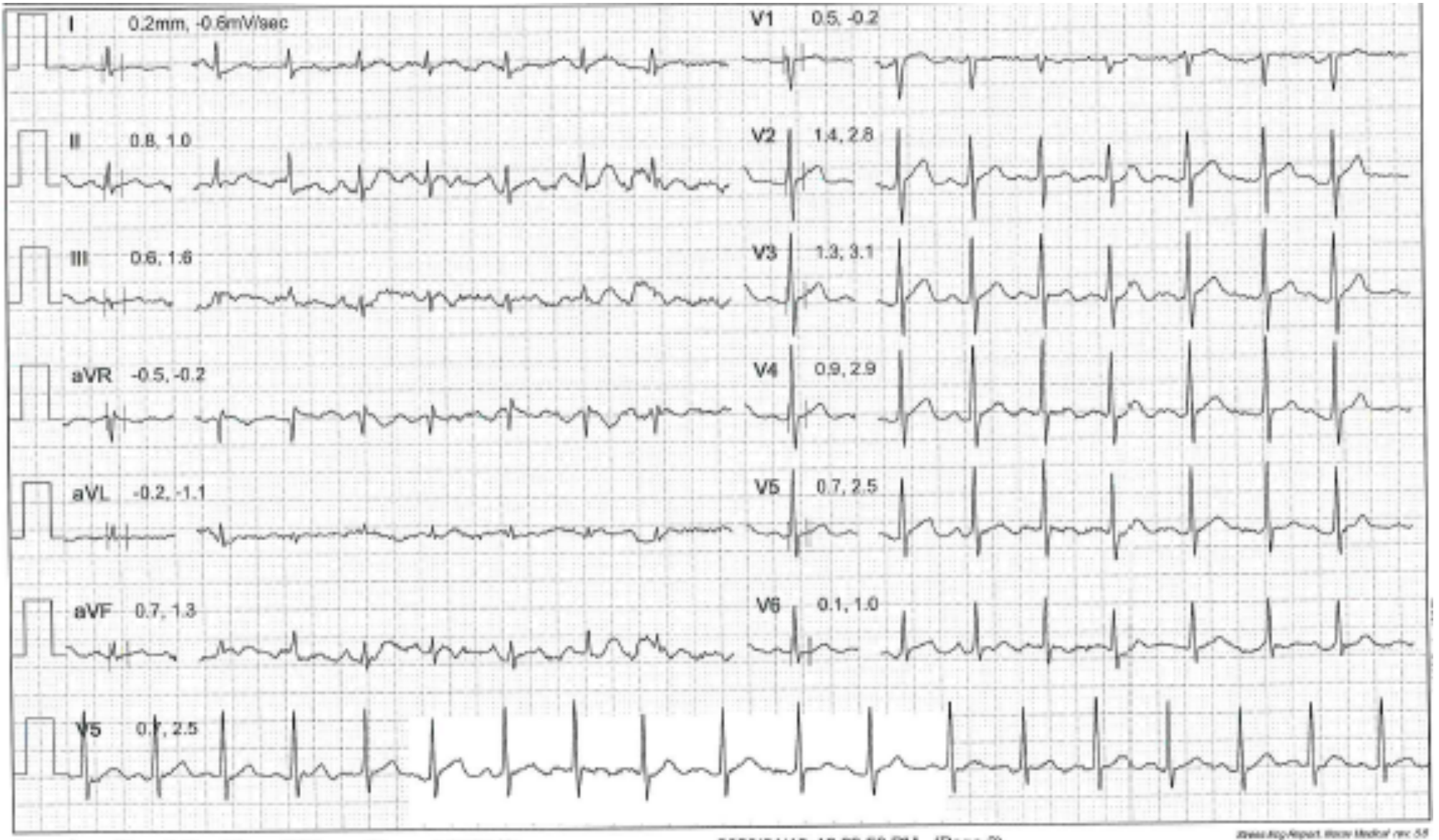
ACS, acute coronary syndrome; CAD, coronary artery disease; HF, heart failure; LV, left ventricular.

Reproduced with kind permission from Dr D. Capodanno.


Cardiac risk (death, MI)
Time
Subclinical phase
Recent diagnosis or revascularization (≤12 months)
Long-standing diagnosis
ACS
12 month post ACS
Revascularization
ACS
12 month post ACS
ACS
12 month post ACS
Revascularization
Revascularization
Higher risk with insufficiently controlled risk factors, suboptimal lifestyle modifications and/or medical therapy, large area at risk of myocardial ischaemia
Lower risk with optimally controlled risk factors, lifestyle changes, adequate therapy for secondary prevention (e.g. aspirin, statins, ACE inhibitors) and appropriate revascularization

CASE STUDY

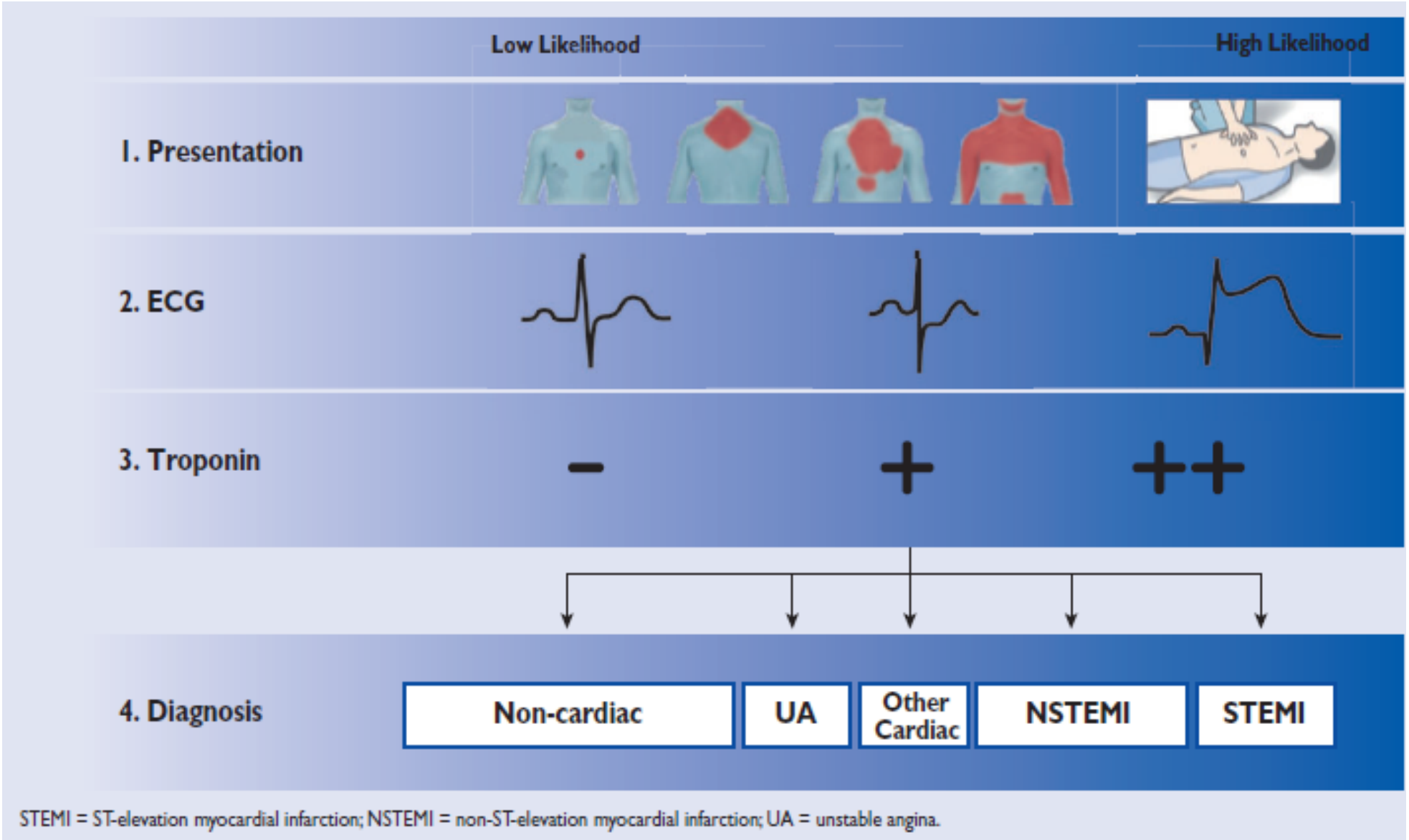
- 50 YEAR OLD
- ***Risk factors**: Hypertension, Smoker*
- Central, dull chest pain when playing touch rugby. @ 15 min into the game. Pain occurring more frequently. Other atypical pain syndromes.
- Presentation via his GP with unstable angina
- ***Reported to my rooms: Electrocardiogram within 10 min***


I 0.2mm, -0.6mV/sec
II 0.8, 1.0
III 0.6, 1.6
aVR -0.5, -0.2
aVL -0.2, -1.1
aVF 0.7, 1.3
V5 0.7, 2.5
V1 0.5, -0.2
V2 1.4, 2.8
V3 1.3, 3.1
V4 0.9, 2.9
V5 0.7, 2.5
V6 0.1, 1.0
25 mm/sec 10 mm/mV Filters: 50Hz -on; BL -on; 0.05-35 Hz
2020/01/13 12:39:50 PM (Page 3)

1. **TROPONIN I < 30 ng/L→ repeat at 2 hours < 30 ng/L**
2. **Mild dyslipidaemia: t chol 5.8, LDL 3.4, HDL 0.9, TG 0.75**
3. **Normal echocardiogram**
4. **Normal CXR**

Differential diagnosis

Cardiac	Pulmonary	Vascular	Gastro-intestinal	Orthopaedic	Other
Myopericarditis Cardiomyopathies[a]	**Pulmonary embolism**	**Aortic dissection**	**Oesophagitis, reflus or spasm**	**Musculoskeletal disorders**	**Anxiety disorders**
Tachyarrhythmias	**(Tension)-Pneumothorax**	Symptomatic aortic aneurysm	Peptic ulcer, gastritis	Chest trauma	Herpes zoster
Acute heart failure	Bronchitis, pneumonia	Stroke	Pancreatitis	Muscle injury/ inflammation	Anaemia
Hypertensive emergencies	Pleuritis		Cholecystitis	Costochondritis	
Aortic valve stenosis				Cervical spine pathologies	
Tako-Tsubo cardiomyopathy					
Coronary spasm					
Cardiac trauma					



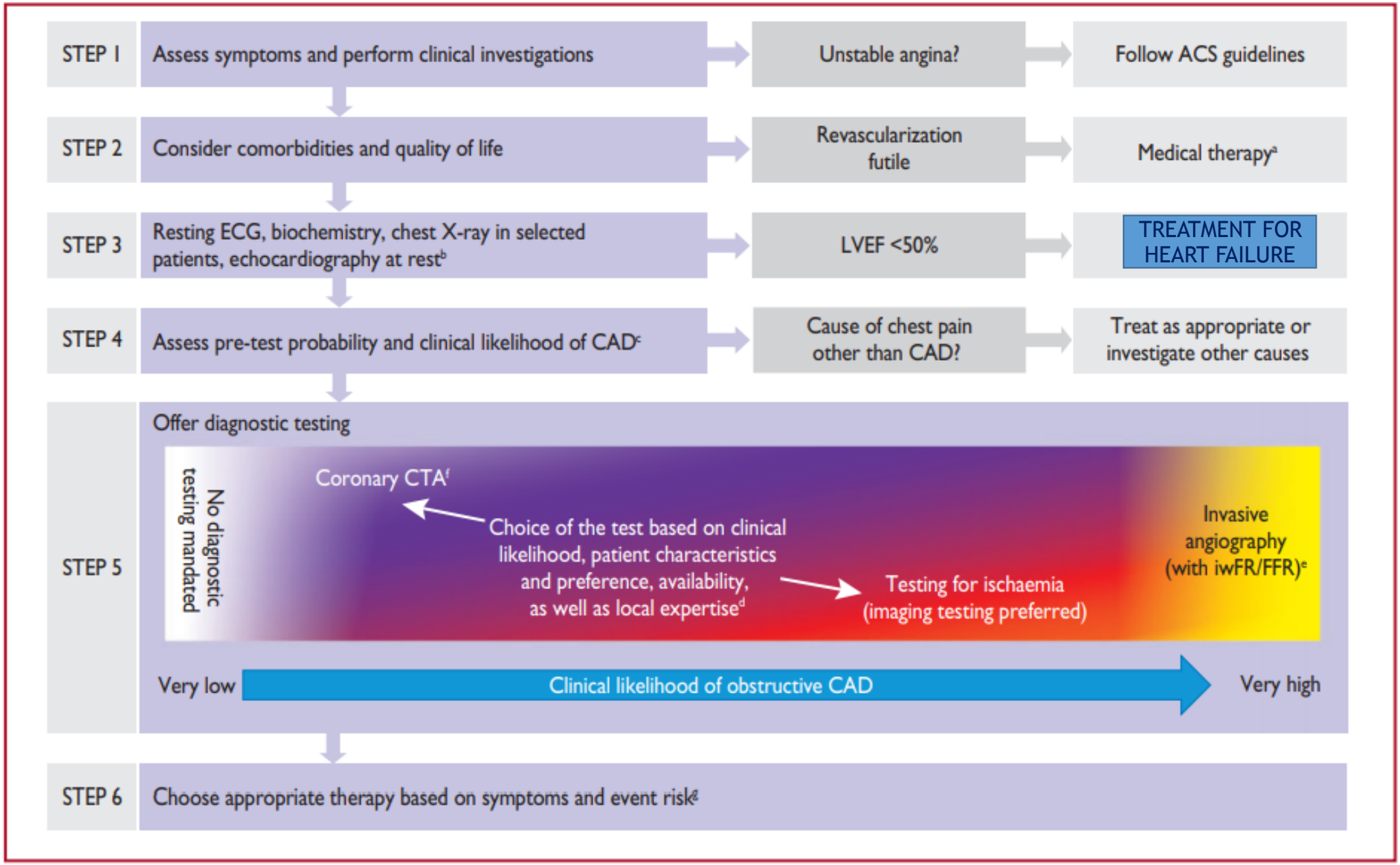
STEMI = ST-elevation myocardial infarction; NSTEMI = non-ST-elevation myocardial infarction; UA = unstable angina.

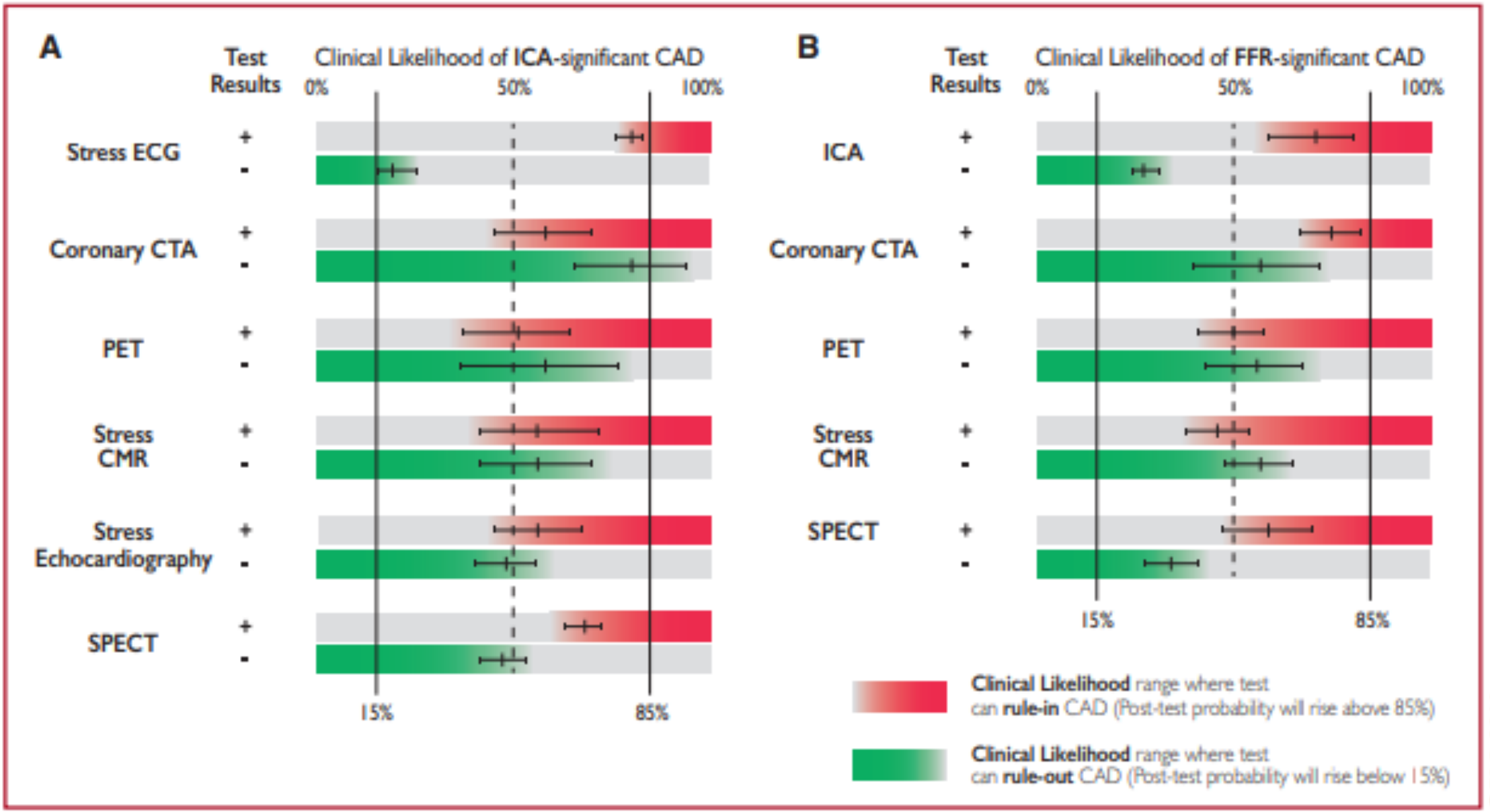
Unstable angina

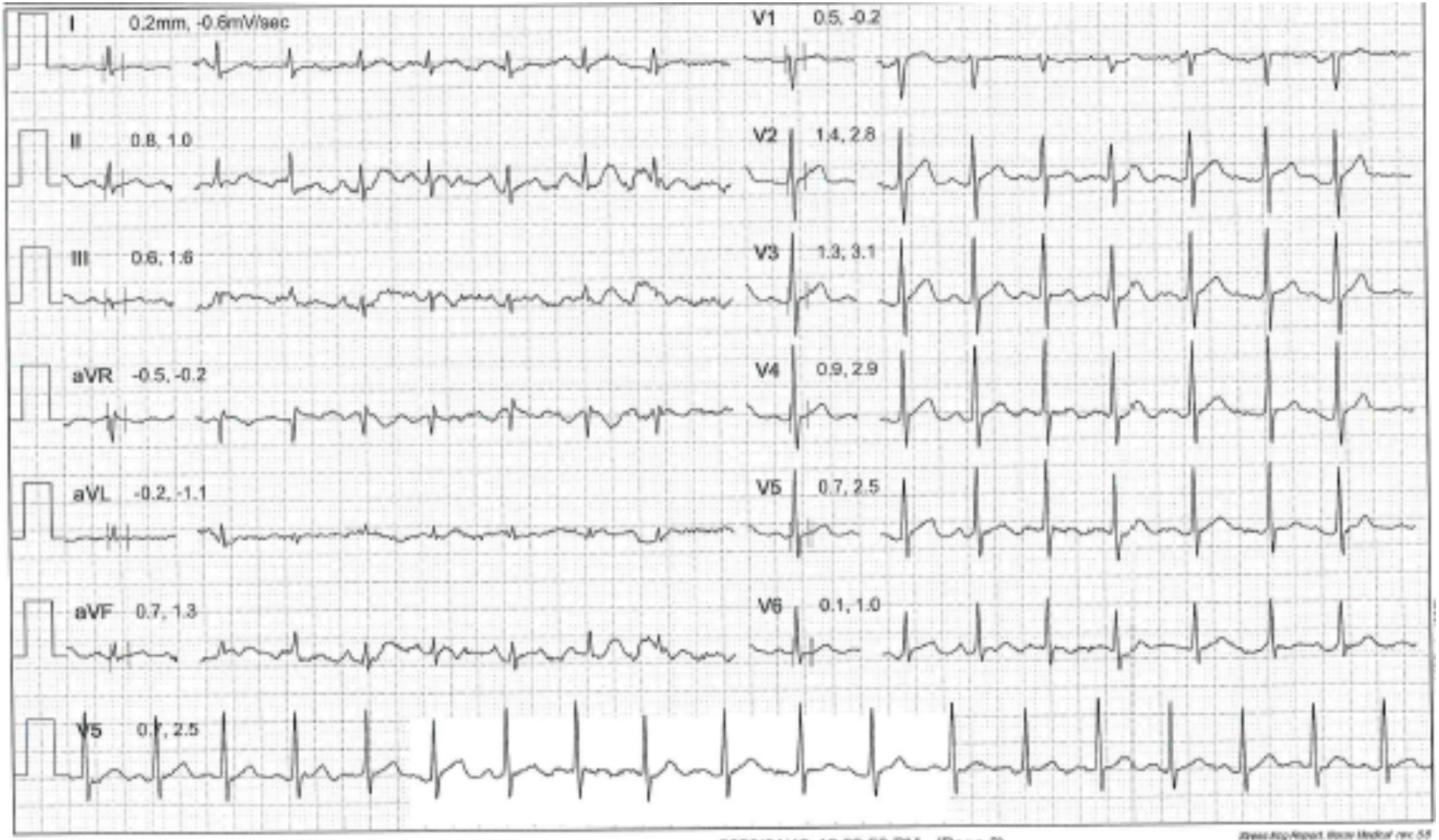
1. New onset angina over 2 months (central, constricting, radiation)
2. Accelerating tempo (crescendo) of symptoms over 48 hrs
3. Resting angina (pain> 20 min)
4. Nocturnal angina
5. Post-infarct angina
6. Post-intervention

What should we do next?

1. **INVASIVE ANGIOGRAPHY ?**
2. **EXERCISE STRESS TESTING ?**
3. **STRESS ECHOCARDIOGRAPHY ?**
4. **CT CORONARY ANGIOGRAPHY ?**
5. **MYOCARDIAL PERFUSION STUDIES ?**
6. **CARDIAC MRI ?**


STEP 1
Assess symptoms and perform clinical investigations
Unstable angina?
Follow ACS guidelines
STEP 2
Consider comorbidities and quality of life
Revascularization futile
Medical therapy[a]
STEP 3
Resting ECG, biochemistry, chest X-ray in selected patients, echocardiography at rest[b]
LVEF <50%
TREATMENT FOR HEART FAILURE
STEP 4
Assess pre-test probability and clinical likelihood of CAD[c]
Cause of chest pain other than CAD?
Treat as appropriate or investigate other causes
STEP 5
Offer diagnostic testing
No diagnostic testing mandated
Coronary CTA[f]
Choice of the test based on clinical likelihood, patient characteristics and preference, availability, as well as local expertise[d]
Testing for ischaemia (imaging testing preferred)
Invasive angiography (with iwFR/FFR)[e]
Very low
Clinical likelihood of obstructive CAD
Very high
STEP 6
Choose appropriate therapy based on symptoms and event risk[g]


A
Test Results
Clinical Likelihood of ICA-significant CAD
0%
50%
100%
Stress ECG
Coronary CTA
PET
Stress CMR
Stress Echocardiography
SPECT
+
-
15%
85%
B
Test Results
Clinical Likelihood of FFR-significant CAD
0%
50%
100%
ICA
Coronary CTA
PET
Stress CMR
SPECT
+
-
15%
85%
Clinical Likelihood range where test can rule-in CAD (Post-test probability will rise above 85%)
Clinical Likelihood range where test can rule-out CAD (Post-test probability will rise below 15%)



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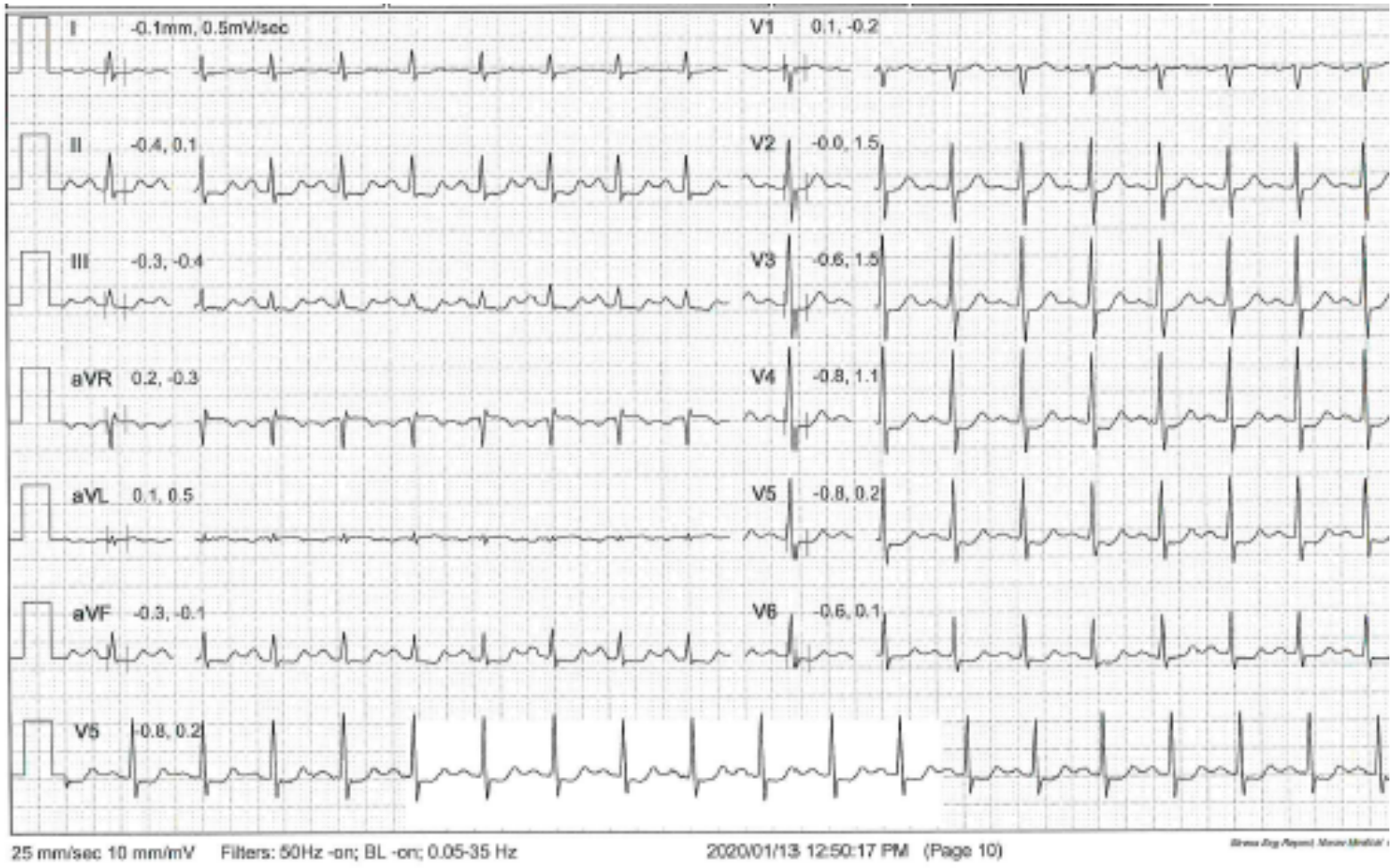
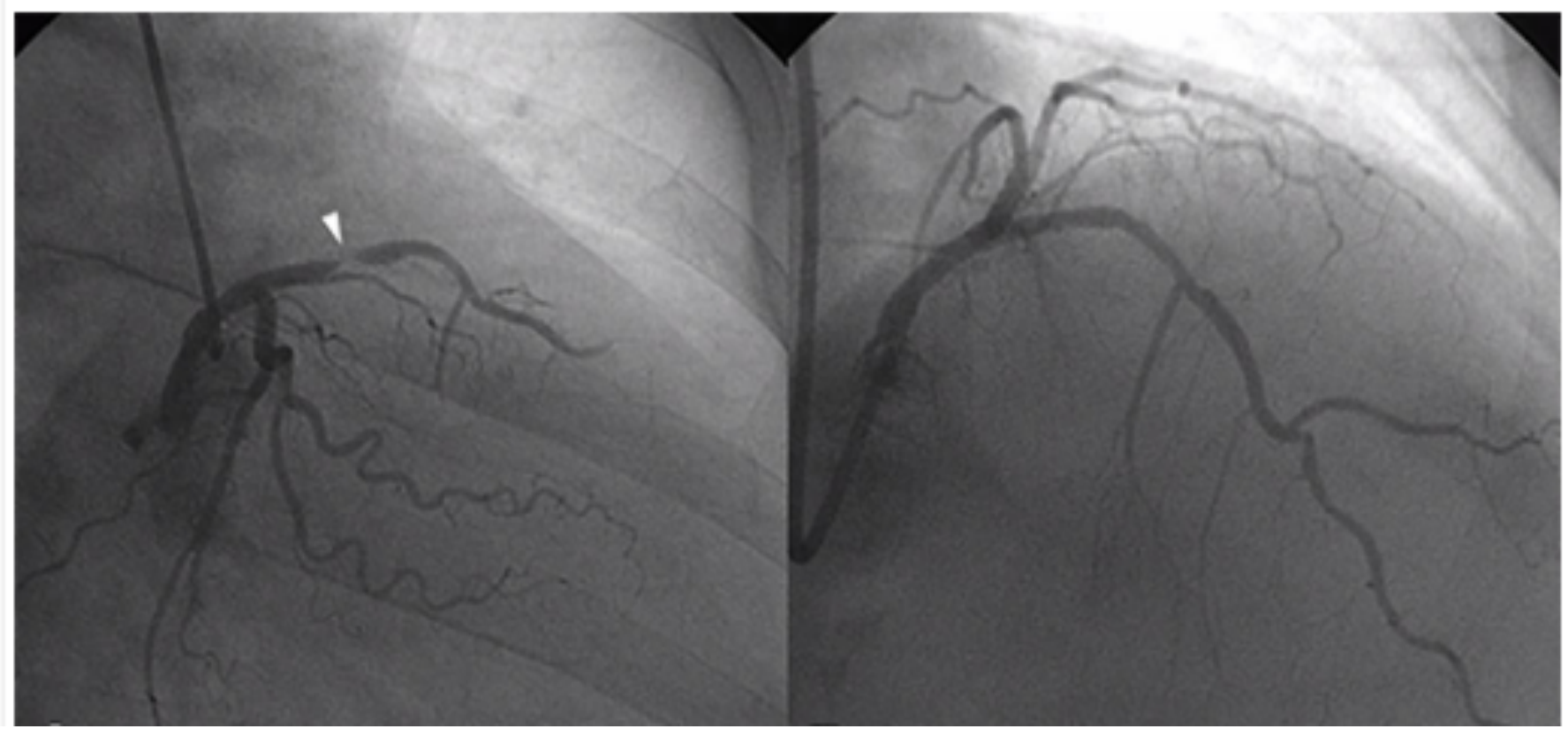
Exercise stress test

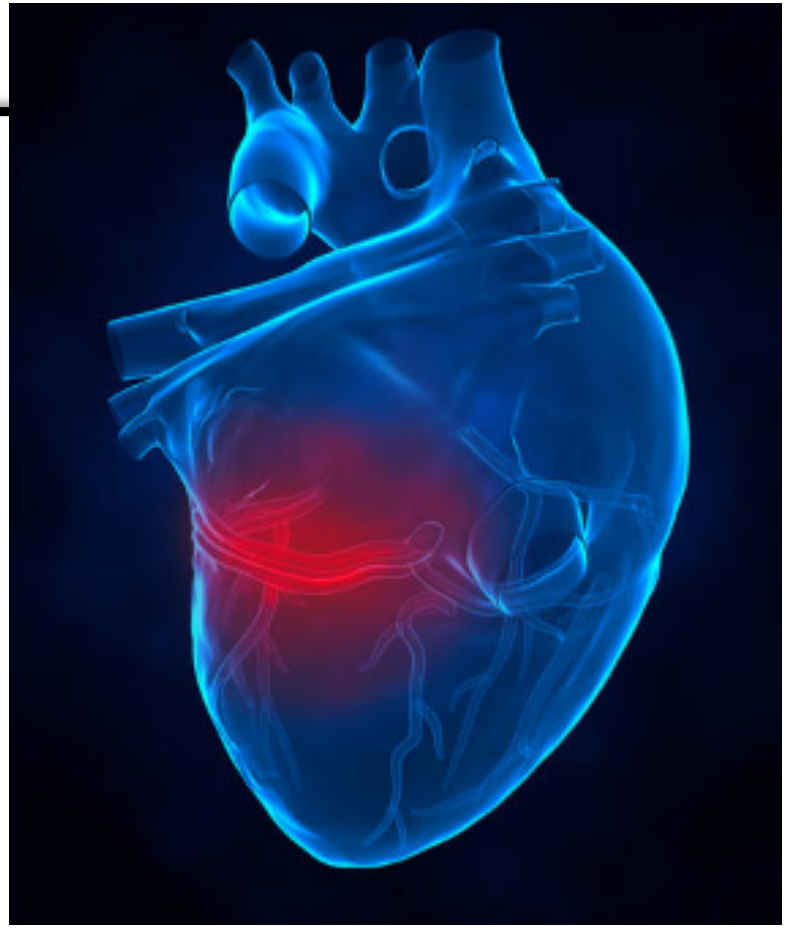


Invasive coronary angiography and percutaneous coronary intervention



MYOCARDIAL INFARCTION

THEORETICAL CONCEPTS



ESC European Society of Cardiology

European Heart Journal (2019) **40**, 237–269
doi:10.1093/eurheartj/ehy462

EXPERT CONSENSUS DOCUMENT

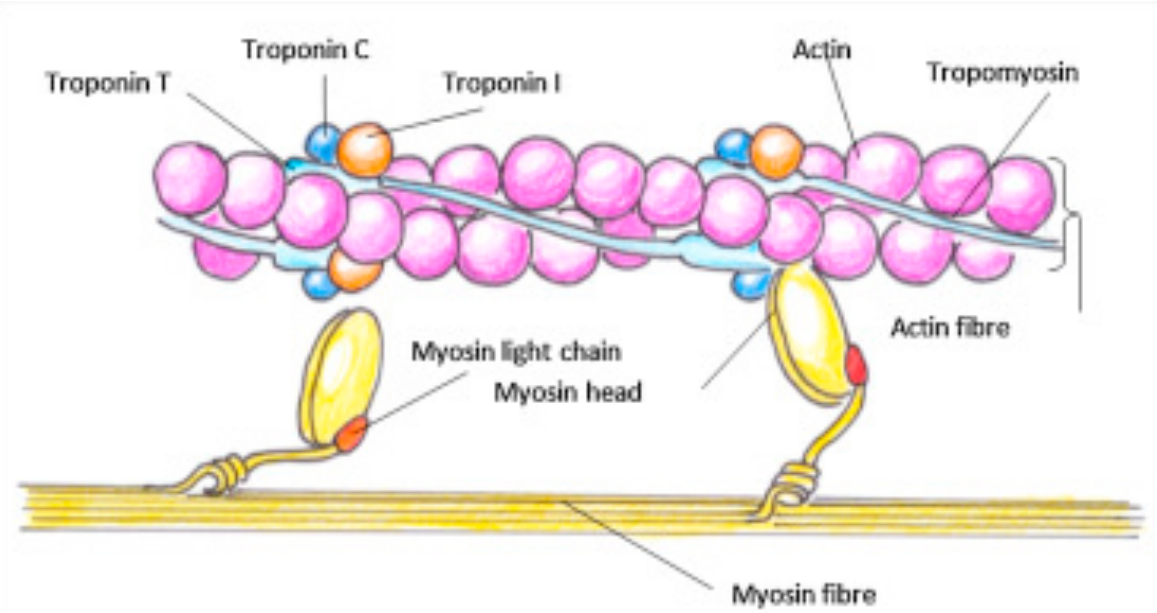
Fourth universal definition of myocardial infarction (2018)

Criteria for acute myocardial infarction (types 1, 2 and 3 MI)

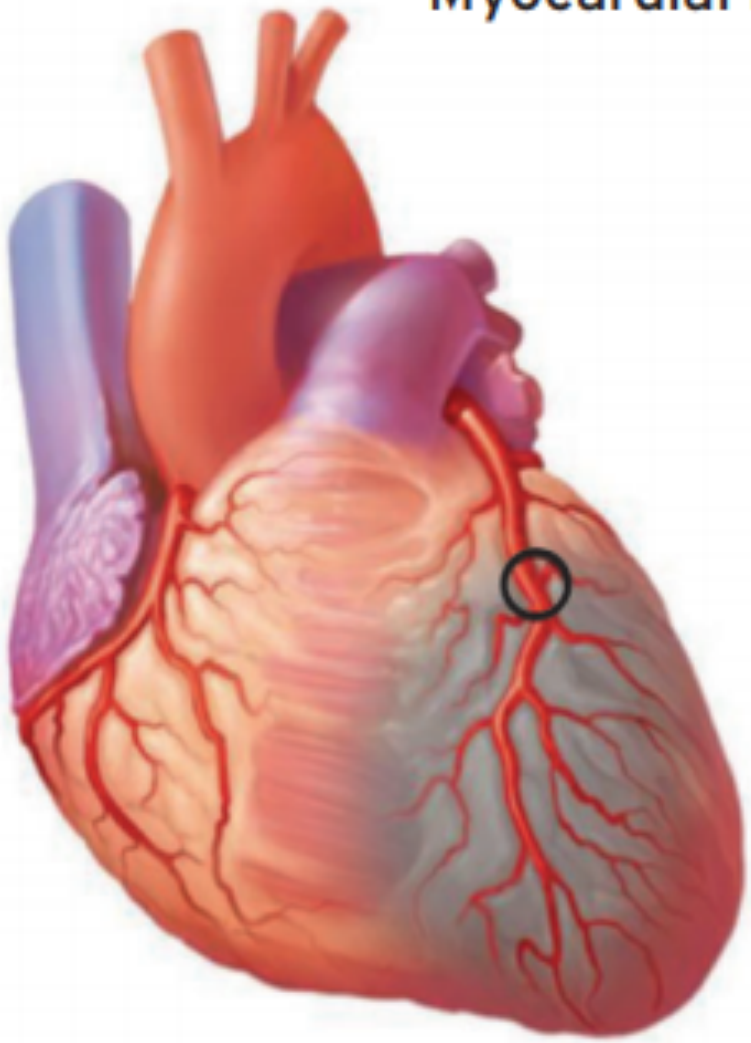
The term acute myocardial infarction should be used when there is acute myocardial injury with clinical evidence of acute myocardial ischaemia and with detection of a rise and/or fall of cTn values with at least one value above the 99th percentile URL and at least one of the following:

- Symptoms of myocardial ischaemia;
- New ischaemic ECG changes;
- Development of pathological Q waves;
- Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality in a pattern consistent with an ischaemic aetiology;
- Identification of a coronary thrombus by angiography or autopsy (not for types 2 or 3 MIs).

1. Myocardial infarction Type (Type 1-5)
2. Myocardial infarction vs myocardial injury
3. Troponin
4. hs troponin



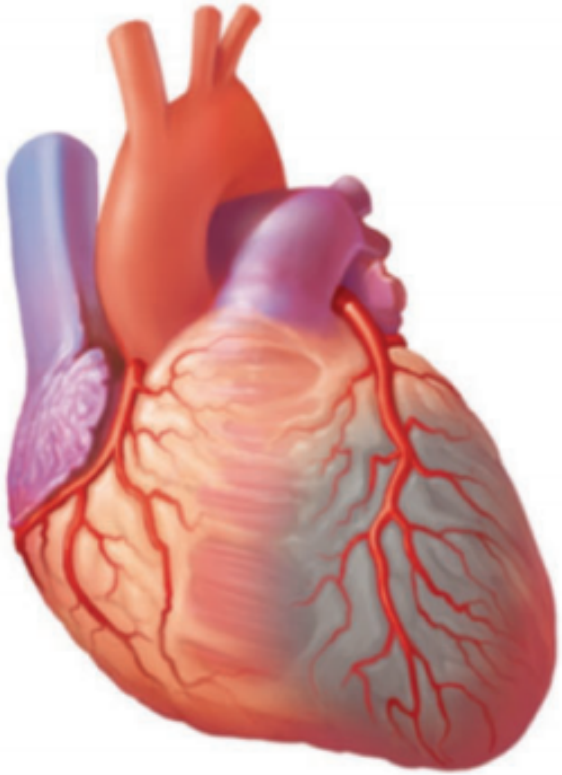
Myocardial Infarction Type 1

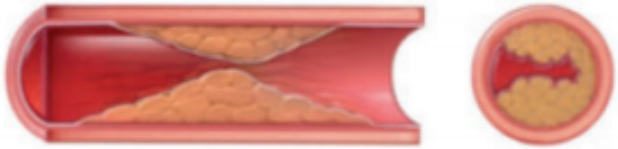


Plaque rupture/erosion with occlusive thrombus

Plaque rupture/erosion with non-occlusive thrombus

Myocardial Infarction Type 2



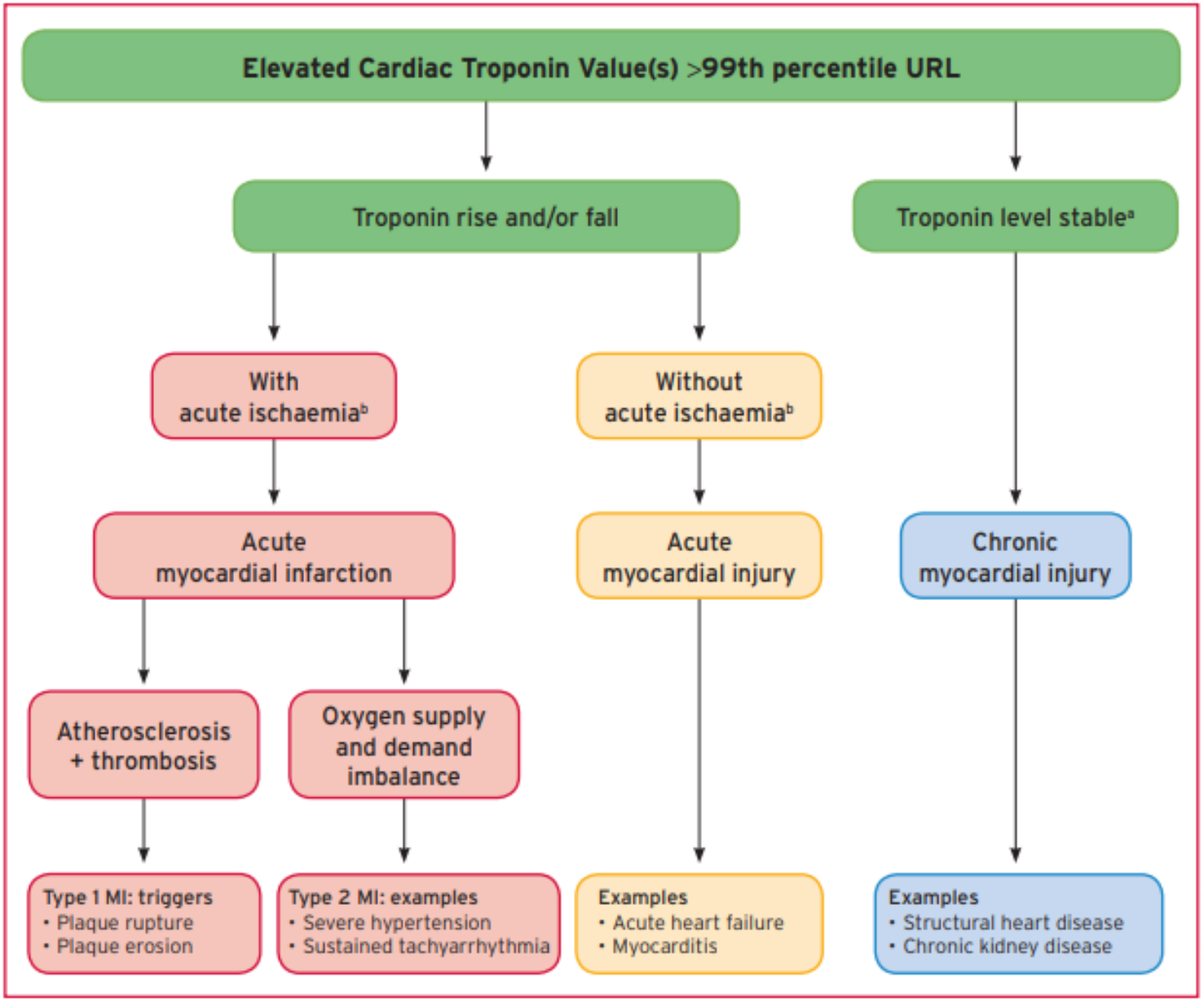


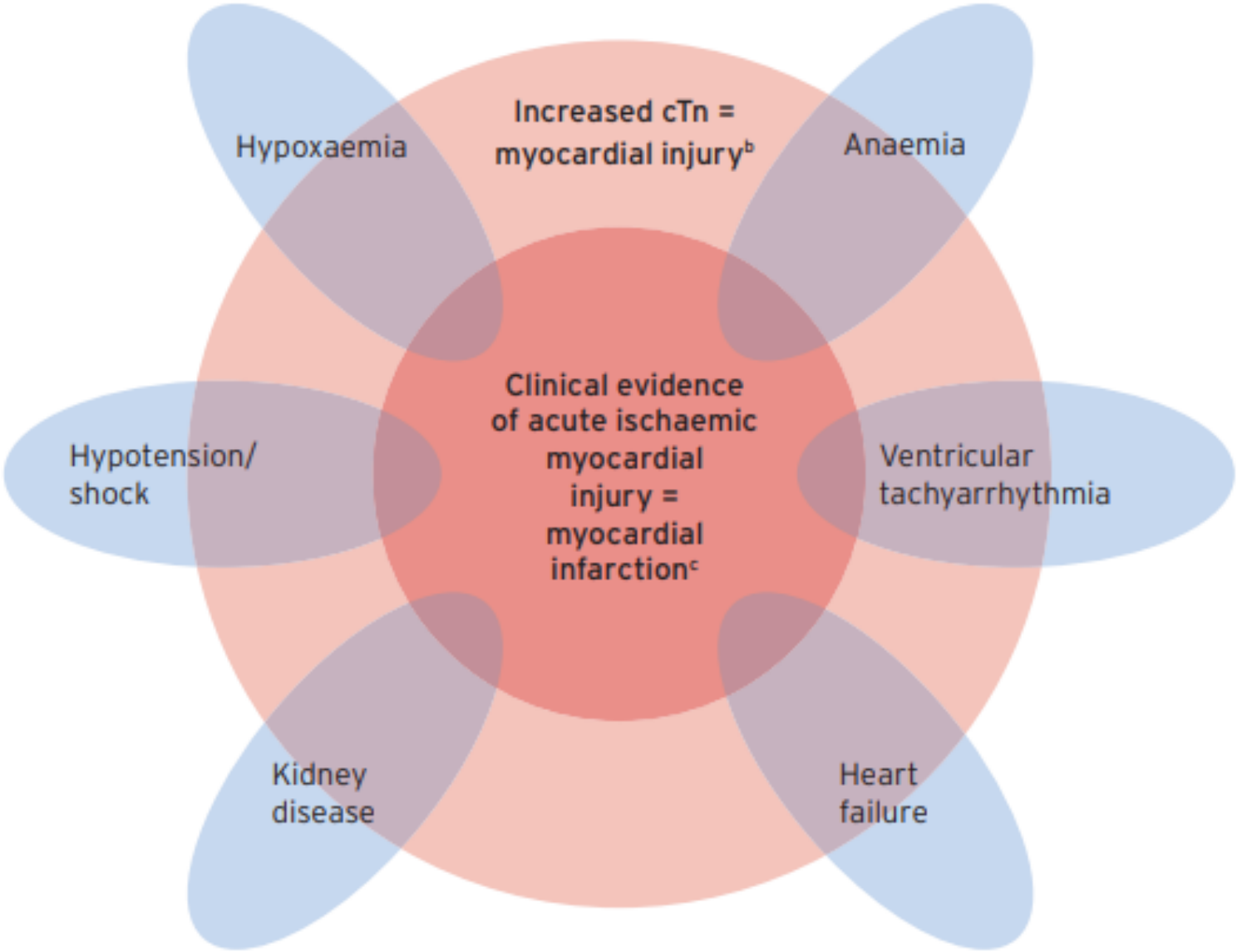
Atherosclerosis and oxygen supply/demand imbalance

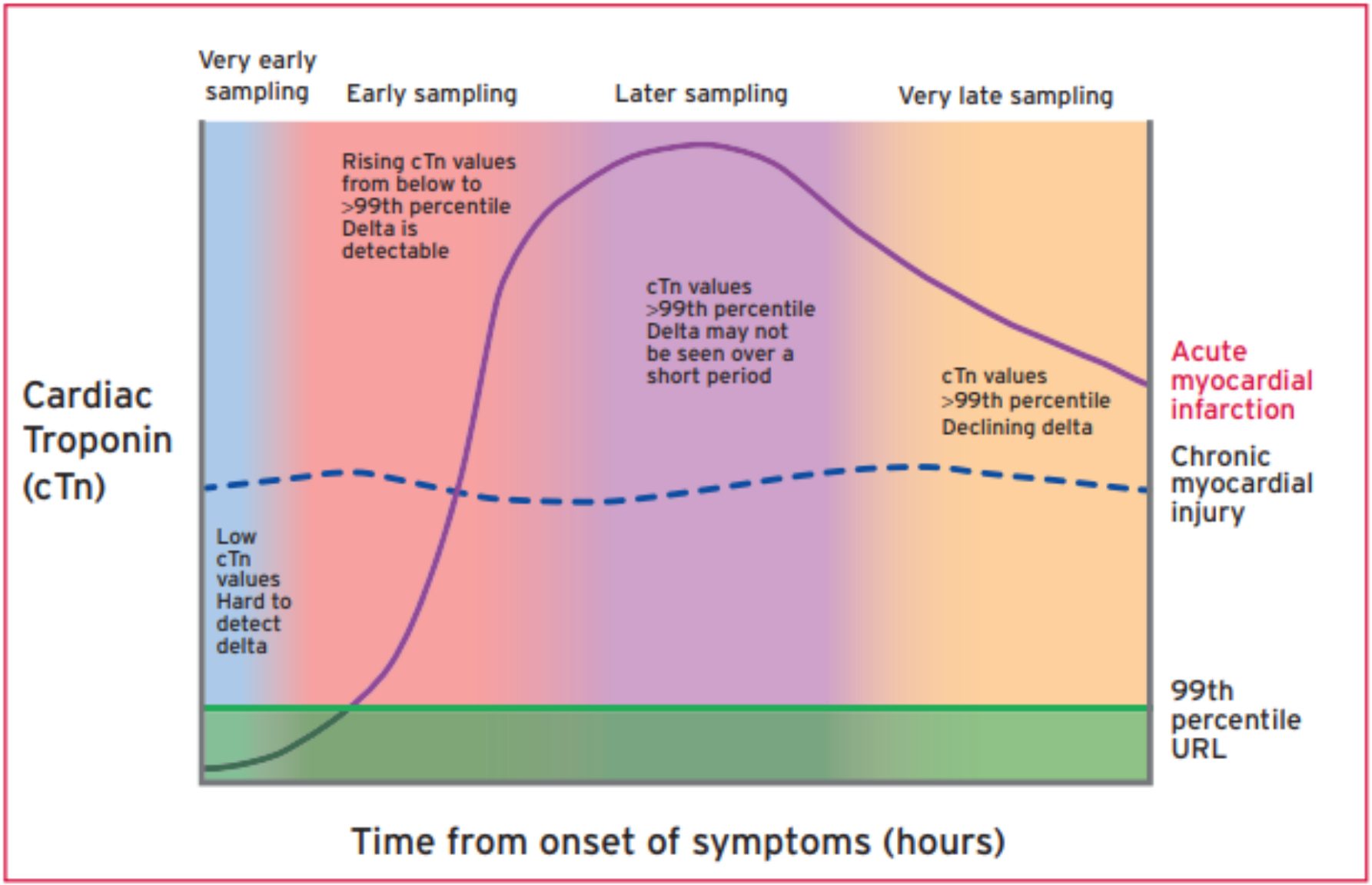
Vasospasm or coronary microvascular dysfunction

Non-atherosclerotic coronary dissection

Oxygen supply/demand imbalance alone


Elevated Cardiac Troponin Value(s) >99th percentile URL
Troponin rise and/or fall
Troponin level stable[a]
With acute ischaemia[b]
Without acute ischaemia[b]
Acute myocardial infarction
Acute myocardial injury
Chronic myocardial injury
Atherosclerosis + thrombosis
Oxygen supply and demand imbalance
Type 1 MI: triggers
• Plaque rupture
• Plaque erosion
Type 2 MI: examples
• Severe hypertension
• Sustained tachyarrhythmia
Examples
• Acute heart failure
• Myocarditis
Examples
• Structural heart disease
• Chronic kidney disease
©ESC/ACC/AHA/WHF 2018

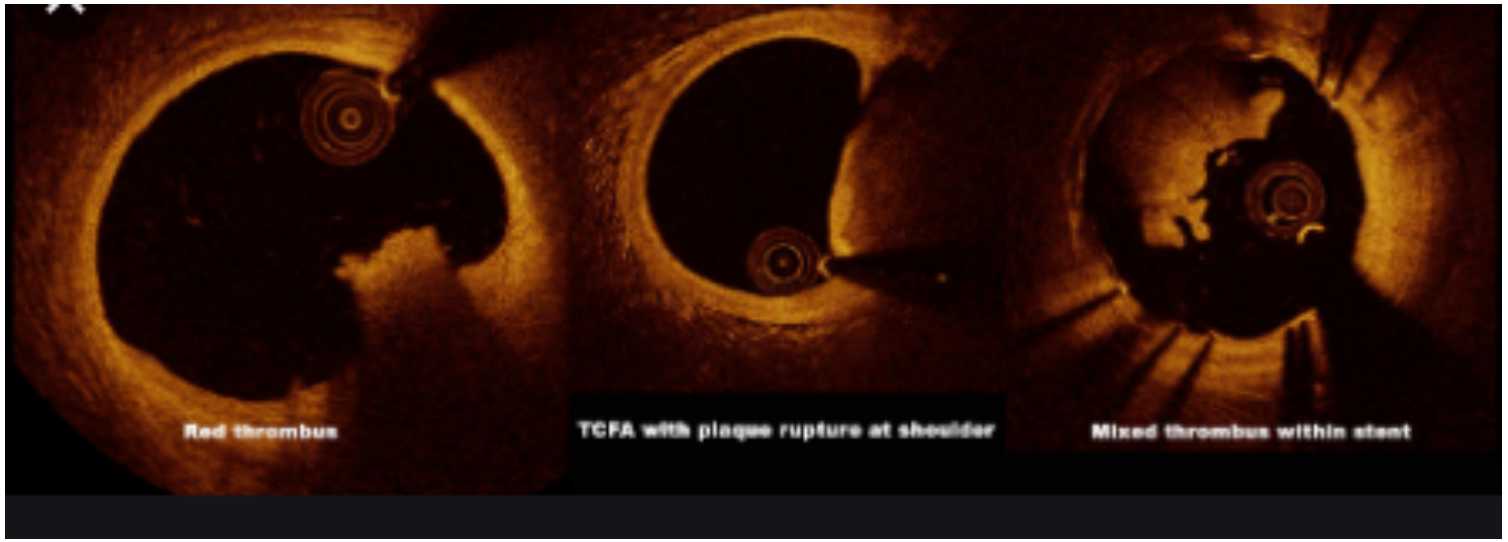

Increased cTn = myocardial injury[b]
Hypoxaemia
Anaemia
Clinical evidence of acute ischaemic myocardial injury = myocardial infarction[c]
Hypotension/ shock
Ventricular tachyarrhythmia
Kidney disease
Heart failure

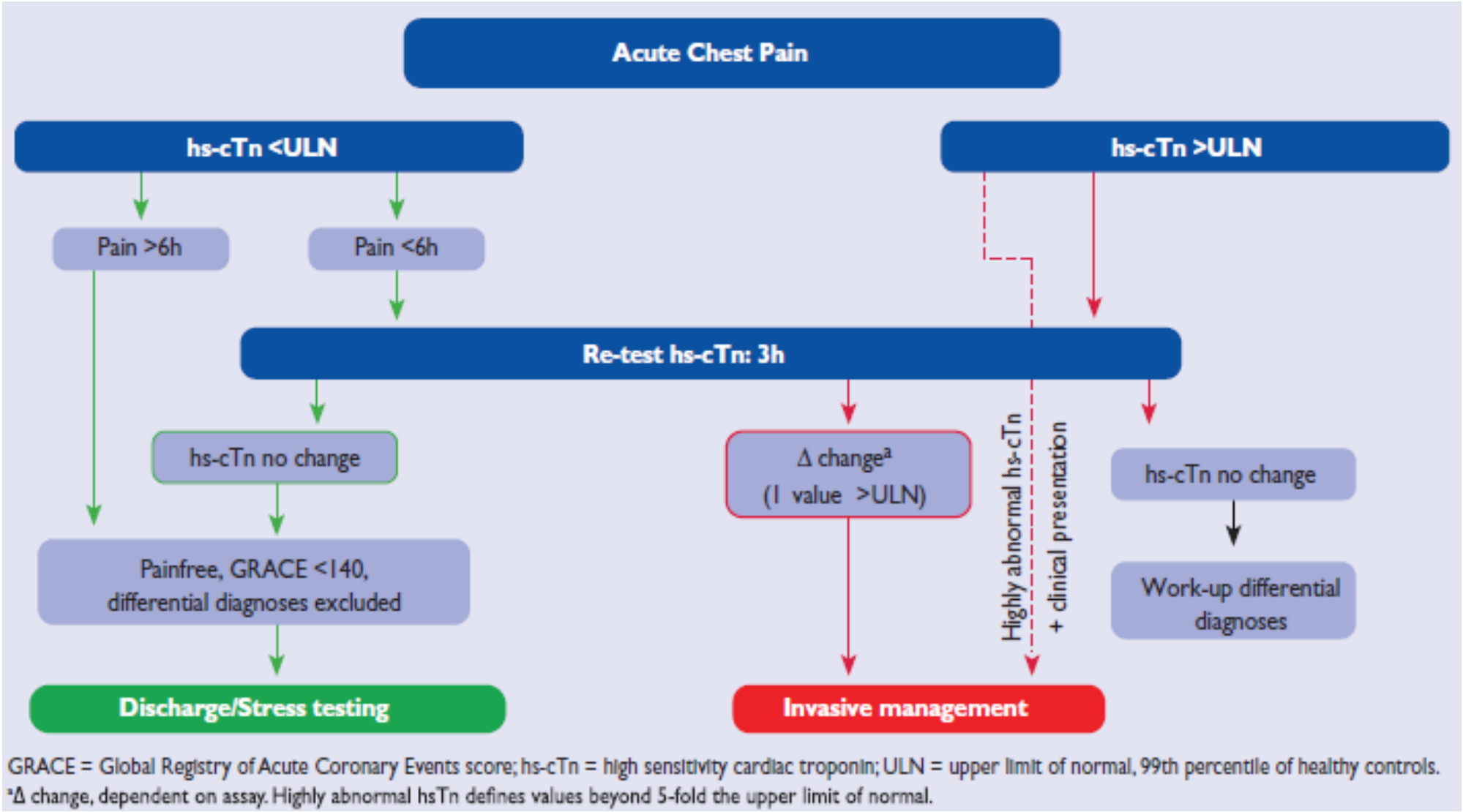

Very early sampling
Early sampling
Later sampling
Very late sampling
Rising cTn values from below to >99th percentile Delta is detectable
cTn values >99th percentile Delta may not be seen over a short period
cTn values >99th percentile Declining delta
Low cTn values Hard to detect delta
Cardiac Troponin (cTn)
Acute myocardial infarction
Chronic myocardial injury
99th percentile URL
Time from onset of symptoms (hours)
©ESC/ACC/AHA/WHF 2018

Compared with standard cardiac troponin assays, high-sensitivity assays:
• Have higher negative predictive value for acute MI.
• Reduce the "troponin-blind" interval leading to earlier detection of acute MI.
• Result in a ~4% absolute and ~20% relative increase in the detection of type 1 MI and a corresponding decrease in the diagnosis of unstable angina.
• Are associated with a 2-fold increase in the detection of type 2 MI.
Levels of high-sensitivity cardiac troponin should be interpreted as quantitative markers of cardiomyocyte damage (i.e. the higher the level, the greater the likelihood of MI):
• Elevations beyond 5-fold the upper reference limit have high (>90%) positive predictive value for acute type 1 MI.
• Elevations up to 3-fold the upper reference limit have only limited (50–60%) positive predictive value for acute MI and may be associated with a broad spectrum of conditions.
• It is common to detect circulating levels of cardiac troponin in healthy individuals.
Rising and/or falling cardiac troponin levels differentiate acute from chronic cardiomyocyte damage (the more pronounced the change, the higher the likelihood of acute MI).

Non ST elevation MI (NSTEMI)
ST elevation MI (STEMI)

PRICIPLES OF MANAGEMENT





GRACE = Global Registry of Acute Coronary Events score; hs-cTn = high sensitivity cardiac troponin; ULN = upper limit of normal, 99th percentile of healthy controls.
[a]Δ change, dependent on assay. Highly abnormal hsTn defines values beyond 5-fold the upper limit of normal.

The greatest challenge is the integration of clinical presentation with information derived from ECG, troponin assessment and imaging modalities into a standardised management strategy

GRACE SCORE: Accurate stratification of risk both on admission and at discharge. (GRACE 2.0 risk calculator) > 120

TIMI risk score

CRUSADE SCORE:
HASBLED SCORE

BLEEDING RISK

Results

Please answer all questions. The results will be computed once all questions are answered.

About this tool

The GRACE 2.0 ACS Risk Calculator implements the revised GRACE algorithms for predicting death or death/myocardial infarction following an initial acute coronary syndrome (ACS).

GRACE (the Global Registry of Acute Coronary Events) is an international observational programme of outcomes for patients who were hospitalized with an ACS in the 10 years from 1999. GRACE includes nearly 250 hospitals in 30 countries, and enrolled a total of 102,341 patients. Participating physicians receive confidential quarterly reports showing their outcomes side by side with the aggregate outcomes of all participating hospitals. The GRACE Risk Score has been extensively validated prospectively and externally.

Variables measured include age, heart rate, systolic blood pressure, renal function, congestive heart failure, ST-segment deviation, cardiac arrest and elevated biomarkers, which together provide more than 90% of the accuracy of the complete multivariable prediction model.

RISK STRATIFICATION FOR UAP/NSTEMI

GRACE

- AGE
- HEART RATE
- BLOOD PRESSURE
- SERUM CREAT
- KILLIP HF CLASS
- CARDIAC ARREST
- INITIAL ENZYMES
- ST DEVIATION

TIMI

- AGE</> 65
- RISK FACTORS
- >0.5 MM ST DEVIATION
- CHEST PAIN<24 HRS AGO
- POSITIVE BIOMARKER
- USE OF ASPRIN IN LAST 7 DAYS

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

IMMEDIATE INTERVENTION

High-risk criteria

- Rise or fall in cardiac troponin compatible with MI
- Dynamic ST- or T-wave changes (symptomatic or silent)
- GRACE score >140

EARLY INTERVENTION
WITHIN 24-28 HRS

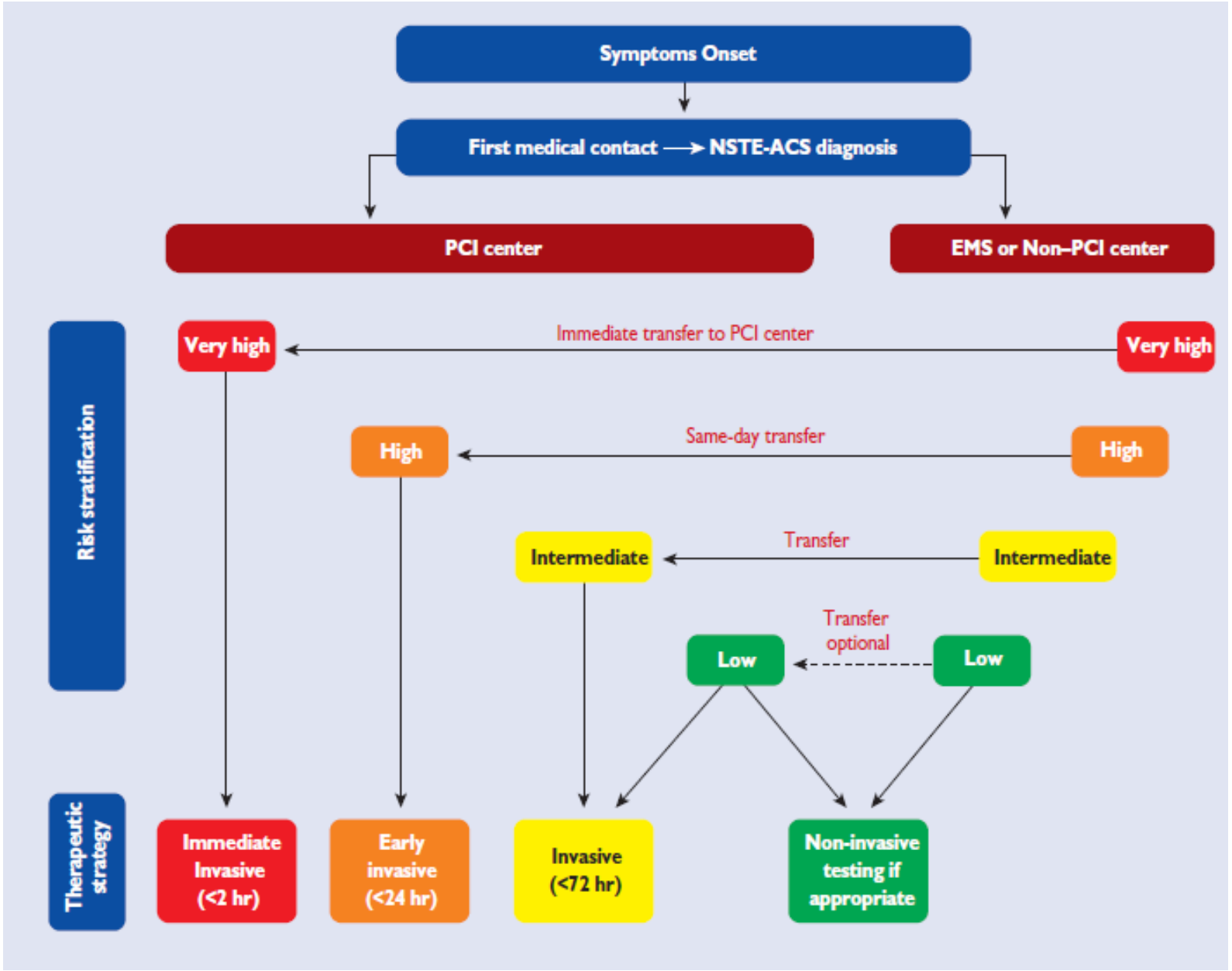
Intermediate-risk criteria

- Diabetes mellitus
- Renal insufficiency (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

INTERVENTION WITHIN 72 HOURS

Low-risk criteria

- Any characteristics not mentioned above


Symptoms Onset
First medical contact → NSTE-ACS diagnosis
PCI center
EMS or Non–PCI center
Risk stratification
Very high
Immediate transfer to PCI center
Very high
High
Same-day transfer
High
Intermediate
Transfer
Intermediate
Transfer optional
Low
Low
Therapeutic strategy
Immediate Invasive (<2 hr)
Early invasive (<24 hr)
Invasive (<72 hr)
Non-invasive testing if appropriate

WHAT IS THE ROLE OF THE GENERAL PRACTITIONER ?

1. **DIAGNOSIS**
2. **INITIAL RISK STRATIFICATION**
3. **STABALIZATION**
4. **INITIATION OF MEDICAL THERAPY**

ANTI-THROMBOTIC THERAPY

1) ANTIPLATELET AGENTS (DUAL ANTIPLATELET THERAPY)

ASPRIN + P2Y12 INHBITOR

2) ANTICOAGULATION

3) INTRAVENOUS ANTIPLATELET THERAPY (ANTI-IIb/IIIa)

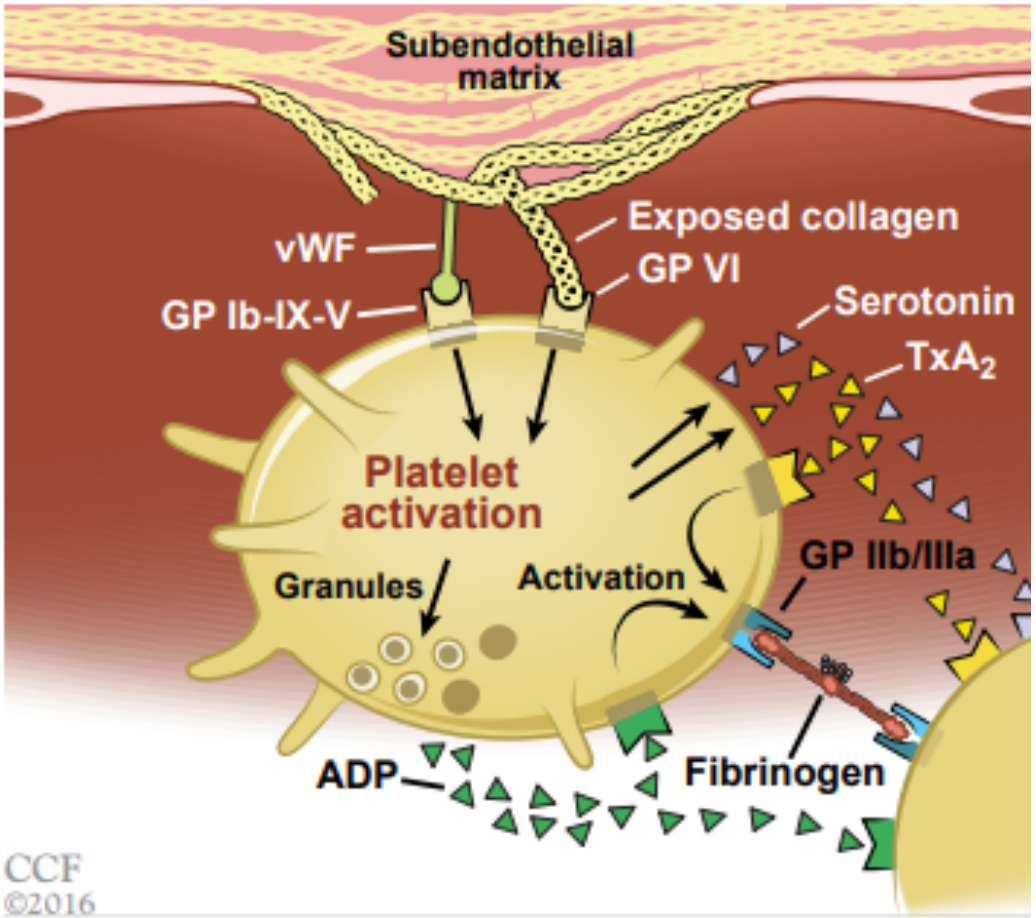
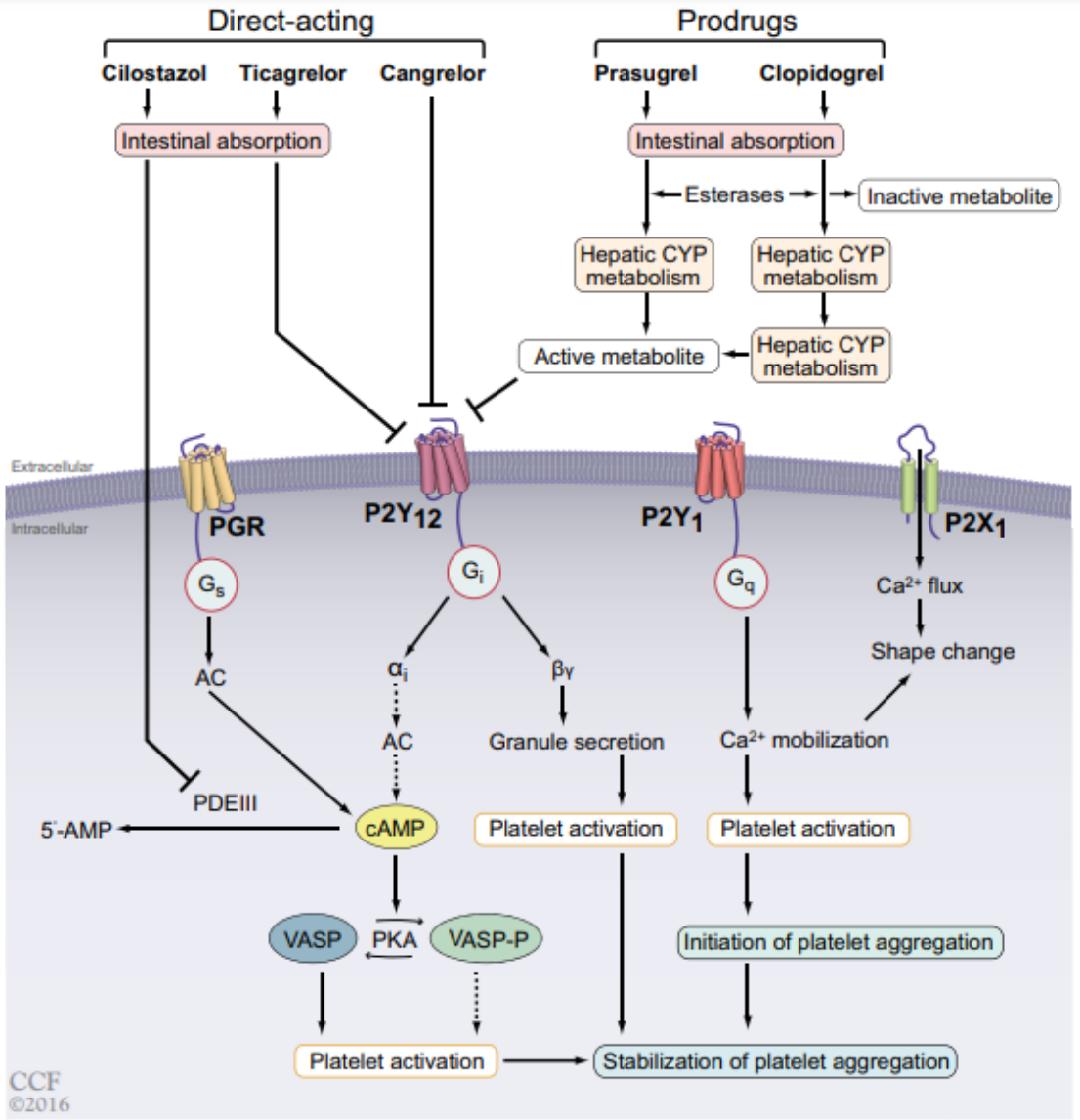


FIGURE 1. The platelet aggregation cascade. Exposure of subendothelial matrix leads to adhesion of platelets to th vessel wall, activation, and aggregation.

ADP = adenosine diphosphate; GP = glycoprotein; TxA_2 = thromboxane A_2; vWF = von Willebrand factor



ANTIPLATELET TRIALS

ARCTIC-Interruption—Assessment by a Double Randomisation of a Conventional Antiplatelet Strategy Versus a Monitoring-Guided Strategy for Drug-Eluting Stent Implantation and of Treatment Interruption Versus Continuation 1 Year After Stenting[46]

CAPRIE—Clopidogrel vs Aspirin in Patients at Risk of Ischemic Events[25]

CHARISMA—Clopidogrel for High Atherothrombotic Risk and Ischemic Stabilization, Management, and Avoidance[36–38]

CLARITY-TIMI 28—Clopidogrel as Adjunctive Reperfusion Therapy-Thrombolysis in Myocardial Infarction[33,34]

COMMIT/CCS 2—Clopidogrel and Metoprolol in Myocardial Infarction Trial[35]

CREDO—Clopidogrel for the Reduction of Events During Observation[20]

CURE—Clopidogrel in Unstable Angina to Prevent Recurrent Ischemic Events[30–32]

DAPT—Dual Antiplatelet Therapy[3,48]

DES-LATE—Optimal Duration of Clopidogrel Therapy With DES to Reduce Late Coronary Arterial Thrombotic Event[47]

Dutch Stent Thrombosis Registry[14,15]

EXCELLENT—Efficacy of Xience/Promus Versus Cypher to Reduce Late Loss After Stenting[41]

OPTIMIZE—Optimized Duration of Clopidogrel Therapy Following Treatment With the Zotarolimus-Eluting Stent in Real-World Clinical Practice[42]

PEGASUS-TIMI 54—Prevention of Cardiovascular Events in Patients With Prior Heart Attack Using Ticagrelor Compared to Placebo on a Background of Aspirin–Thrombolysis in Myocardial Infarction 54[39]

PLATO—Study of Platelet Inhibition and Patient Outcomes[23]

PRODIGY—Prolonging Dual Antiplatelet Treatment After Grading Stent-Induced Intimal Hyperplasia[45]

RESET—Real Safety and Efficacy of 3-Month Dual Antiplatelet Therapy Following Endeavor Zotarolimus-Eluting Stent Implantation[43]

SECURITY—Second Generation Drug-Eluting Stent Implantation Followed by Six- Versus Twelve-Month Dual Antiplatelet Therapy[40]

STARS—Stent Anticoagulation Restenosis Study[10]

TRITON-TIMI 38—Trial to Assess Improvement in Therapeutic Outcomes by Optimising Platelet Inhibition With Prasugrel[22]

WOEST—What is the Optimal Antiplatelet and Anticoagulant Therapy in Patients With Oral Anticoagulation and Coronary Stenting[49]

Antiplatelet agents

Drug	Metabolic activation	Reversibility	Time to peak activity	Elimination half-life	Duration of effect	Elimination	Dosage
Aspirin	By esterases in gastrointestinal mucosa	No	1–2 hours	3 hours	7–10 days	Renal	162–325 mg loading dose, then 81–162 mg daily
Clopidogrel	By CYP450	No	2–6 hours	6 hours	5–7 days	Renal and gastrointestinal	300–600 mg loading dose, then 75 mg daily
Prasugrel	By CYP450	No	0.5–4 hours	2–15 hours	5–9 days	Renal and gastrointestinal	60 mg loading dose, then 10 mg daily
Ticagrelor	No	Yes	0.5–2 hours	7–9 hours	3–5 days	Gastrointestinal and renal	180 mg loading dose, then 90 mg twice a day
Cangrelor	No	Yes	2–30 minutes	3–5 minutes	0–30 minutes	Renal and gastrointestinal	4 µg/kg/min intravenous infusion

	Clopidogrel	Prasugrel	Ticagrelor	Cangrelor
Chemical class	Thienopyridine	Thienopyridine	Cyclopentyl-triazolopyrimidine	Stabilized ATP analogue
Administration	Oral	Oral	Oral	Intravenous
Dose	300–600 mg orally then 75 mg a day	60 mg orally then 10 mg a day	180 mg orally then 90 mg twice a day	30 µg/kg bolus and 4 µg/kg/min infusion
Dosing in CKD				
• Stage 3 (eGFR 30–59 mL/min/1.73m^2)	No dose adjustment	No dose adjustment	No dose adjustment	No dose adjustment
• Stage 4 (eGFR 15–29 mL/min/1.73m^2)	No dose adjustment	No dose adjustment	No dose adjustment	No dose adjustment
• Stage 5 (eGFR <15 mL/min/1.73m^2)	Use only for selected indications (e.g. stent thrombosis prevention)	Not recommended	Not recommended	No dose adjustment
Binding reversibility	Irreversible	Irreversible	Reversible	Reversible
Activation	Prodrug, with variable liver metabolism	Prodrug, with predictable liver metabolism	Active drug, with additional active metabolite	Active drug
Onset of loading dose effect[a]	2–6 hours[b]	30 min[b]	30 min[b]	2 min
Duration of effect	3–10 days	7–10 days	3–5 days	1–2 hours
Withdrawal before surgery	5 days[c]	7 days[c]	5 days[c]	1 hour
Plasma half-life of active $P2Y_{12}$ inhibitor[d]	30–60 min	30–60 min[e]	6–12 hours	5–10 min
Inhibition of adenosine reuptake	No	No	Yes	Yes ('inactive' metabolite only)

	Clopidogrel	Prasugrel	Ticagrelor	Cangrelor
Chemical class	Thienopyridine	Thienopyridine	Cyclopentyl-triazolopyrimidine	Stabilized ATP analogue
Administration	Oral	Oral	Oral	Intravenous
Dose	300–600 mg orally then 75 mg a day	60 mg orally then 10 mg a day	180 mg orally then 90 mg twice a day	30 μg/kg bolus and 4 μg/kg/min infusion
Dosing in CKD				
• Stage 3 (eGFR 30–59 mL/min/1.73m^2)	No dose adjustment	No dose adjustment	No dose adjustment	No dose adjustment
• Stage 4 (eGFR 15–29 mL/min/1.73m^2)	No dose adjustment	No dose adjustment	No dose adjustment	No dose adjustment
• Stage 5 (eGFR <15 mL/min/1.73m^2)	Use only for selected indications (e.g. stent thrombosis prevention)	Not recommended	Not recommended	No dose adjustment
Binding reversibility	Irreversible	Irreversible	Reversible	Reversible
Activation	Prodrug, with variable liver metabolism	Prodrug, with predictable liver metabolism	Active drug, with additional active metabolite	Active drug
Onset of loading dose effect[a]	2–6 hours[b]	30 min[b]	30 min[b]	2 min
Duration of effect	3–10 days	7–10 days	3–5 days	1–2 hours
Withdrawal before surgery	5 days[c]	7 days[c]	5 days[c]	1 hour
Plasma half-life of active $P2Y_{12}$ inhibitor[d]	30–60 min	30–60 min[e]	6–12 hours	5–10 min
Inhibition of adenosine reuptake	No	No	Yes	Yes ('inactive' metabolite only)

Drug	Recommendations		
	Normal renal function or stage 1–3 CKD (eGFR ≥30 mL/min/1.73m²)	Stage 4 CKD (eGFR 15–29 mL/min/1.73m²)	Stage 5 CKD (eGFR <15 mL/min/1.73m²)
Unfractionated heparin	• Prior to coronary angiography: 60–70 IU/kg i.v. (max 5000 IU) and infusion (12–15 IU/kg/h) (max 1000 IU/h), target aPTT 1.5–2.5x control • During PCI according to ACT or 70–100 IU/kg i.v. in patients not anticoagulated (50–70 IU/kg if concomitant with GPIIb/IIIa inhibitors)	No dose adjustment	No dose adjustment
Enoxaparin	1 mg/kg s.c. twice a day	1 mg/kg s.c. once a day	Not recommended
Fondaparinux	2.5 mg s.c. once a day	Not recommended if eGFR <20 mL/min/1.73m²	Not recommended
Bivalirudin	Bolus 0.75 mg/kg i.v., infusion 1.75 mg/kg/h*	Not recommended	Not recommended

ANTICOAGULATION

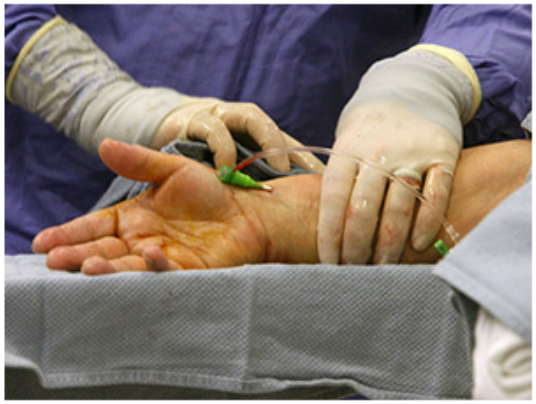
DO NOT SWITCH ANTICOAGULATION BEFORE PCI

Arixtra 2.5 mg SC daily

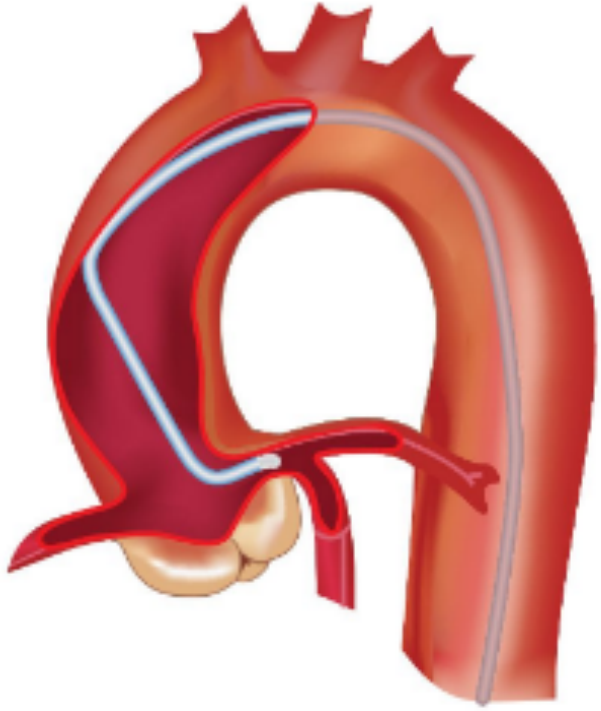
FONDAPARINUX VS CLEXANE

OASIS-5 TRIAL

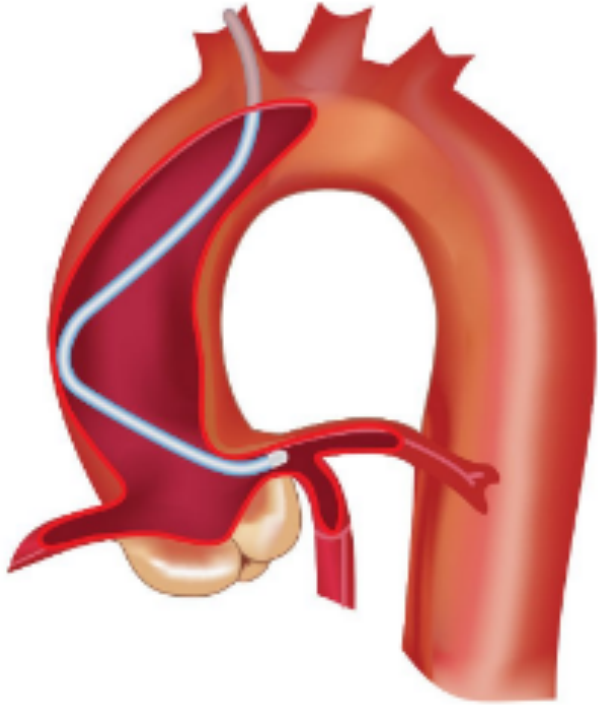
CORONARY ANGIOGRAPHY



Radial artery access being used to perform transradial cardiac catheterization

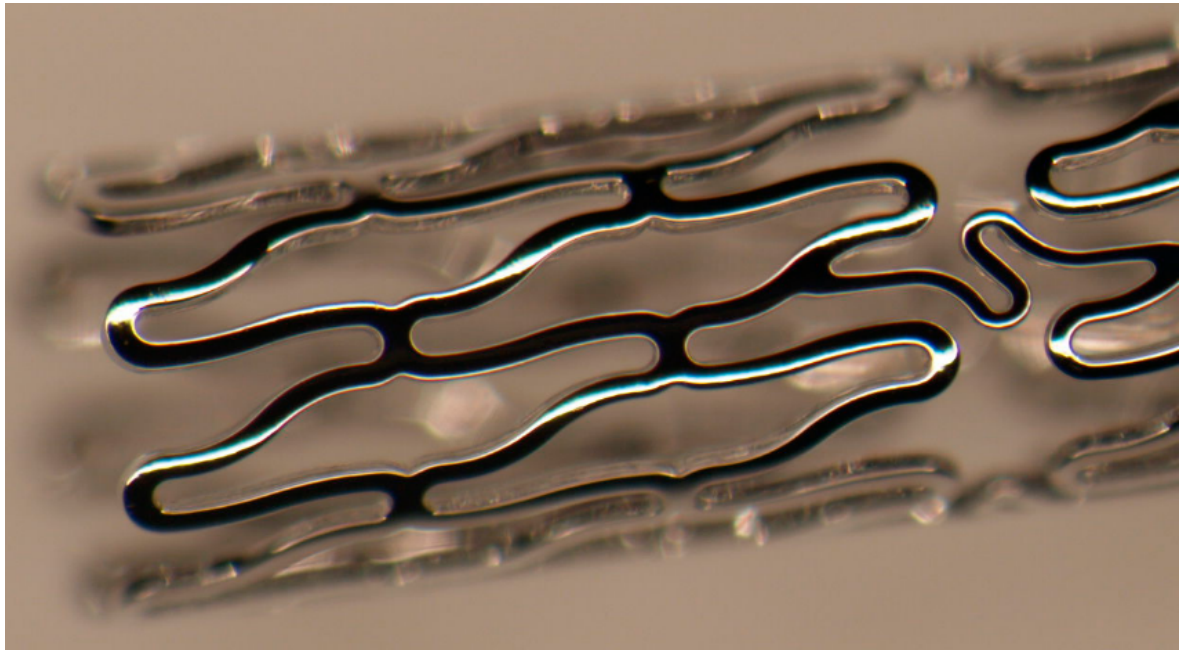


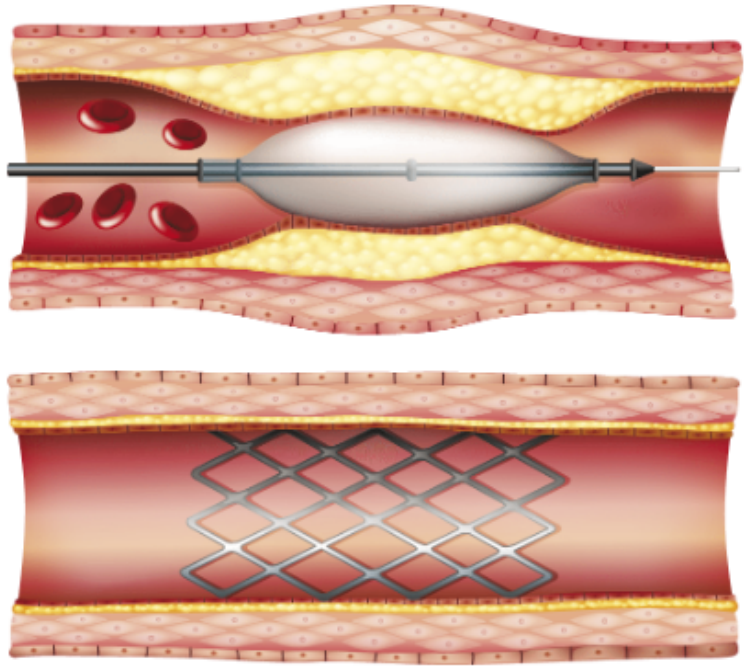
A



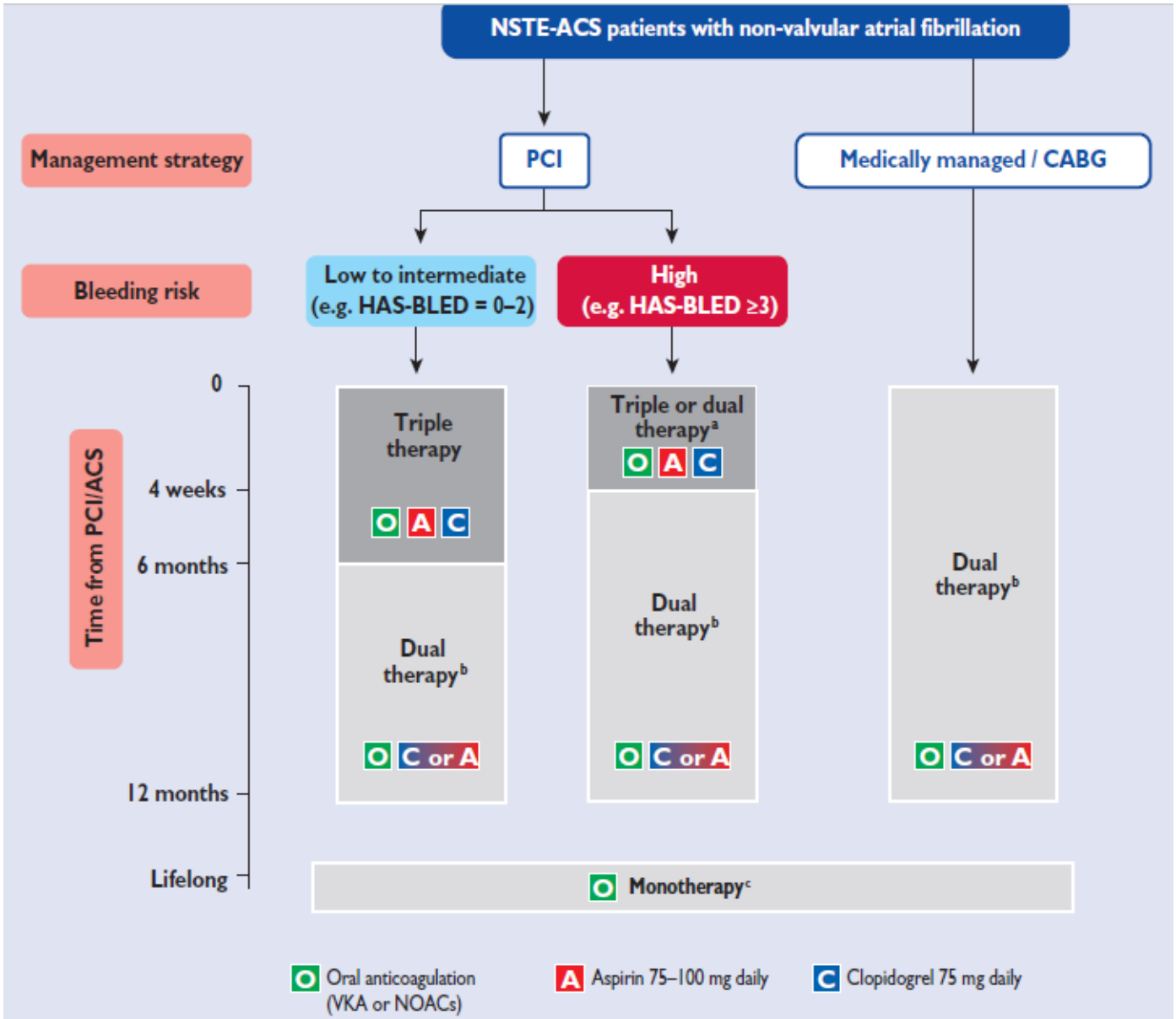
B

PERCUTANEOUS CORONARY INTERVENTION





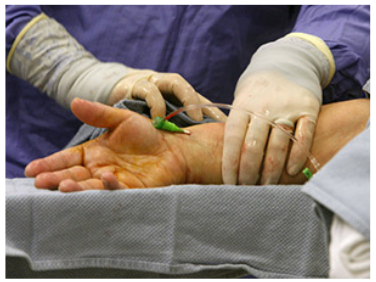
WHAT ABOUT PATIENTS ON ORAL ANTICOAGULANTS ?


NSTE-ACS patients with non-valvular atrial fibrillation
Management strategy
PCI
Medically managed / CABG
Bleeding risk
Low to intermediate (e.g. HAS-BLED = 0–2)
High (e.g. HAS-BLED ≥3)
Time from PCI/ACS
0
4 weeks
6 months
12 months
Lifelong
Triple therapy
O A C
Dual therapy[b]
O C or A
Triple or dual therapy[a]
O A C
Dual therapy[b]
O C or A
Dual therapy[b]
O C or A
Monotherapy[c]
O Oral anticoagulation (VKA or NOACs)
A Aspirin 75–100 mg daily
C Clopidogrel 75 mg daily

Suggested strategies to reduce bleeding risk related to PCI

1) RADIAL APPROACH

2) ADD A PROTON PUMP INHIBITOR

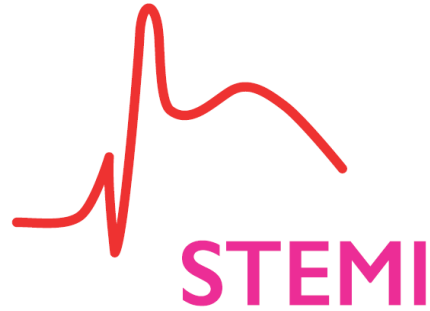


Radial artery access being used to perform transradial cardiac catheterization

- In patients on OAC
  - PCI performed without interruption of VKAs or NOACs.
  - In patients on VKAs, do not administer UFH if INR value >2.5.
  - In patients on NOACs, regardless of the timing of the last administration of NOACs, add additional low-dose parenteral anticoagulation (e.g. enoxaparin 0.5 mg/kg i.v. or UFH 60 IU/kg).
  - Aspirin indicated but avoid pretreatment with $P2Y_{12}$ inhibitors.
  - GPIIb/IIIa inhibitors only for bailout of periprocedural complications.

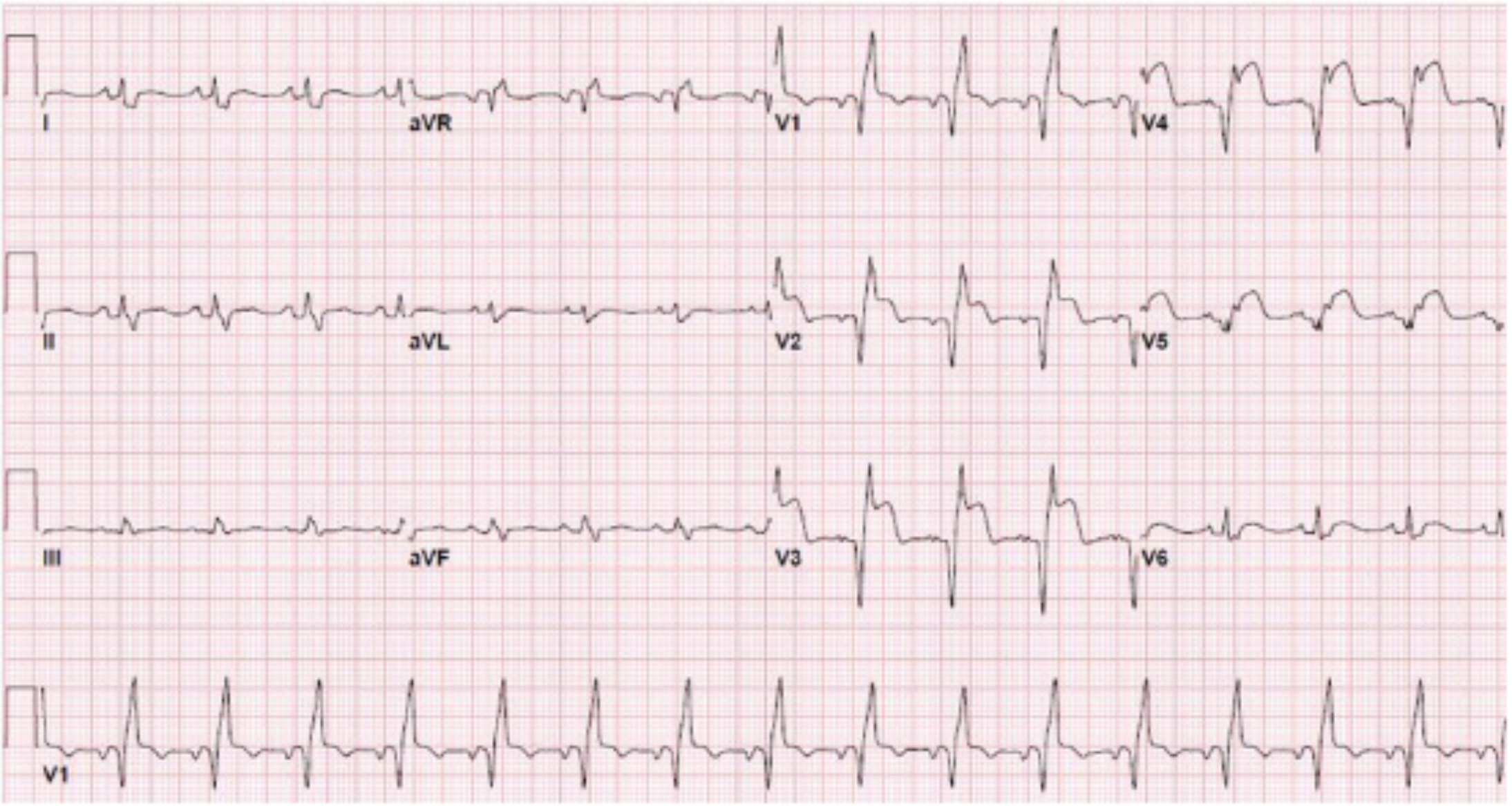
EVIDENCE-BASEDPERFORMANCE MEASURES

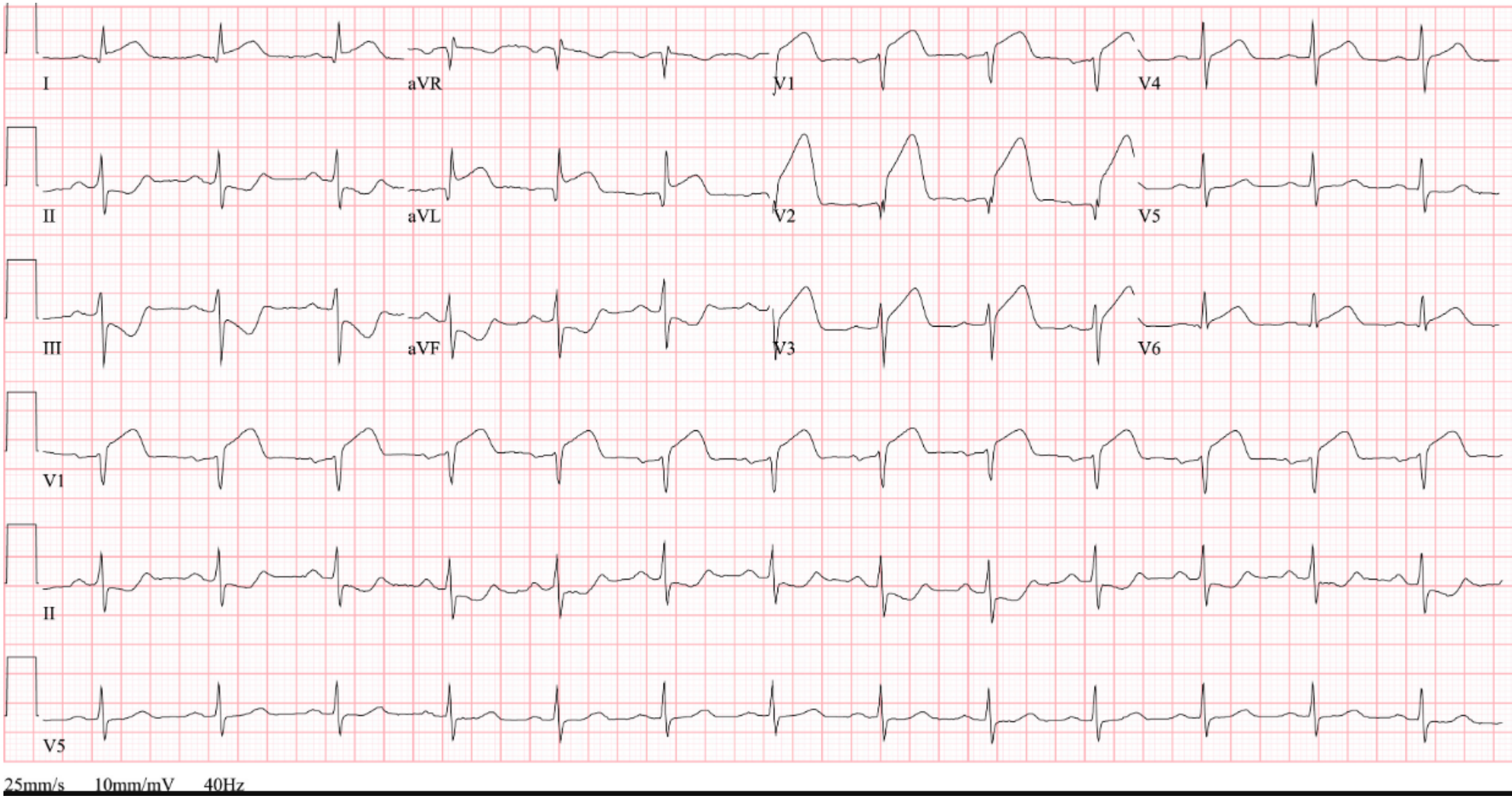
- Use of aspirin
- Use of ticagrelor/prasugrel/clopidogrel
- Use of fondaparinux/bivalirudin/UFH/enoxaparin
- Use of beta-blocker at discharge in patients with LV dysfunction
- Use of statins
- Use of ACE-inhibitor or ARB in patients with systolic LV dysfunction or heart failure, hypertension or diabetes
- Use of early invasive procedures in intermediate- to high-risk patients
- Smoking cessation advice/counselling
- Enrolment in a secondary prevention/ cardiac rehabilitation programme
- Development of regional and/or national programmes to measure performance indicators systematically and provide feedback to individual hospitals

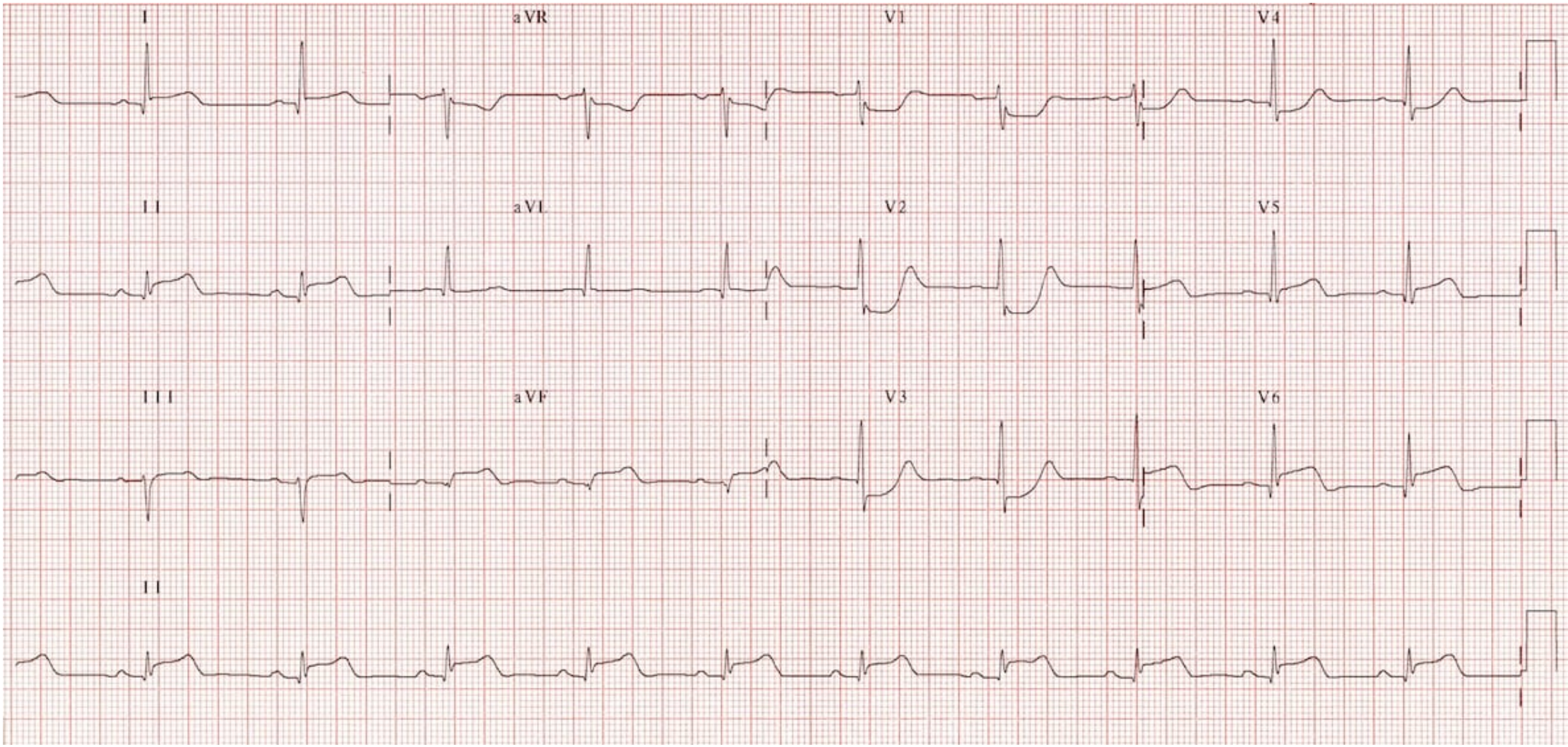


ST ELEVATION MYOCARDIAL INFARCTION

1. ST-segment elevation 2.5mm in men < 40 years, in leads V2–V3
2. 2mm in men > 40 years in leads V2–V3
3. 1.5mm in women in leads V2–V3
4. 1mm in the other leads [in the absence of left ventricular (LV) hypertrophy or left bundle branch block LBBB)].

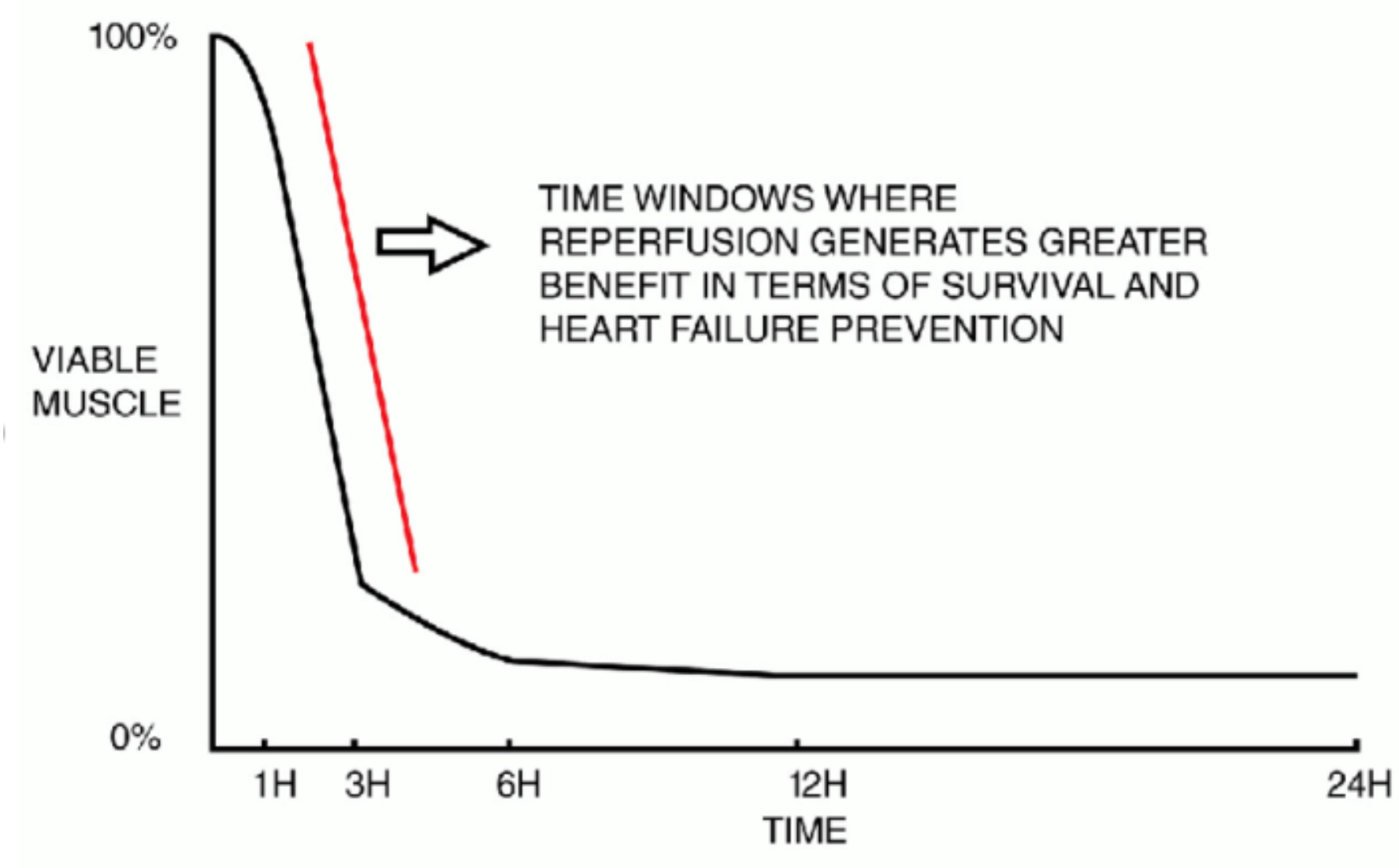

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
25mm/s 10mm/mV 40Hz

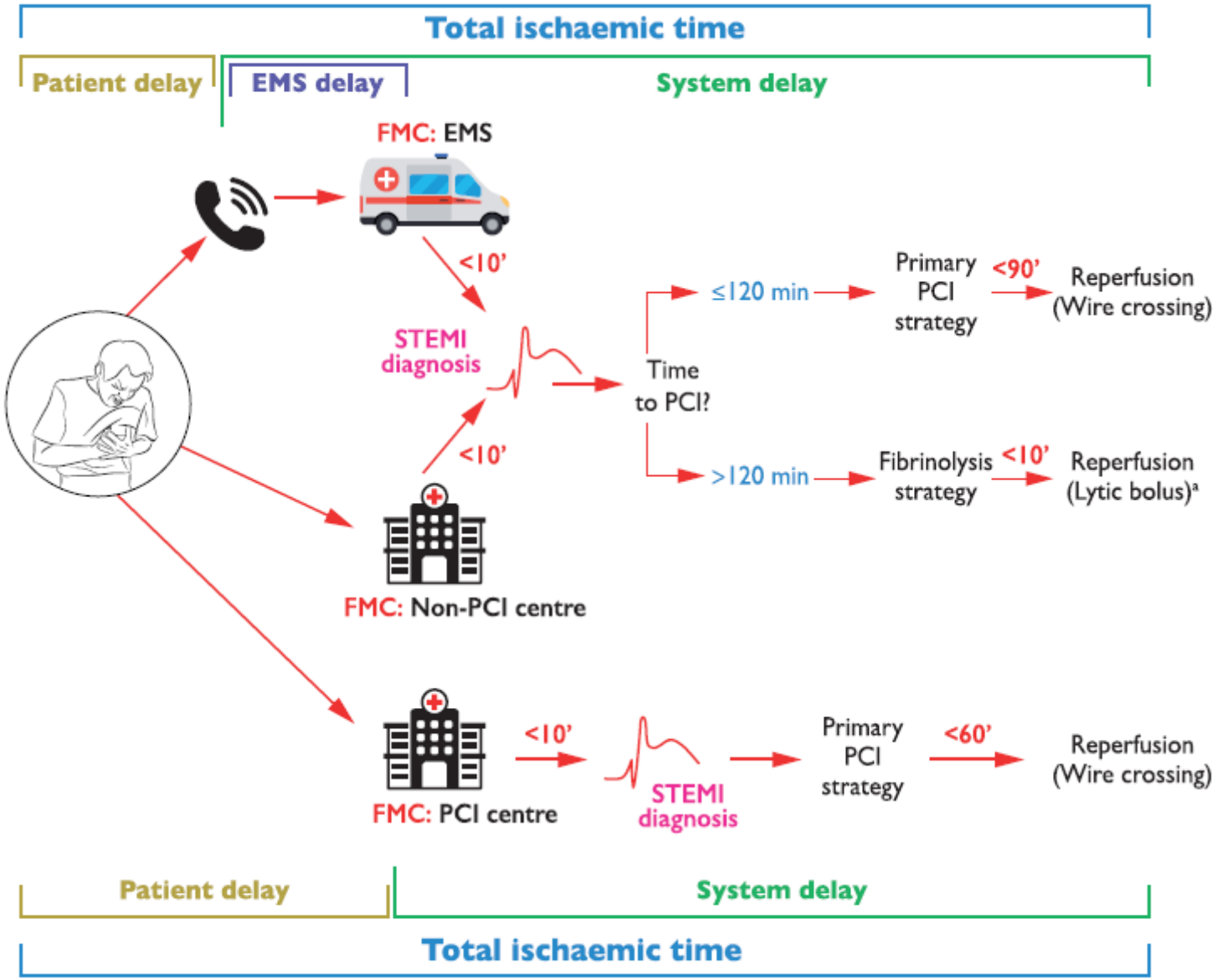

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

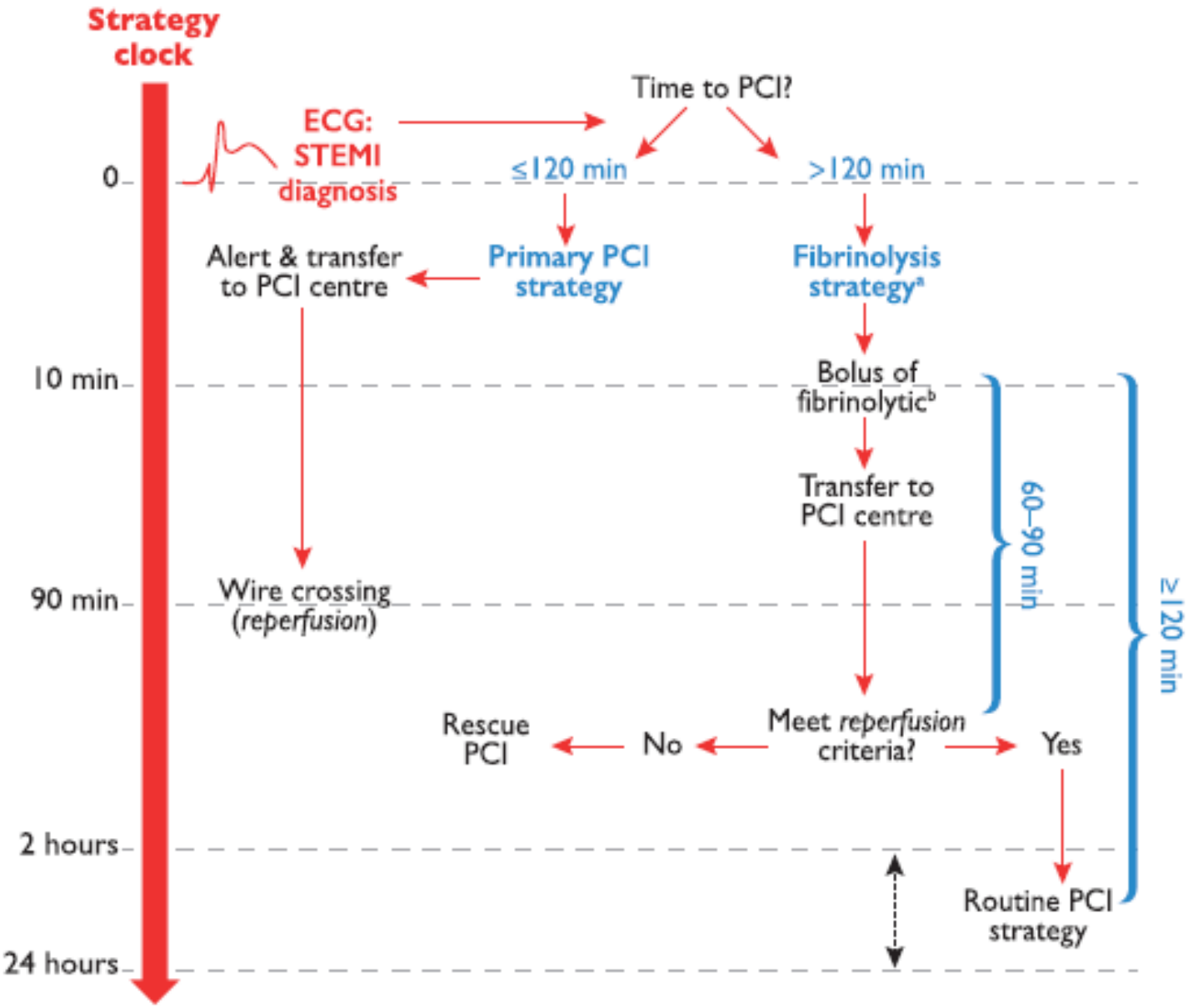
2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation

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



Relationship between time, extent of myocardial salvage, and mortality reduction.

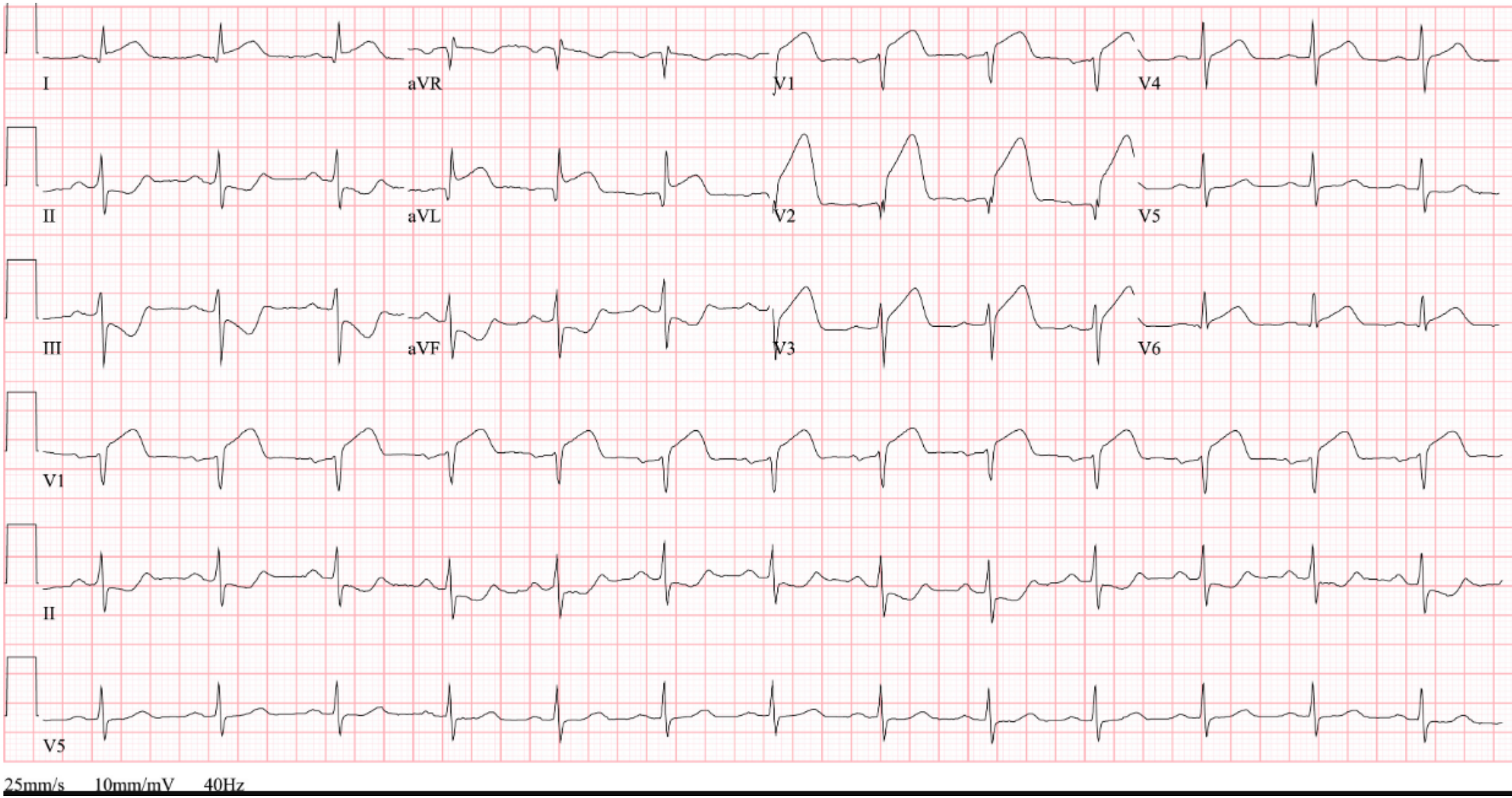

Total ischaemic time
Patient delay
EMS delay
System delay
FMC: EMS
<10'
STEMI diagnosis
Time to PCI?
≤120 min
Primary PCI strategy
<90'
Reperfusion (Wire crossing)
>120 min
Fibrinolysis strategy
<10'
Reperfusion (Lytic bolus)a
<10'
FMC: Non-PCI centre
FMC: PCI centre
<10'
STEMI diagnosis
Primary PCI strategy
<60'
Reperfusion (Wire crossing)
Patient delay
System delay
Total ischaemic time

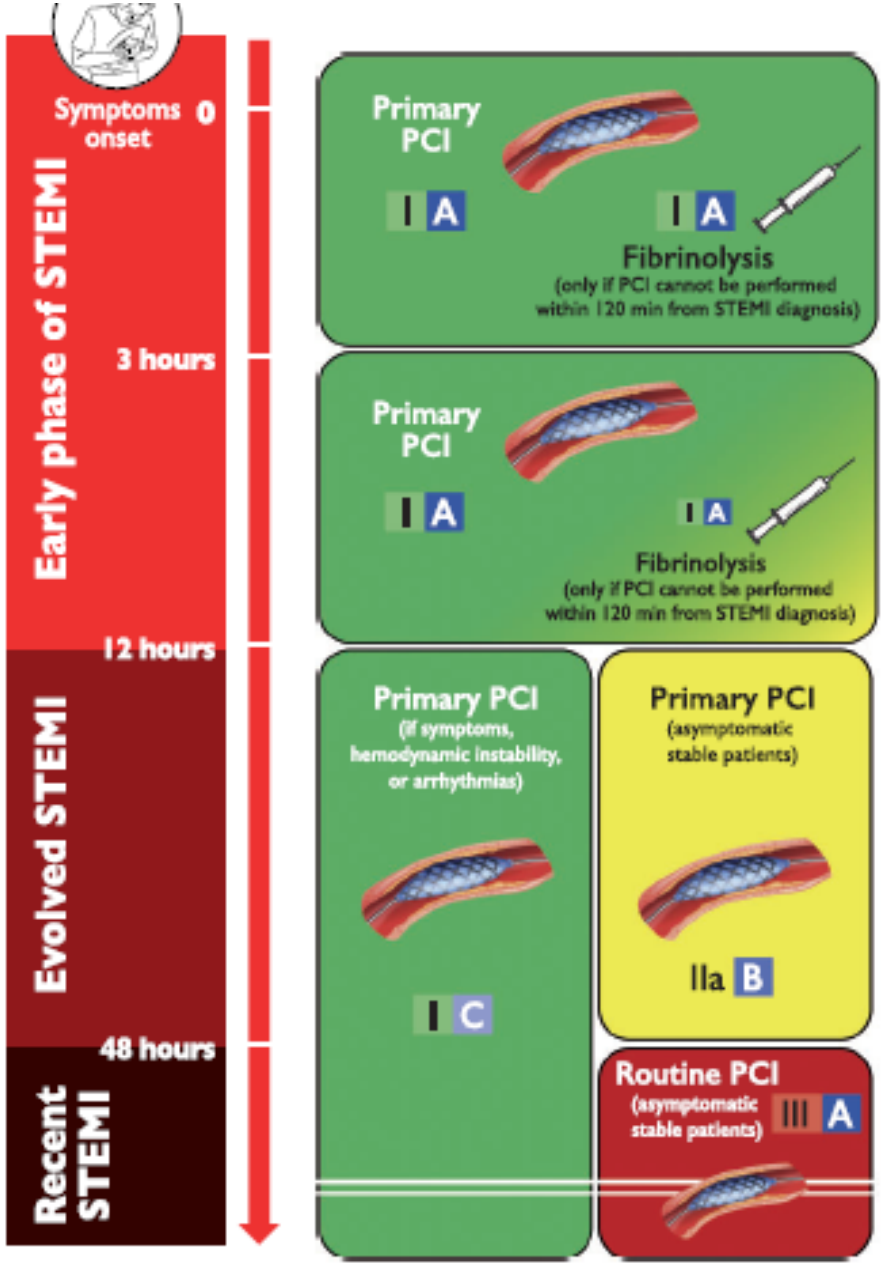

Strategy clock
ECG: STEMI diagnosis
Time to PCI?
≤120 min
>120 min
0
Alert & transfer to PCI centre
Primary PCI strategy
Fibrinolysis strategy[a]
10 min
Bolus of fibrinolytic[b]
Transfer to PCI centre
60–90 min
≥120 min
90 min
Wire crossing (reperfusion)
Rescue PCI
No
Meet reperfusion criteria?
Yes
2 hours
Routine PCI strategy
24 hours

ER MANAGEMENT (ACLS/ABC)

ECG monitoring		
12-lead ECG recording and interpretation is indicated as soon as possible at the point of FMC, with a maximum target delay of 10 min.[36,38]	I	B
ECG monitoring with defibrillator capacity is indicated as soon as possible in all patients with suspected STEMI.[44,45]	I	B

Recommendations	Class[a]	Level[b]
Hypoxia		
Oxygen is indicated in patients with hypoxaemia (SaO_2 < 90% or PaO_2 < 60 mmHg).	I	C
Routine oxygen is not recommended in patients with $SaO_2 \geq 90\%$.[64–66]	III	B
Symptoms		
Titrated i.v. opioids should be considered to relieve pain.	IIa	C
A mild tranquillizer (usually a benzodiazepine) should be considered in very anxious patients.	IIa	C


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
25mm/s 10mm/mV 40Hz


Symptoms onset
0
Early phase of STEMI
3 hours
Evolved STEMI
12 hours
Recent STEMI
48 hours
Primary PCI
I A
I A
Fibrinolysis
(only if PCI cannot be performed within 120 min from STEMI diagnosis)
Primary PCI
I A
I A
Fibrinolysis
(only if PCI cannot be performed within 120 min from STEMI diagnosis)
Primary PCI
(if symptoms, hemodynamic instability, or arrhythmias)
I C
Primary PCI
(asymptomatic stable patients)
IIa B
Routine PCI
(asymptomatic stable patients)
III A

Doses of antiplatelet and parenteral anticoagulant co-therapies in primary PCI

Antiplatelet therapies	
Aspirin	Loading dose of 150–300 mg orally or of 75–250 mg i.v. if oral ingestion is not possible, followed by a maintenance dose of 75–100 mg/day
Clopidogrel	Loading dose of 600 mg orally, followed by a maintenance dose of 75 mg/day
Prasugrel	Loading dose of 60 mg orally, followed by a maintenance dose of 10 mg/day
Ticagrelor	Loading dose of 180 mg orally, followed by a maintenance dose of 90 mg *b.i.d.*

WHEN ANTICIPATING PRIMARY PCI

Parenteral anticoagulant therapies	
UFH	70–100 IU/kg i.v. bolus when no GP IIb/IIIa inhibitor is planned 50–70 IU/kg i.v. bolus with GP IIb/IIIa inhibitors
Enoxaparin	0.5 mg/kg i.v. bolus
Bivalirudin	0.75 mg/kg i.v. bolus followed by i.v. infusion of 1.75 mg/kg/hour for up to 4 hours after the procedure

IF NO PRIMARY PCI

ECG: STEMI diagnosis

Alert & transfer to PCI centre

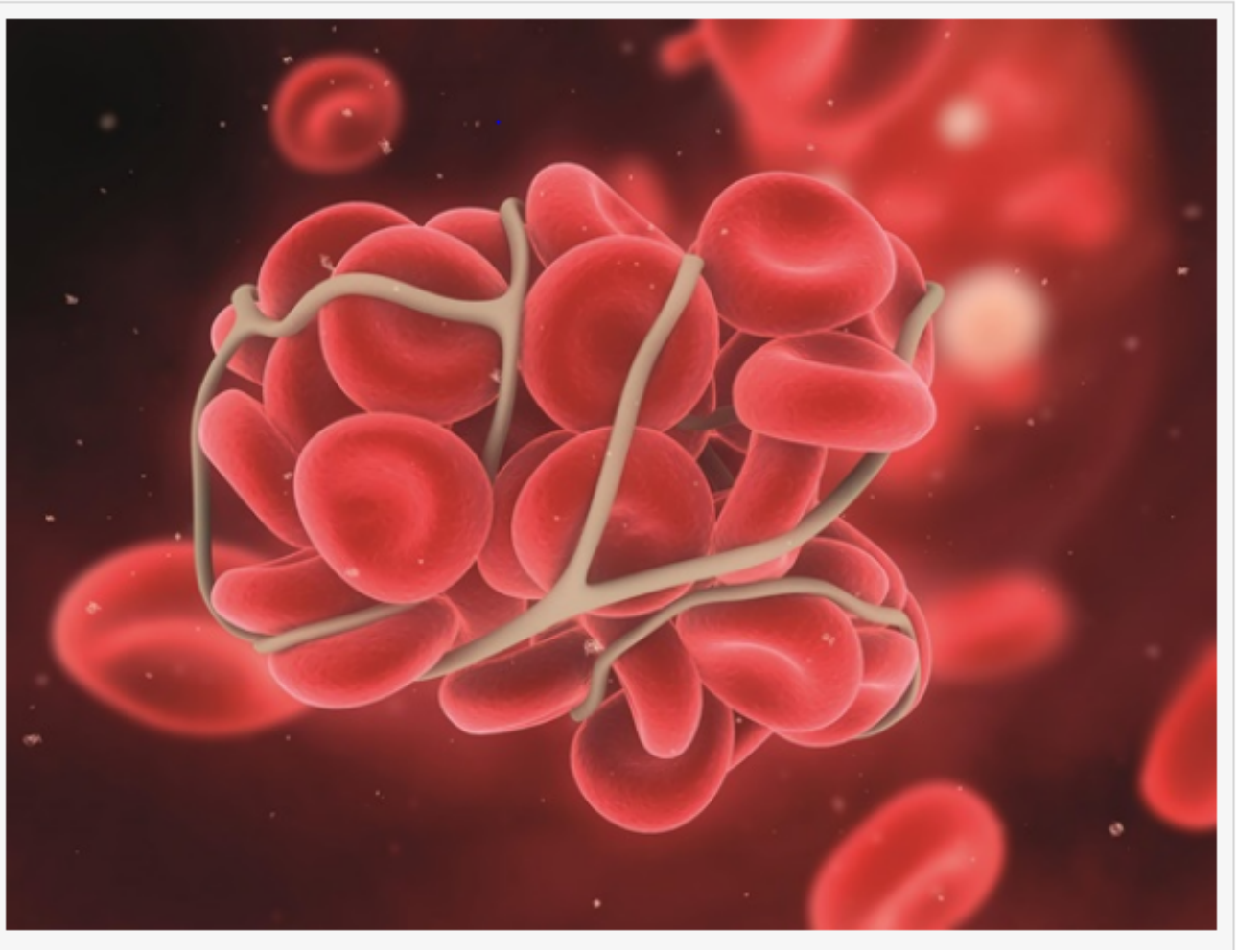
>120 min

Fibrinolysis strategy[a]

Bolus of fibrinolytic[b]

Transfer to PCI centre

Streptokinase, the first thrombolytic drug to reach the market, achieved fame as the iconic clot buster.



- Discovered in 193(
- 1945: VTE Rx
- 1980's: AMI
- ISIS TRIALS
- ASA RR 25%
- STREP RR 25%

The Pharmaceutical Journal | 18 JUL 2014 | By Jenny Bryan

FIBRINOLYTICS

Drug	Initial treatment
Doses of fibrinolytic therapy	
Streptokinase	1.5 million units over 30–60 min i.v.
Alteplase (tPA)	15 mg i.v. bolus 0.75 mg/kg i.v. over 30 min (up to 50 mg) then 0.5 mg/kg i.v. over 60 min (up to 35 mg)
Reteplase (rPA)	10 units + 10 units i.v. bolus given 30 min apart
Tenecteplase (TNK-tPA)	Single i.v. bolus: 30 mg (6000 IU) if <60 kg 35 mg (7000 IU) if 60 to <70 kg 40 mg (8000 IU) if 70 to <80 kg 45 mg (9000 IU) if 80 to <90 kg 50 mg (10000 IU) if ≥90 kg It is recommended to reduce to half-dose in patients ≥75 years of age.

tenecteplase tissue plasminogen activator (TNK-tPA) is equivalent to accelerated tPA in reducing 30 day mortality, but is
safer in preventing non-cerebral bleeds and blood transfusion, and is easier to use in the pre-hospital setting

Comparison of fibrinolytic agents

1. Tenecteplase tissue plasminogen activator (TNK-tPA) is equivalent to accelerated tPA in reducing 30 day mortality,

2. TNK is safer compared to TPA in preventing non-cerebral bleeds and blood transfusion, and is easier to use in the pre-hospital setting

ANTICOAGULANT CO-THERAPIES

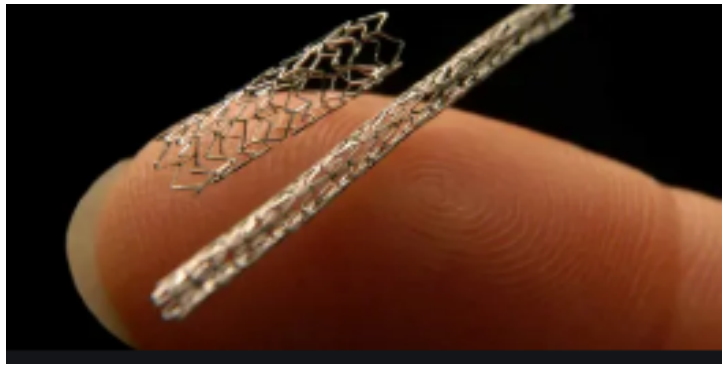
Doses of anticoagulant co-therapies	
Enoxaparin	In patients <75 years of age: 30 mg i.v. bolus followed 15 min later by 1 mg/kg s.c. every 12 hours until revascularization or hospital discharge for a maximum of 8 days. The first two s.c. doses should not exceed 100 mg per injection. In patients ≥75 years of age: no i.v. bolus; start with first s.c. dose of 0.75 mg/kg with a maximum of 75 mg per injection for the first two s.c. doses. In patients with eGFR <30 mL/min/1.73 m^2, regardless of age, the s.c. doses are given once every 24 hours.
UFH	60 IU/kg i.v. bolus with a maximum of 4000 IU followed by an i.v. infusion of 12 IU/kg with a maximum of 1000 IU/hour for 24–48 hours. Target aPTT: 50–70 s or 1.5 to 2.0 times that of control to be monitored at 3, 6, 12 and 24 hours.
Fondaparinux (only with streptokinase)	2.5 mg i.v. bolus followed by a s.c. dose of 2.5 mg once daily up to 8 days or hospital discharge.

CONTRAINDICATIONS

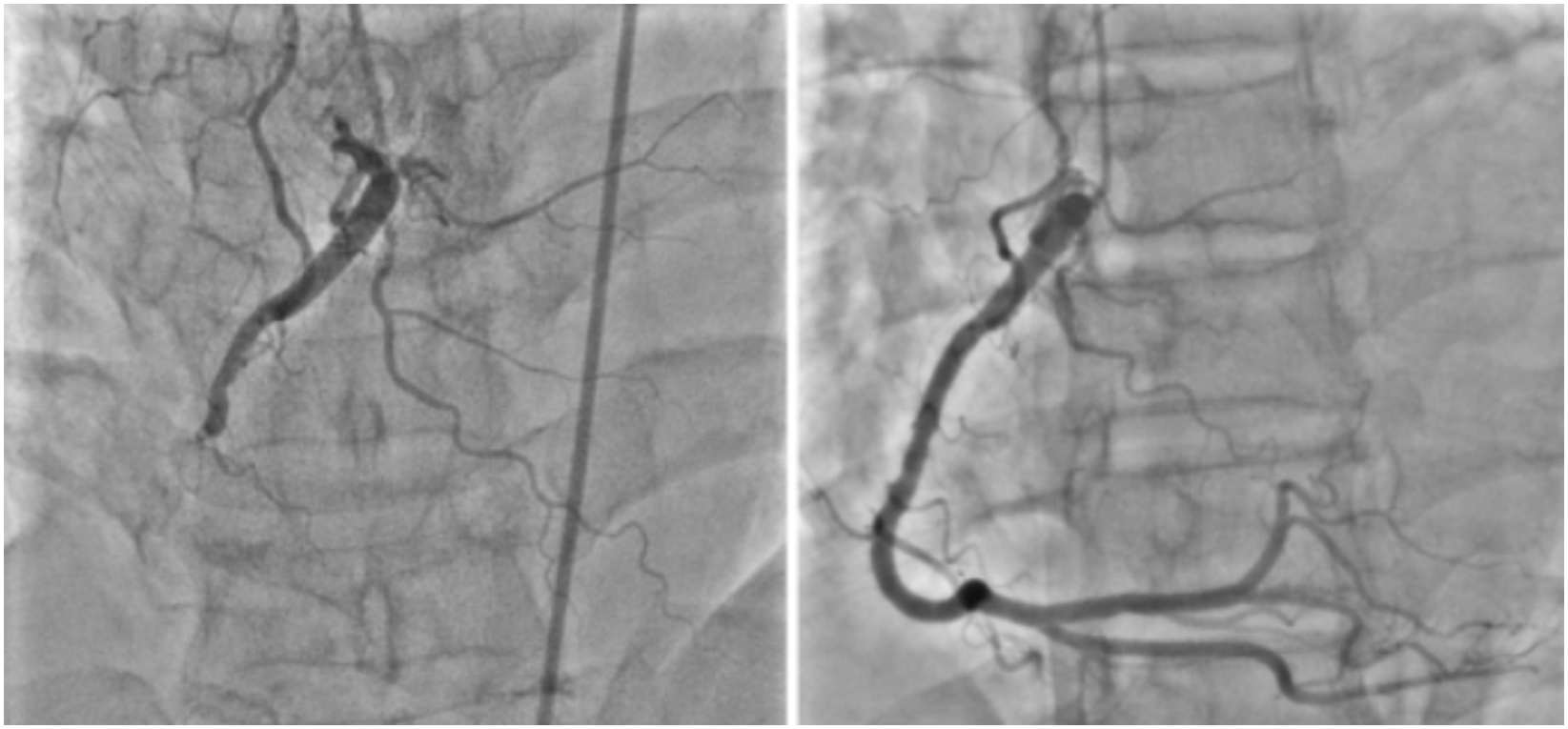
Absolute
Previous intracranial haemorrhage or stroke of unknown origin at anytime
Ischaemic stroke in the preceding 6 months
Central nervous system damage or neoplasms or arteriovenous malformation
Recent major trauma/surgery/head injury (within the preceding month)
Gastrointestinal bleeding within the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

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

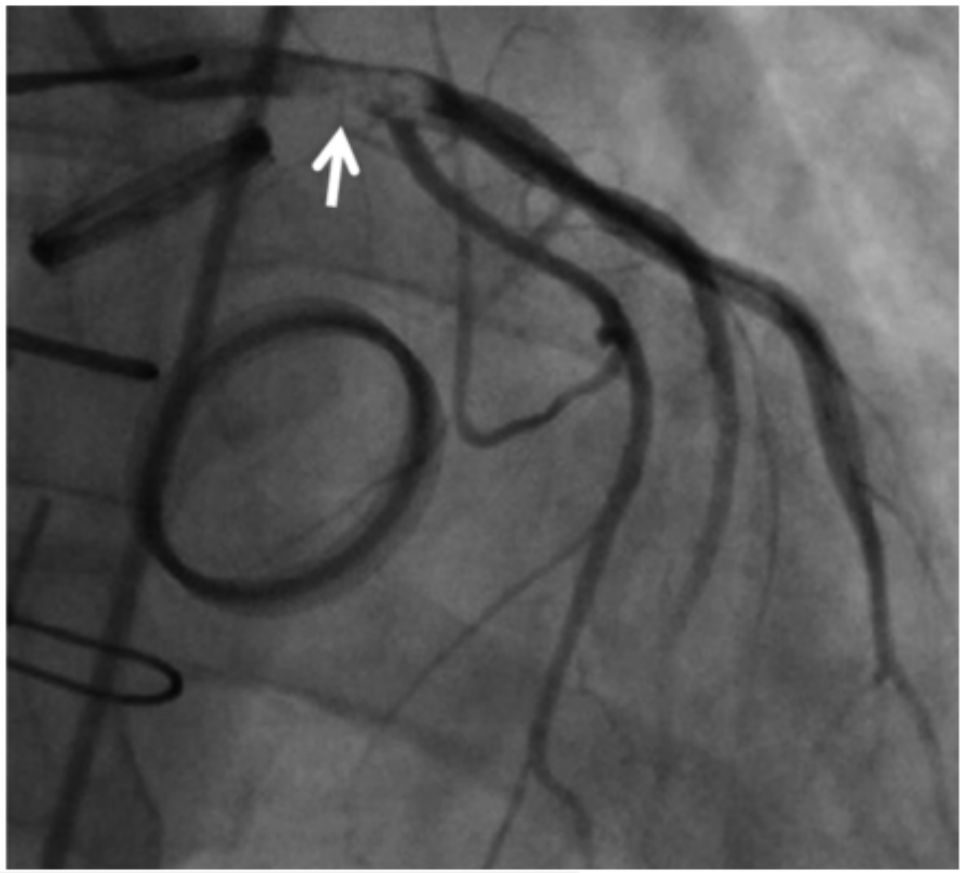
EARLY ANGIOGRAPHY AND PCI AFTER FIBRINOLYSIS



1. PCI RECOMMENDED BETWEEN 2-24 HRS



PERCUTANEOUS INTERVENTION



ANTICIPATE AN ADMISSION FOR 48-72 HRS TO SCREEN FOR COMPLICATIONS

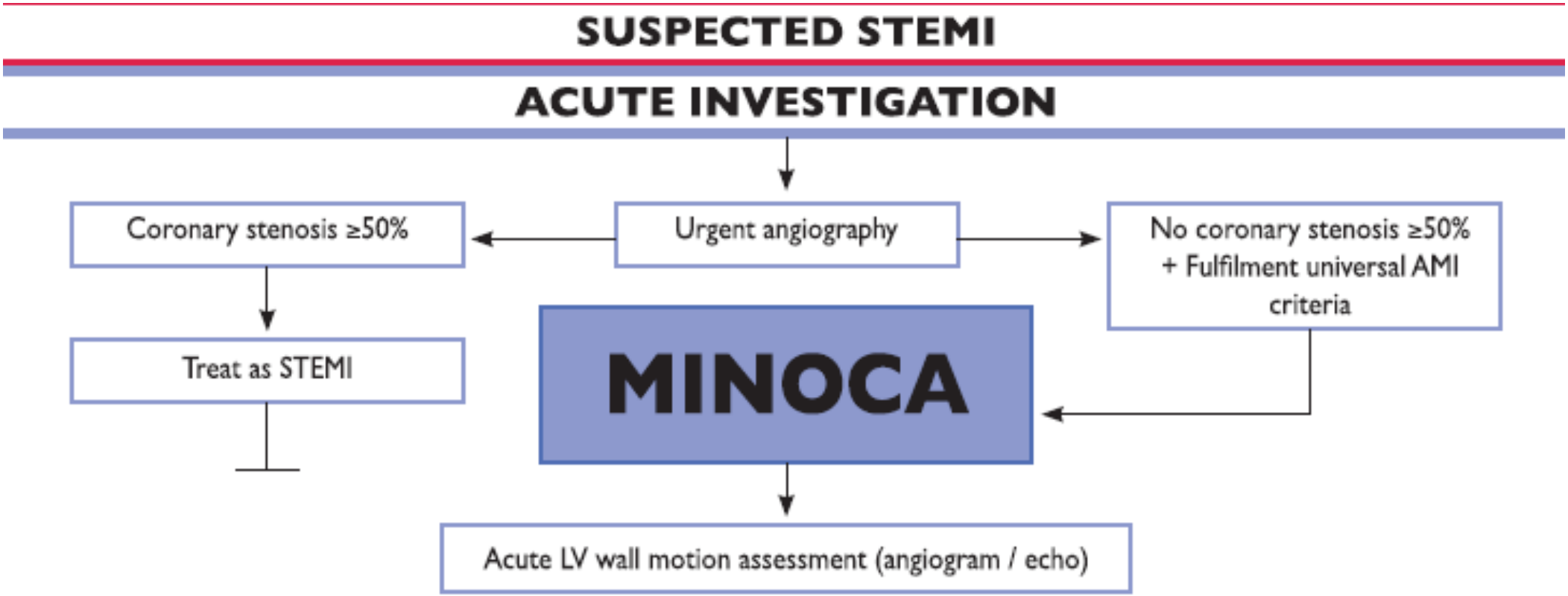
1. **MYOCARDIAL DYSFUNCTION AND CARDIAC FAILURE**

2. **MECHANICAL COMPLICATIONS (FREE WALL RUPTURE, PAPILLARY MUSCLE RUPTURE, VSD)**

3. **ARRHYTHMIAS (VT, AF, VF)**

4. **PERICARDITIS**

MYOCARDIAL INFARCTION WITH NON-OBSTRUCTED CORONARY ARTERIES



SUSPECTED DIAGNOSIS AND FURTHER DIAGNOSTIC TESTS

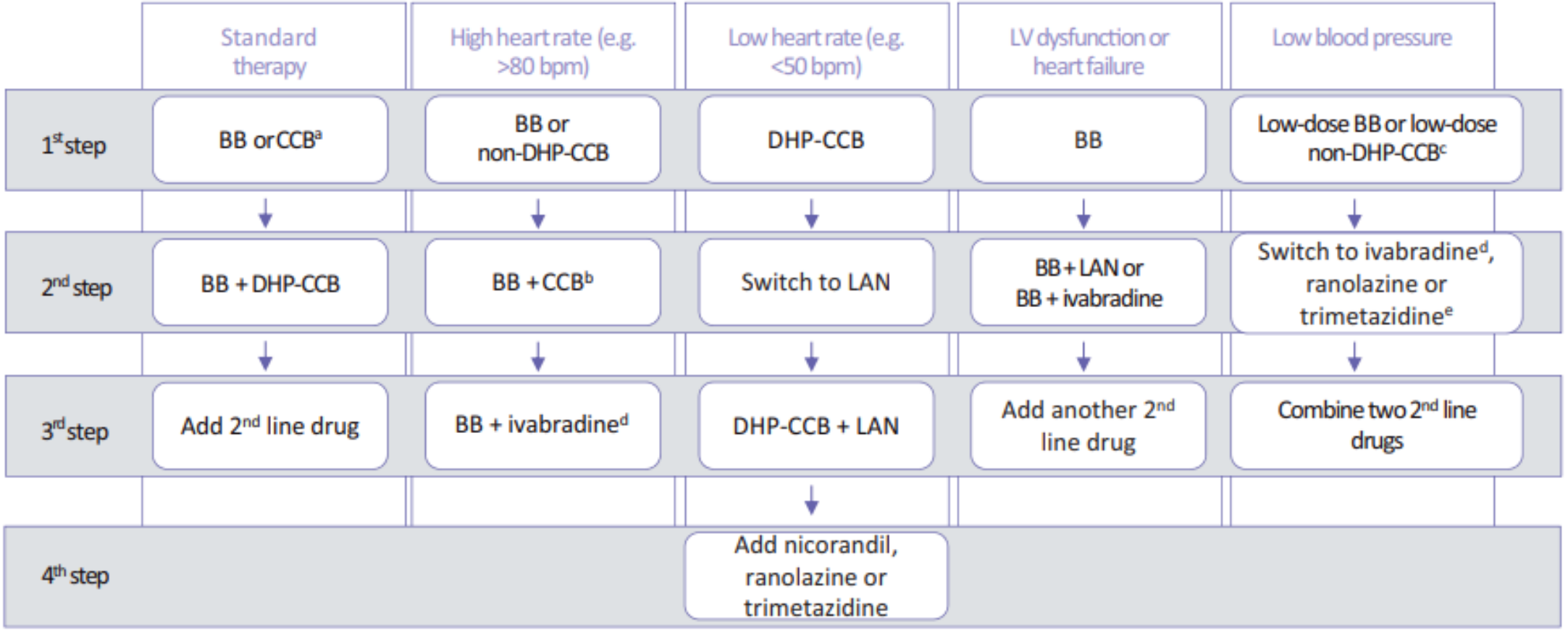
	Non-invasive	Invasive
Myocarditis	**TTE Echo** (pericardial effusion) **CMR** (myocarditis[2], pericarditis)	**Endomyocardial biopsy** (myocarditis)
Coronary (epicardial/ microvascular)	**TTE Echo** (Regional wall motion abnormalities, embolic source) **CMR** (small infarction) **TOE/Bubble Contrast Echo** (Patent foramen ovale, atrial septal defect	**IVUS/OCT** (plaque disruption/dissection) **Ergonovine/Ach test**[1] (spasm) **Pressure/Doppler wire** (microvascular dysfunction)
Myocardial disease	**TTE Echo** **CMR** (Takotsubo, others)	
Pulmonary Embolism	**D-dimer** (Pulmonary embolism) **CT scan** (Pulmonary embolism) **Thrombophilia screen**	
Oxygen supply/ demand imbalance- Type 2 MI	**Blood tests,** **Extracardiac investigation**	

MEDICAL THERAPY

Dual Antiplatelet Therapy FOR 12 MONTHS

Beta-blockers
Oral treatment with beta-blockers is indicated in patients with heart failure and/or LVEF ≤40% unless contraindicated.[357–361]
Intravenous beta-blockers should be considered at the time of presentation in patients undergoing primary PCI without contraindications, with no signs of acute heart failure, and with an SBP >120 mmHg.[346–348,350,403]
Routine oral treatment with beta-blockers should be considered during hospital stay and continued thereafter in all patients without contraindications.[344,354–356,404,405]

STRATEGIES OF MEDICAL MANAGEMENT



Lipid lowering therapies
It is recommended to start high-intensity statin therapy[c] as early as possible, unless contraindicated, and maintain it long-term.[364,366,368]
An LDL-C goal of < 1.8 mmol/L (70 mg/dL) or a reduction of at least 50% if the baseline LDL-C is between 1.8–3.5 mmol/L (70–135 mg/dL) is recommended.[367,369,376,382]
It is recommended to obtain a lipid profile in all STEMI patients as soon as possible after presentation.[369,406]
In patients with LDL-C ≥1.8 mmol/L (≥70 mg/dL) despite a maximally tolerated statin dose who remain at high risk, further therapy to reduce LDL-C should be considered.[376,382]
If a patient's goal[c] is not achieved with the maximum tolerated dose of statin, combination with ezetimibe is recommended.[317,320]
For patients at very high risk who do not achieve their goal[c] on a maximum tolerated dose of statin and ezetimibe, combination with a PCSK9 inhibitor is recommended.[320,323]

ACE inhibitors/ARBs
ACE inhibitors are recommended, starting within the first 24 h of STEMI in patients with evidence of heart failure, LV systolic dysfunction, diabetes, or an anterior infarct.[383]
An ARB, preferably valsartan, is an alternative to ACE inhibitors in patients with heart failure and/or LV systolic dysfunction, particularly those who are intolerant of ACE inhibitors.[396,407]
ACE inhibitors should be considered in all patients in the absence of contraindications.[394,395]
MRAs
MRAs are recommended in patients with an LVEF ≤40% and heart failure or diabetes, who are already receiving an ACE inhibitor and a beta-blocker, provided there is no renal failure or hyperkalaemia.[397]

ORIGINAL ARTICLE

Empagliflozin, Cardiovascular Outcomes, and Mortality in Type 2 Diabetes

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The sodium-glucose co-transporter 2 inhibitors empagliflozin, canagliflozin, or dapagliflozin are recommended in patients with diabetes and CVD.[c] [485–487]	I	A
A glucagon-like peptide-1 receptor agonist (liraglutide or semaglutide) is recommended in patients with diabetes and CVD.[c] [488–490]	I	A

Lifestyle factor	
Smoking cessation	Use pharmacological and behavioural strategies to help patients quit smoking. Avoid passive smoking.
Healthy diet	Diet high in vegetables, fruit, and wholegrains. Limit saturated fat to <10% of total intake. Limit alcohol to <100 g/week or 15 g/day.
Physical activity	30 - 60 min moderate physical activity most days, but even irregular activity is beneficial.
Healthy weight	Obtain and maintain a healthy weight (<25 kg/m^2), or reduce weight through recommended energy intake and increased physical activity.
Other	Take medications as prescribed. Sexual activity is low risk for stable patients not symptomatic at low-to-moderate activity levels.

IN SUMMARY

1. Have an institutional approach to chest pain
2. Exclude other possible fatal causes
   - ACS and the differential diagnosis as discussed
3. Electrocardiogram within 10m minutes of arrival
4. Biomarkers and repeat at 3 hours to confirm or exclude a rise/fall.
5. If unsure, then pick up the phone and call
6. If suspecting an ACS, commence Asplrin loading and activate the ACS network
7. STEMI: time is muscle. If no PCI→ Lysis

References

- **Uptodate**
- **ESC guidelines**
- **ESC textbook of cardiovascular medicine 2019**
- **NEJM**
- **JACC**
- **Brawnwald's Cardiovascular disease: ninth edition**
- **Personal experience (Life)**
- **Google images**