HKU Med
LKS Faculty of Medicine
School of Nursing
香港大學護理學院

NURS2600
NURSING OF ADULT I

Cardiovascular System III
Coronary Artery Diseases (CAD)

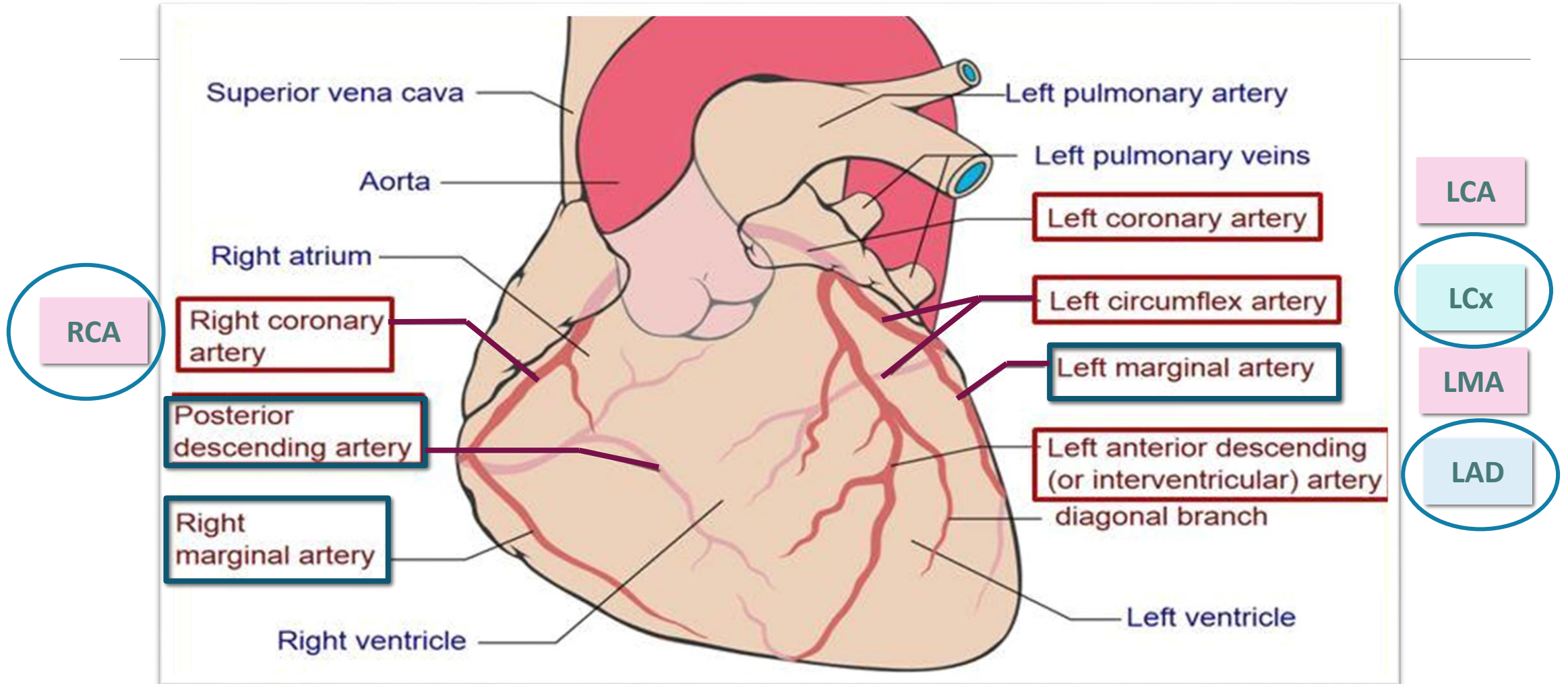DR. JOANNA KO
LECTURER
TEL: +852 3917 6630/EMAIL: KOJOANNA@HKU.HK

Learning Outcomes

After this lecture, students will be able to:

- Understand the definition and pathophysiology of CAD

- Identify different CAD such as atherosclerosis, angina pectoris and acute coronary syndrome (ACS)/acute myocardial infarction (AMI)

- Familiarize with the risk factors and clinical manifestations of ACS/AMI

- Understand the medical and surgical management of treating ACS/AMI

- Demonstrate the nursing process to manage patients with ACS/AMI

Anatomy of Coronary Arteries

Superior vena cava

Aorta

Right atrium

Right coronary artery

Posterior descending artery

Right marginal artery

Right ventricle

Left pulmonary artery

Left pulmonary veins

Left coronary artery

Left circumflex artery

Left marginal artery

Left anterior descending (or interventricular) artery

diagonal branch

Left ventricle

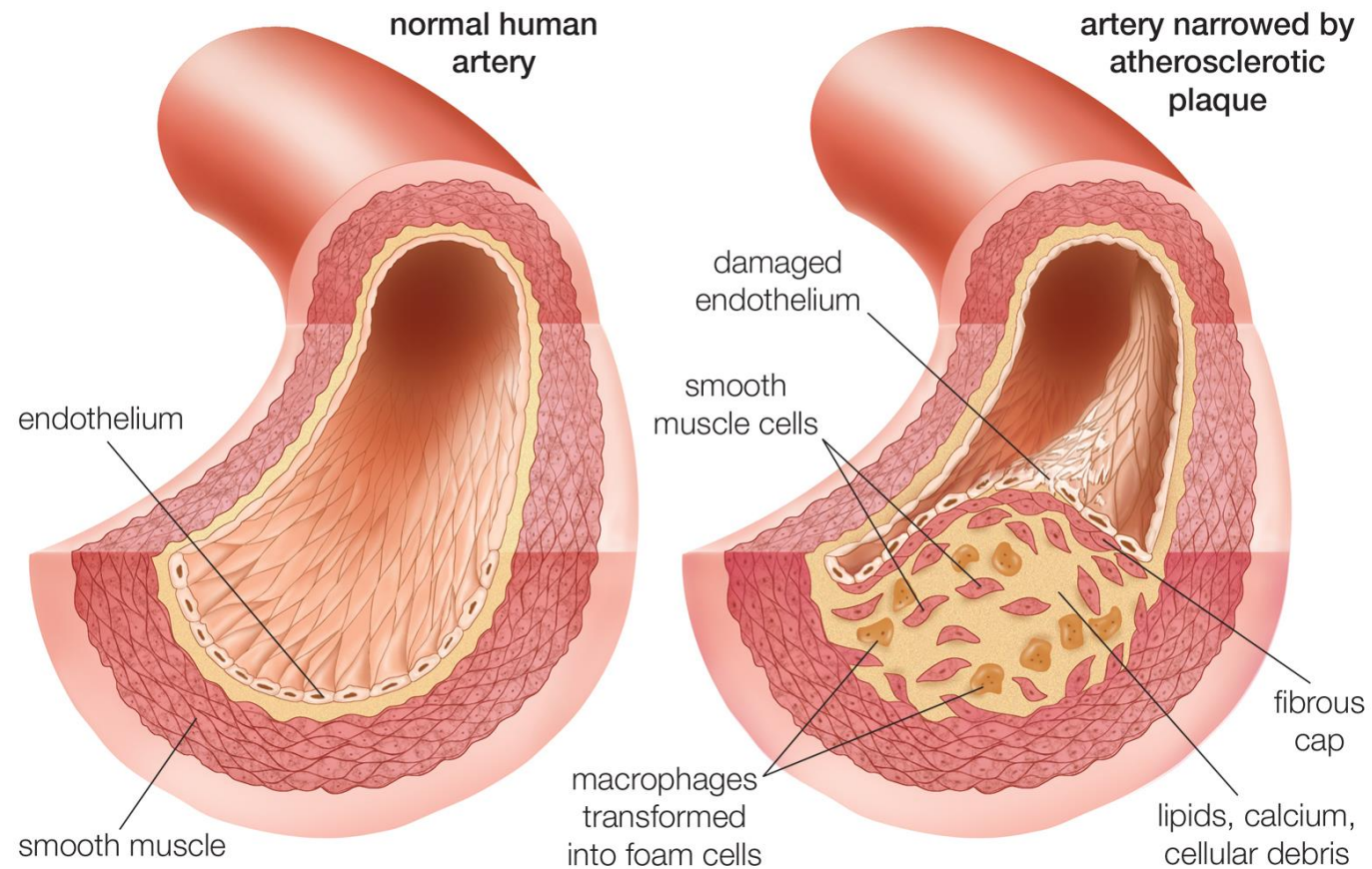LCA

LCx

RCA

LMA

LAD

Coronary Artery Disease (CAD)

Coronary artery disease

I. Atherosclerosis

II. Angina Pectoris

III. Acute Coronary Syndrome / Acute Myocardial Infarction (AMI)

Major Coronary Arteries that supply the 💙 with O_2 and nutrient become damaged or diseased or containing ***deposits (plaque)*** in these coronary arteries and ***inflammation*** are usually to blame for coronary artery disease.

I. Atherosclerosis

Atherosclerosis

normal human artery

artery narrowed by atherosclerotic plaque

endothelium

smooth muscle

damaged endothelium

smooth muscle cells

macrophages transformed into foam cells

fibrous cap

lipids, calcium, cellular debris

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Pathophysiology of Atherosclerosis

Deposition of fats, cholesterol, calcium, and other substances in of endothelium of coronary arteries

The loss of arterial elasticity due to vessel thickening and stiffening

Accumulation of lipid complexes triggers the inflammatory response of immune system

Macrophages are drawn to the site to scavenge the materials

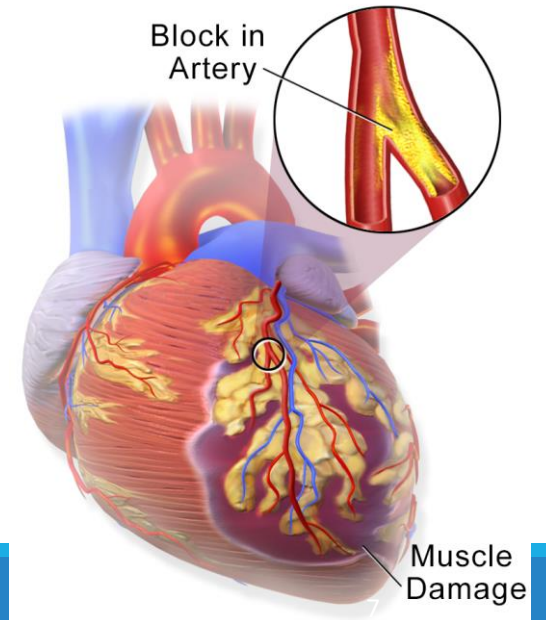Macrophages fill with lipids to form atherosclerotic plaque (+/-rupture)
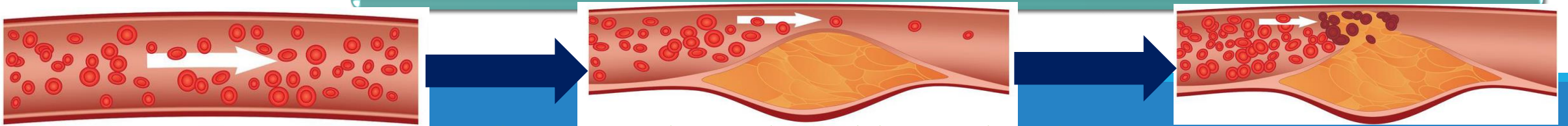
Consequence of Atherosclerosis

➤ Coronary artery stenosis

➤ Myocardial ischemia

➡️ Acute coronary syndrome/myocardial infarction

Risk Factors of Atherosclerosis

Non-modifiable	Modifiable
• Family history of CAD • Increasing age (> 45 years for men; > 55 years for women) • Gender (men develop CAD at an earlier age than women) • Race (higher incidence in African Americans than in Caucasians)	• Hyperlipidemia (LDL: harmful effect on the arterial wall) • Cigarette smoking, tobacco use • Hypertension • Diabetes • Metabolic syndrome • Obesity • Physical inactivity

II. Angina Pectoris

➢A medical term for chest pain or discomfort due to coronary heart disease
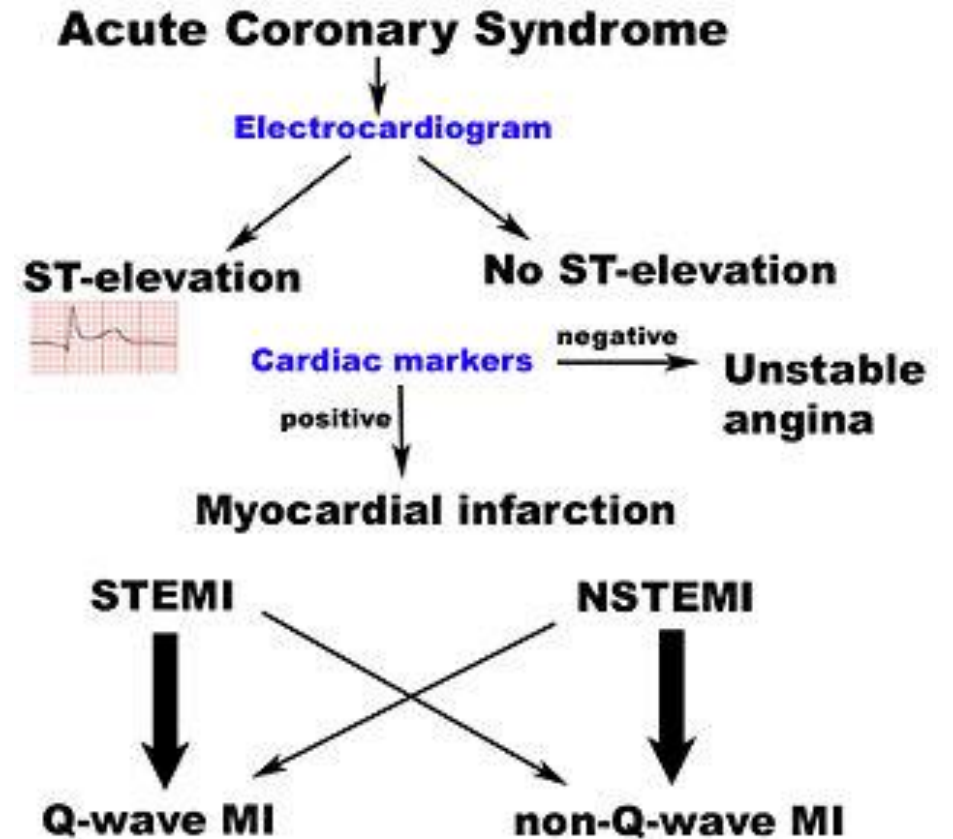
➢The heart muscle demand>supply

Types of Angina Pectoris

- **Stable Angina:** predictable and consistent pain that occurs on exertion and is relieved by rest and / or nitroglycerin (TNG)

- **Unstable angina:** Due to rupture of plaque and symptoms increase in frequency and severity; it **may not be relieved with rest or nitroglycerin (TNG)**
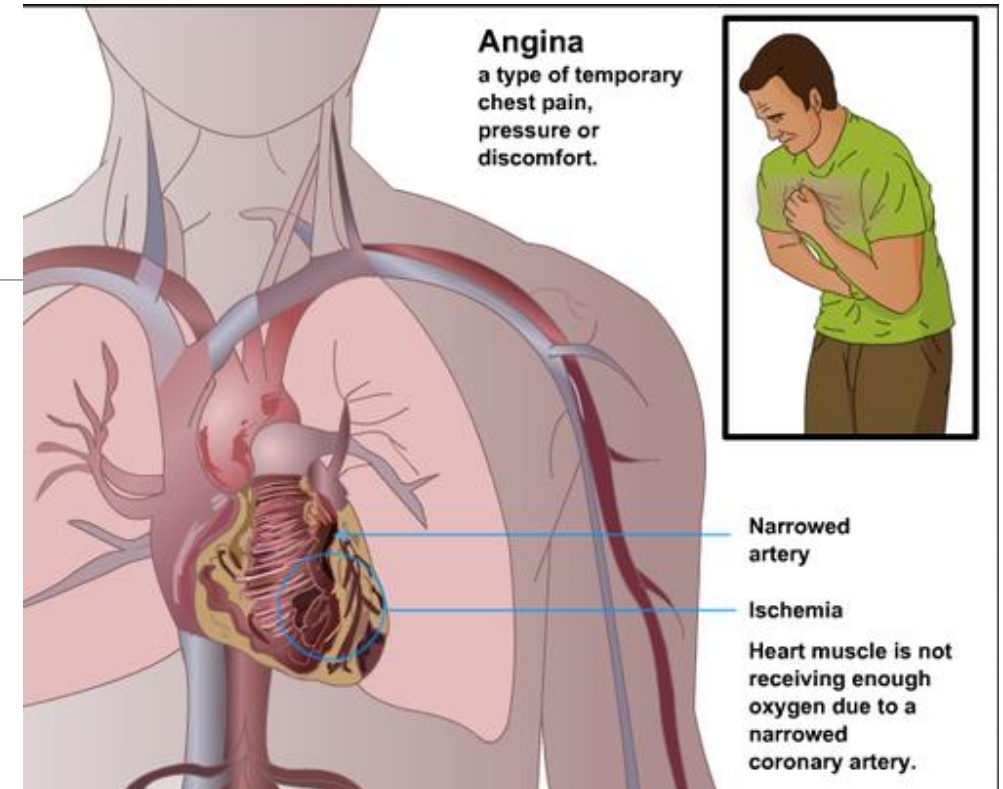
III. Acute Coronary Syndrome

- An umbrella term for conditions caused by sudden blockage of the blood supply to the heart:
  - ➤ **Unstable angina**
 - ➤ **ECG change**
  - ➤ **Elevation of cardiac enzymes**

Acute Coronary Syndrome

Electrocardiogram

ST-elevation   No ST-elevation

Cardiac markers —negative→ Unstable angina

positive ↓

Myocardial infarction

STEMI   NSTEMI

Q-wave MI   non-Q-wave MI

Cardiac Markers

- Cardiac markers are used in the diagnosis and risk stratification of patients with chest pain and suspected acute coronary syndrome (ACS).

- Substances that are released into the blood when the heart is damaged or stressed

CK & CT ✓✓

Cardiac markers	Descriptions	Indications
Cardiac troponin	▪ Regulatory protein complex ▪ Two cardiac-specific isoforms: T and I	▪ Injury to heart ▪ Released within 3-4 hours
Creatine Kinase (CK)	▪ Enzyme ▪ CK-MM, found mostly in skeletal muscles ▪ CK-MB, found mostly in the heart muscles ▪ CK-BB, found mostly in brain tissues	▪ Injury to skeletal muscle and/or heart cells ▪ 3 to 6 hours after injury, peaks in 18 to 24 hours
Myoglobin	▪ Heme protein that helps transport oxygen ▪ Found in cardiac and skeletal muscle	▪ Injury to skeletal muscle and/or heart cells ▪ not specific in indicating cardiac event

Cardiac Markers

High-sensitive Troponin I (HsTnI)
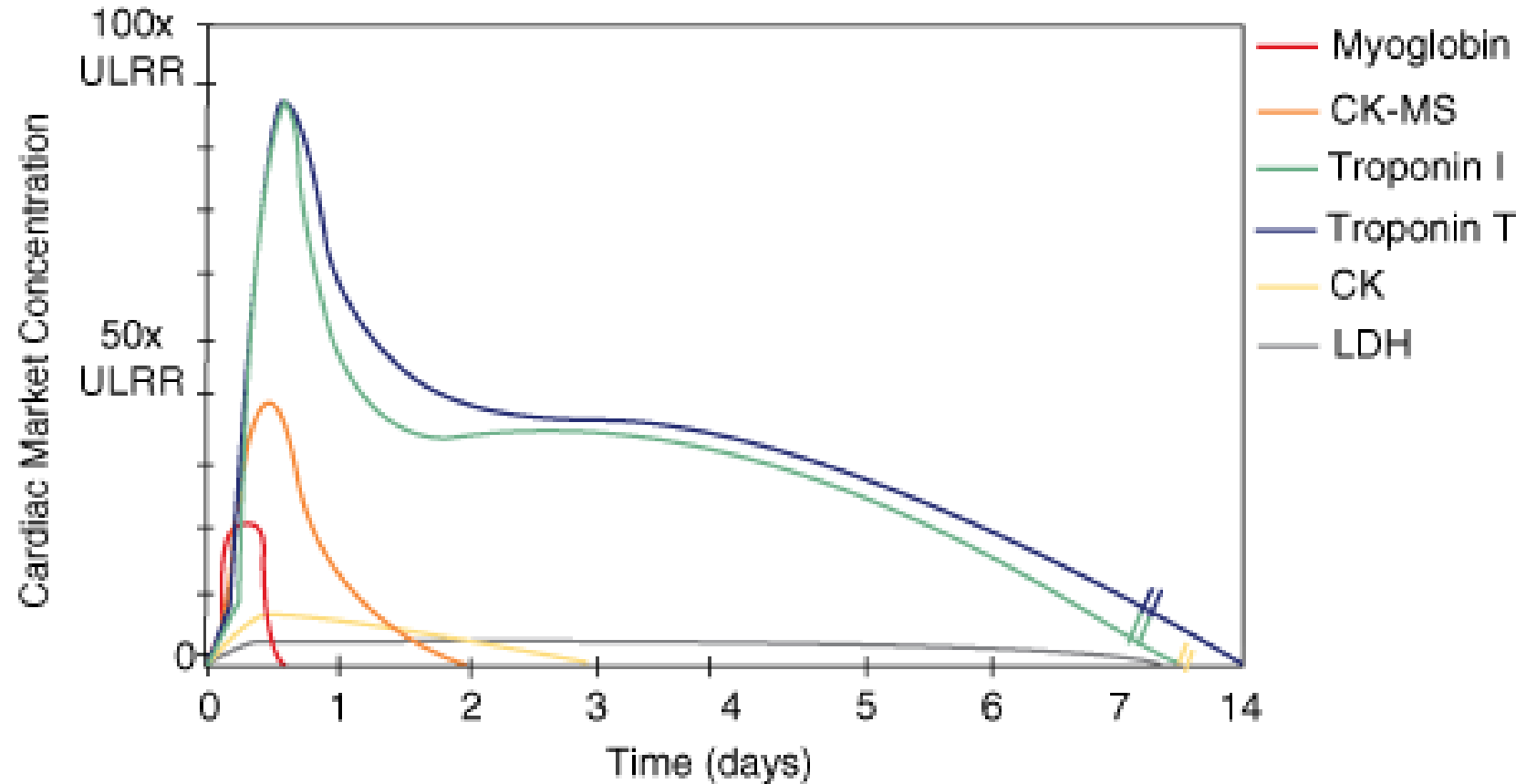
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RESEARCH ARTICLE

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Tools   Share

Jump to

Abstract

Methods

Results

Discussion

Sources of Funding

Disclosures

Footnotes

References

eLetters

High-Sensitivity Troponin I Levels and Coronary Artery Disease Severity, Progression, and Long-Term Outcomes

Ayman Samman Tahhan, Pratik Sandesara, Salim S. Hayek, Muhammad Hammadah, Ayman Alkhoder, Heval M. Kelli, Matthew Topel, Wesley T. O'Neal, Nima Ghasemzadeh, Yi-An Ko, Mohamad Mazen Gafeer, Naser Abdelhadi, Fahad Choudhary, Keyur Patel, Agim Beshiri, Gillian Murtagh, Jonathan Kim, Peter Wilson, Leslee Shaw, Viola Vaccarino, ... See all authors

Abstract

Background

The associations between high-sensitivity troponin I (hsTnI) levels and coronary artery disease (CAD) severity and progression remain unclear. We investigated whether there is an association between hsTnI and angiographic severity and progression of CAD and whether the predictive value of hsTnI level for incident cardiovascular outcomes is independent of CAD severity.

Methods and Results

In 3087 patients (aged 63±12 years, 64% men) undergoing cardiac catheterization without evidence of acute myocardial infarction, the severity of CAD was calculated by the number of major coronary arteries with ≥50% stenosis and the Gensini score. CAD progression was assessed in a subset of 717 patients who had undergone ≥2 coronary angiograms >3 months before enrollment. Patients were followed up for incident all-cause mortality and incident cardiovascular events. Of the total population, 11% had normal angiograms, 23% had nonobstructive CAD, 20% had 1-vessel CAD, 20% had 2-vessel CAD, and 26% had 3-vessel CAD. After adjusting for age, sex, race, body mass index, smoking, hypertension, diabetes mellitus history, and renal function, hsTnI levels were independently associated with the severity of CAD measured by the Gensini score (log 2 ß=0.31; 95% confidence interval, 0.18–0.44; $P<0.001$) and with CAD progression (log 2 ß=0.36; 95% confidence interval, 0.14–0.58; $P=0.001$). hsTnI level was also a significant predictor of incident death, cardiovascular death, myocardial infarction, revascularization, and cardiac hospitalizations, independent of the aforementioned covariates and CAD severity.

Conclusions

Higher hsTnI levels are associated with the underlying burden of coronary atherosclerosis, more rapid progression of CAD, and higher risk of all-cause mortality and incident cardiovascular events. Whether more aggressive treatment aimed at reducing hsTnI levels can modulate disease progression requires further investigation.

Point-of-Care Testing for HsTnI
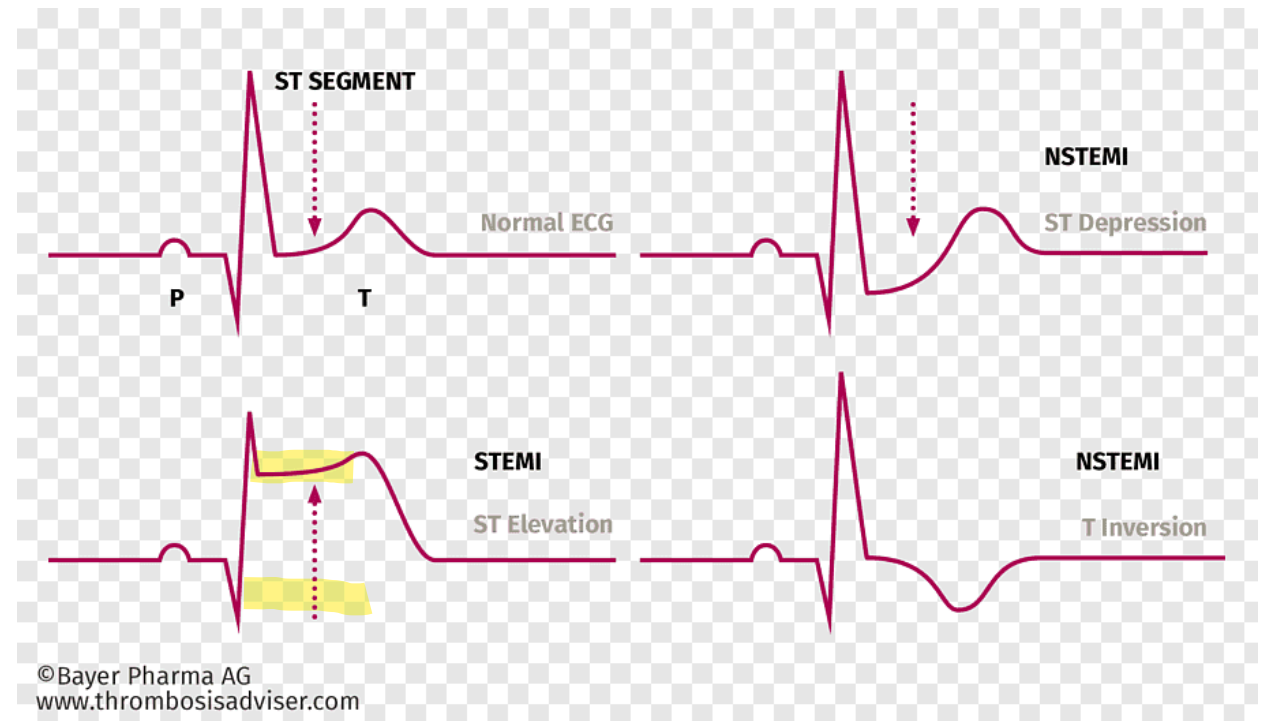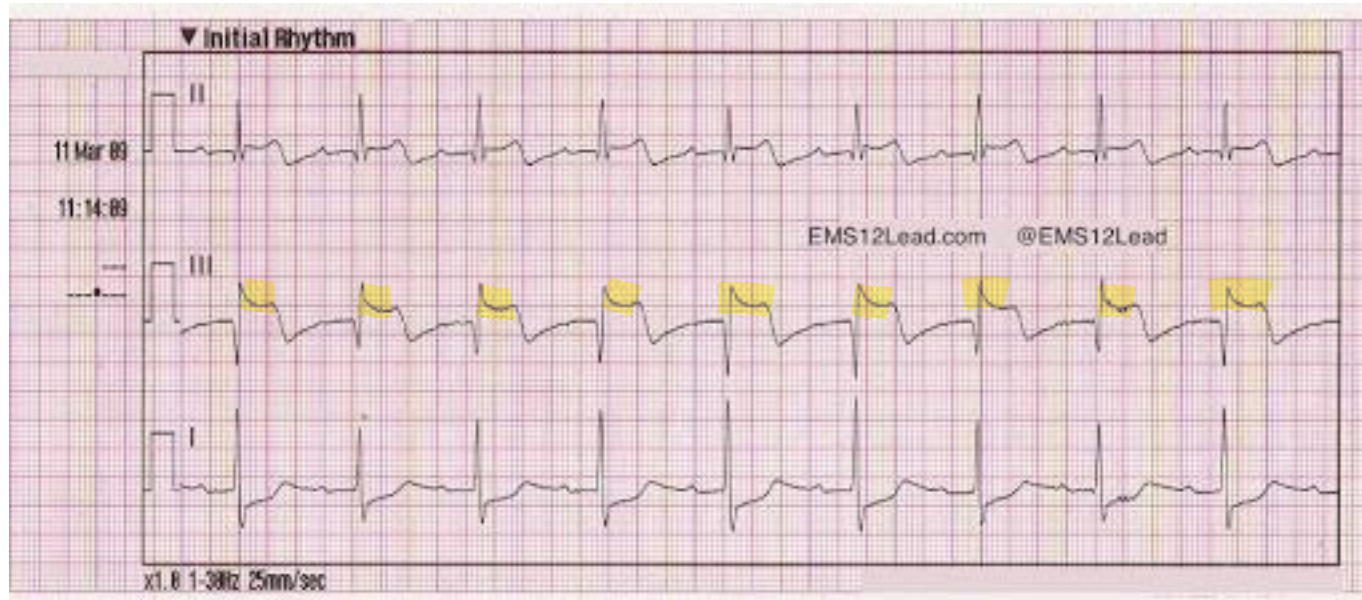
High-sensitive troponin I reading for only 3 minutes

https://blog.hightechcampus.com/htce/siemens-healthineers-bringing-point-of-care-testing-closer-to-the-patient
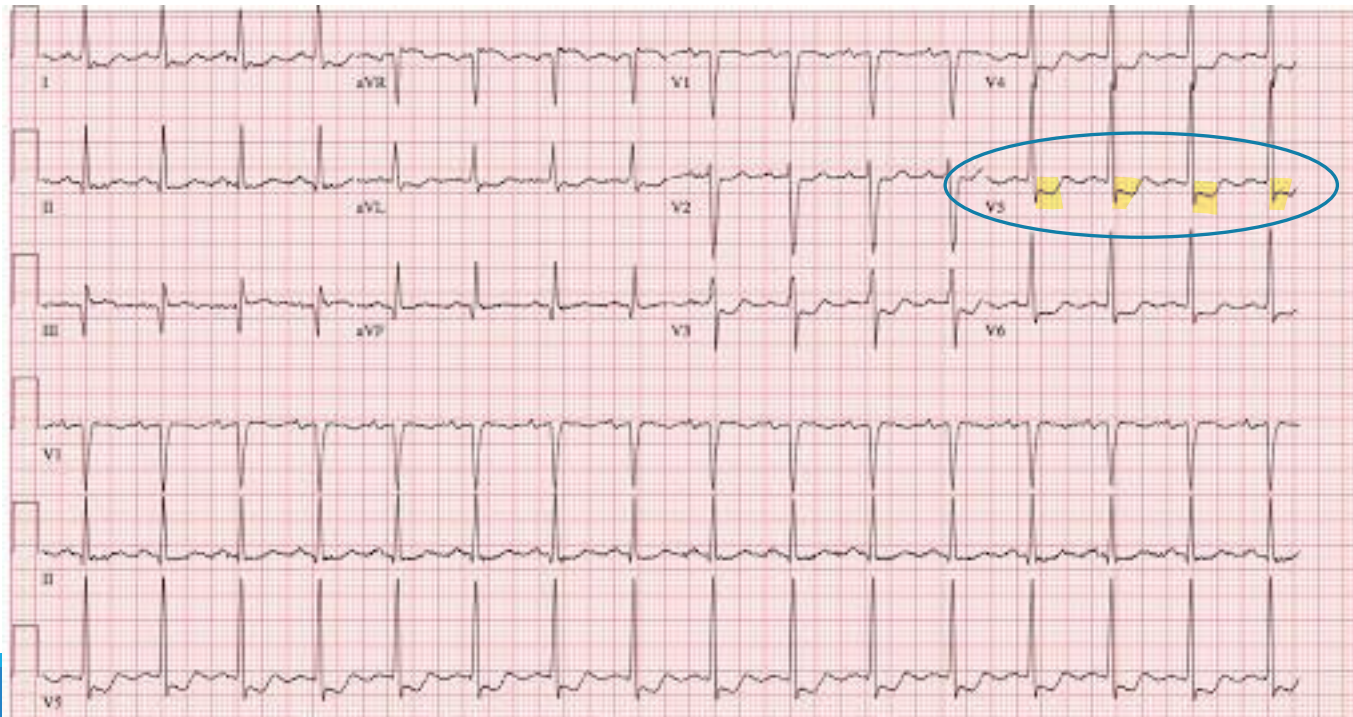
Myocardial Infarction

- **Non-ST elevated MI (NSTEMI)**
  - Usually have **transient** thrombosis or **incomplete** coronary occlusion
  - ST-segment depression or T wave inversion; Usually do not develop pathological Q wave

- **ST elevated MI (STEMI)**
  - Tend to have **more extensive** MI that is associated with **prolonged and complete** coronary occlusion
  - ST-segment elevation in 2 or more contiguous leads; Pathological Q wave usually seen

ST SEGMENT

Normal ECG

P   T

NSTEMI
ST Depression

STEMI
ST Elevation

NSTEMI
T Inversion

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www.thrombosisadviser.com

acute →

ST elevation MI

Non-ST elevation MI

16

Pathological Q Wave

➤ During MI, Q wave can be normal or abnormal

➤ Abnormal Q wave usually follows ST elevation

➤ Wider and deeper than normal Q

➤ Presence of pathological Q can represent old infarct

➤ Indication of myocardial necrosis
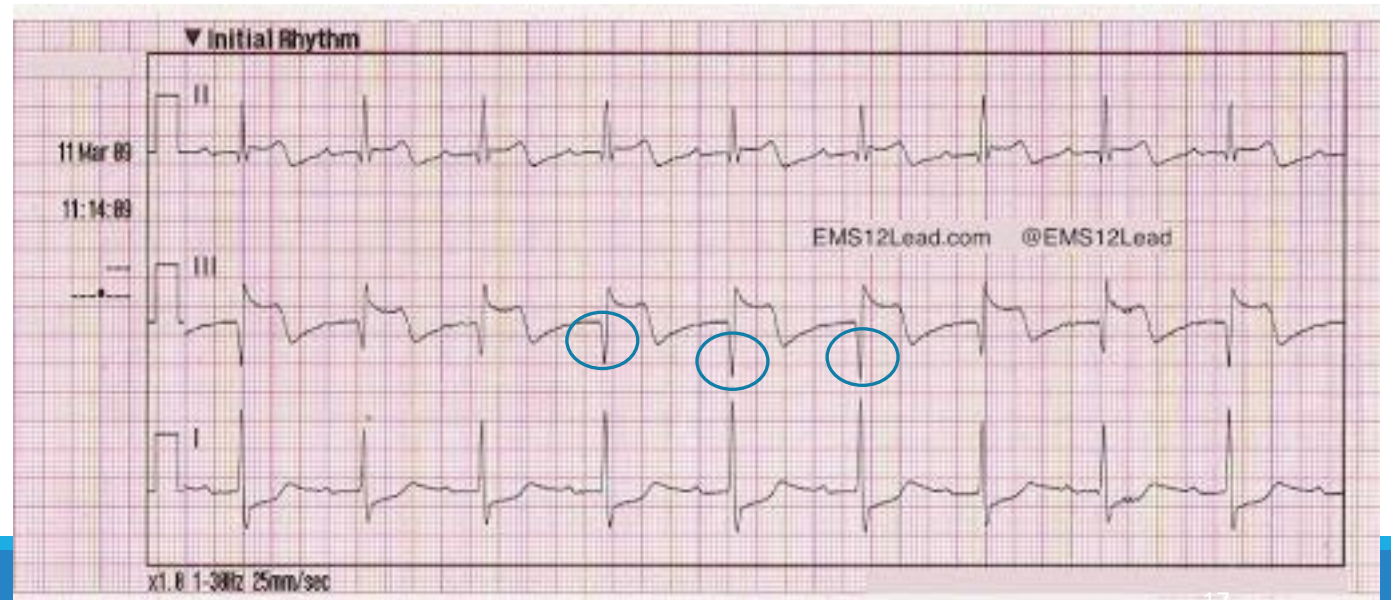
Myocardial Infarction (MI) – Clinical Manifestations

➢ Chest pain
  ➢ Sudden onset, not relieved by rest or medications
    ◦ Location: substernal, retrosternal, epigastric area
    ◦ May radiate like angina
    ◦ Quality: heaviness, crushing pressure, burning, constriction
    ◦ More severe
    ◦ Timing: last longer than 15-20 mins
➢ Dyspnoea
➢ Sweating, weakness
➢ Nausea & vomiting
➢ Cool, pale and moist skin
➢ ⬆ HR; ⬆RR
➢ Severe anxiety: has a sense of impending doom and death
➢ ± loss of consciousness and even sudden death
➢ *Approximately 1/3 of all myocardial infarctions are silent, without chest pain or other symptoms*

Myocardial Infarction (MI) – Complications

- ➤ Arrhythmias
  - Premature ventricular contraction (PVC)
  - Ventricular tachycardia (VT) or ventricular fibrillation (VF)
- ➤ Cardiogenic shock
- ➤ Infarct extension
- ➤ Heart failure
- ➤ Structural defect
- ➤ Pericarditis

Assessment of ACS

- History taking: past medical history, family history, medication history of antiplatelet or cholesterol lowering drugs

- Physical examination: chest pain, heart murmurs

- Obtain *12-lead ECG* to be read within 10 minutes

- Monitor patient's *vital signs* and connect patient to *cardiac monitor*

- Obtain laboratory blood specimens of *cardiac biomarkers*

- Obtain other diagnostics to clarify the diagnosis:

  ➢ Echocardiogram

  ➢ Cardiac catheterization

COLDSPA

COLDSPAA

Symptom Analysis Mnemonic

Mnemonic	Question
Character	Describe the sign or symptom (feeling, appearance, sound, smell or taste if applicable)
Onset	When did it begin?
Location	Where is it? Does it radiate? Does it occur anywhere else?
Duration	How long does it last? Does it recur?
Severity	How bad is it? How much does it bother you?
Pattern	What makes it better or worse?
Associated factors / how it **A**ffects the pt	What other symptoms occur with it? How does it affect you?

Table 2-3 taken from:
Lewis, P and Foley, D 2011, *Weber & Kelly's Health Assessment in Nursing,* Lippincott Williams & Wilkins Pty Ltd, a division of Wolters Kluwer Health, NSW.

Chest Pain – PQRST Assessment

	Factor	Questions to ask patient
P	**Precipitating events/Provocation**	What events or activities precipitated the pain E.g. exercise
Q	**Quality of pain**	What does the pain feel like (e.g. pressure, dull, aching, tight, squeezing, heaviness)? Dull pain: MI; Sharp pain: ? Aortic dissection
R	**Radiating of pain**	Where is the pain located? Any radiation? MI: pain commonly radiate to left shoulder
S	**Severity of pain**	On a scale of 0 to 10 with 0 indicating no pain and 10 being the most severe pain you would imagine, what no. would you give the pain?
T	**Timing**	When did the pain begin? Has the pain changed since this time? Have you had pain like this before?

Implications of Chest Pain

CARDIAC	NON-CARDIAC
• Acute coronary syndrome	• Gastrointestinal Esophageal spasm or reflux Peptic ulcer
• Aortic dissection	• Pulmonary Pneumonia Pulmonary embolism Pneumothorax
• Pericarditis	
• Myocarditis	• Neurological (nerve root pain, herpes zoster)
• Valvular disease	• Musculoskeletal (e.g. osteochondritis)

Atypical presentations of ACS (e.g. epigastric pain, upper back pain or dizziness) are frequent in younger (25-40 years) and older (>75 years) patients and in women. Asymptomatic myocardial ischemia (**silent ischemia**) is particularly common among diabetics.

CENTRAL ILLUSTRATION: Patient Assessment With Suspected ACS

Twerenbold, R. et al. J Am Coll Cardiol. 2017;70(8):996-1012.

AHA Guideline (2021)

https://www.ahajournals.org/doi/10.1161/CIR.0000000000001029
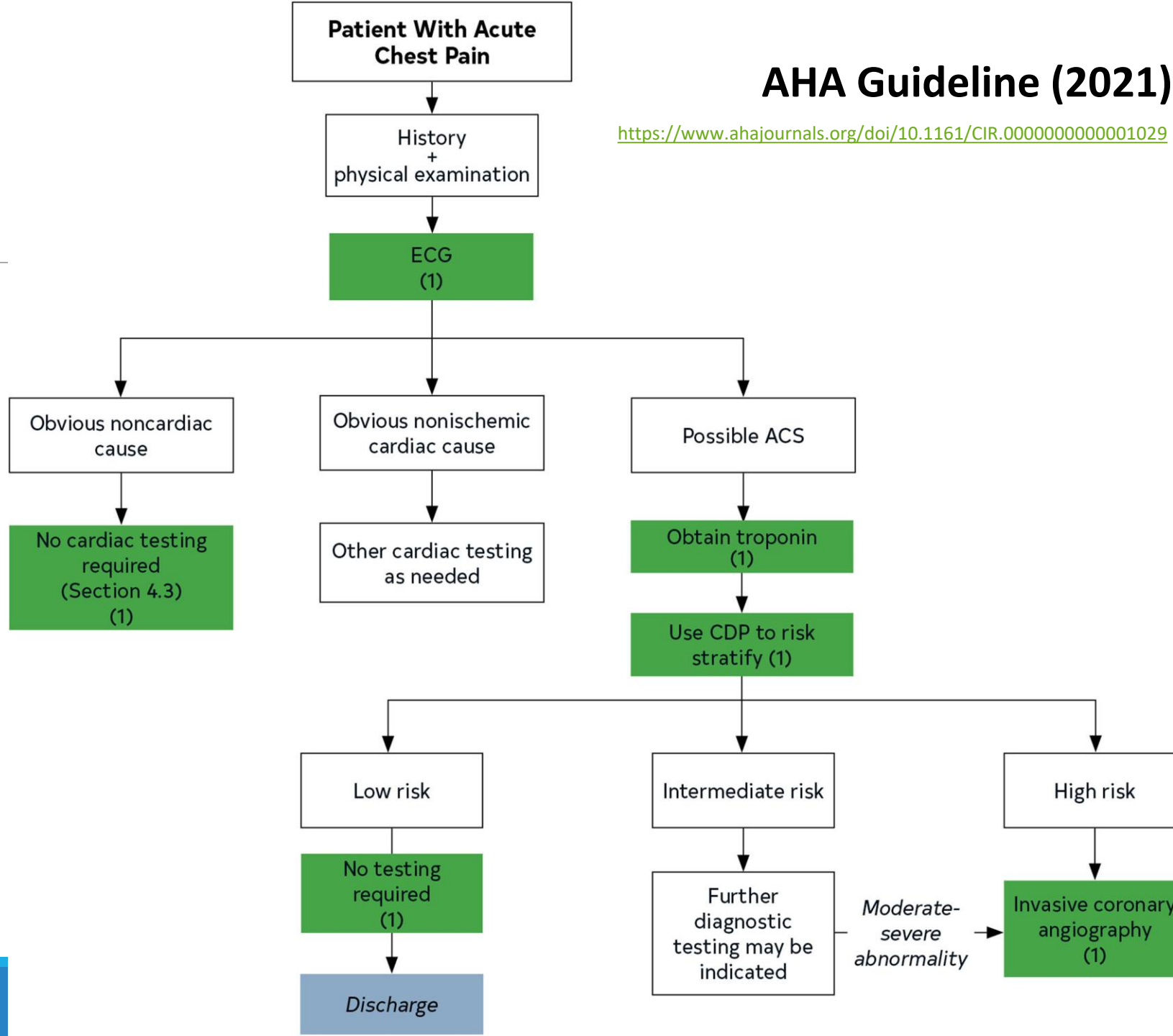
Diagnostic Investigations of ACS

1. Echocardiography/Transthoracic Echocardiography

➢ Transmission of high-frequency sound waves through the chest wall & the recording of the return signals

➢ Determine cardiac output (ejection fraction), ventricular wall motion, chamber size & the etiology of heart murmurs

➢ Evaluate the function of heart valves, including prosthetic heart valves
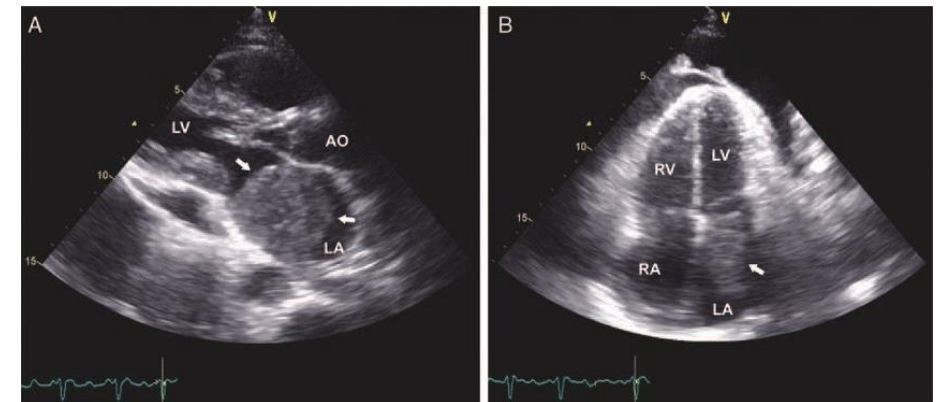
https://www.specialistcardiology.com.au/tests/echocardiography/transthoracic-echocardiogram-echo-tte
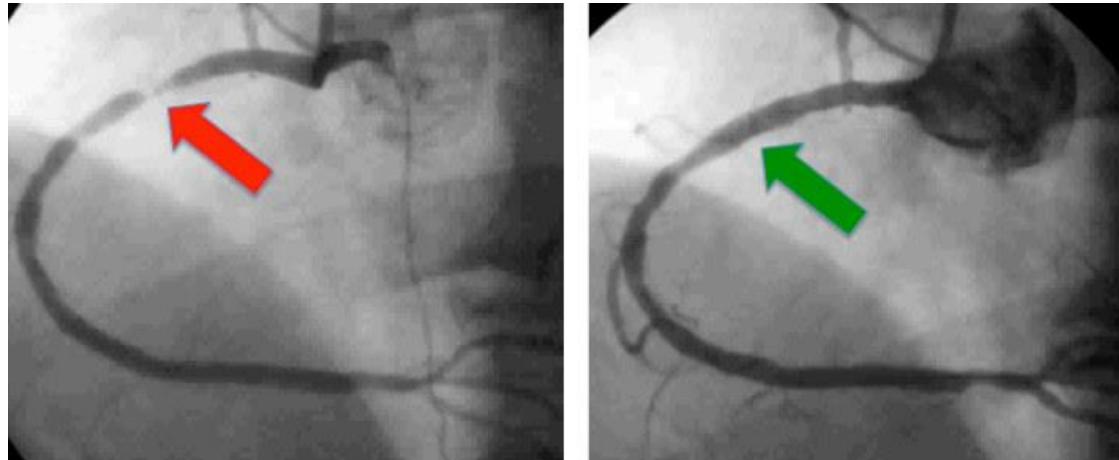
Diagnostic Investigations of ACS (Cont'd)

2. Cardiac angiogram

▪An invasive test performed to look for narrowings or blockages in the blood vessels that supply the heart

▪It is the gold standard diagnostic test for CAD (Bluemke et al., 2008)

https://unitedcardiology.com.au/tests-procedures/coronary-angiography-angioplasty-and-stenting/

Medical Management of ACS

❖ **Goals:**

✓ **Minimize myocardial damage**

✓ **Preserve myocardial function**

✓ **Prevent complications**

Medical Management Options

➢ Evaluate for indication for ***reperfusion therapy***:

  ➢ Reestablish coronary flow

  ➢ ***Percutaneous Coronary Intervention (PCI):*** Door-to-balloon inflation time is 90 minutes

  ➢ ***Thrombolytic (fibrinolytic) therapy:*** Door-to-needle time is 30 minutes

  ➢ ***Coronary Artery Bypass Grafting***

➢ Continue therapy as indicated:
  ◦ IV heparin, low-molecular-weight heparin
  ◦ Antiplatelet: Aspirin, Clopidogrel (Plavix), Ticagrelor (Brilinta)
  ◦ Beta-blocker (Metoprolol, Atenolol)
  ◦ ACEI (Enalapril, Lisinopril)
  ◦ Statin (Simvastatin, Atorvastatin)
  ◦ Nitroglycerin

Updated Medical Treatment for ACS

❖ In 1990, **MONA** was given a Class 1 recommendation for almost all patients with myocardial infarction

❖ MONA is no longer as beneficial to the cardiac patient

❖ **Morphine** had been found to potentially <u>mask ischemic symptoms</u>

❖ **Oxygen** was not found to make a difference in the patients with normal SpO2

❖ Gouda et al. (2016): oxygen could have <u>paradoxical effects</u> of increased coronary vascular resistance

❖ Morphine and oxygen **increased mortality** in patients with ACS

Nitroglycerin

- Treat episodes of angina (chest pain) in people who have coronary artery disease

- Spray or sublingual vasodilator

Chest pain

Take 1st dose of TNG

Not relieved: take 2nd dose after 5 minutes

Not relieved: take 3rd dose after another 5 minutes

Not relieved: seek medical help!!!

https://www.indiamart.com/proddetail/nitroglycerin-sublingual-tablet-usp-0-5-mg-16880074548.html

Percutaneous Coronary Intervention (PCI)

➢Invasive interventional procedures to ***treat angina and acute MI***

➢A guide wire is inserted through radial or femoral artery

➢Relieves narrowing and obstruction of the arteries by compressing the atheroma

➢***Improve blood flow ➔ Allows more blood and oxygen delivered to the heart muscle***

➢Includes:
- ✧ ***Percutaneous transluminal coronary angioplasty (PCI)***
- ✧ ***Intracoronary stent implantation***
- ✧ *Atherectomy:* a non-surgical procedure that inserts a tiny device on the end of a catheter inside the artery and the plaque is "shaved" away
- ✧ *Brachytherapy:* Transluminal laser revascularization

https://www.indiamart.com/proddetail/angiography-surgery-19187188848.html
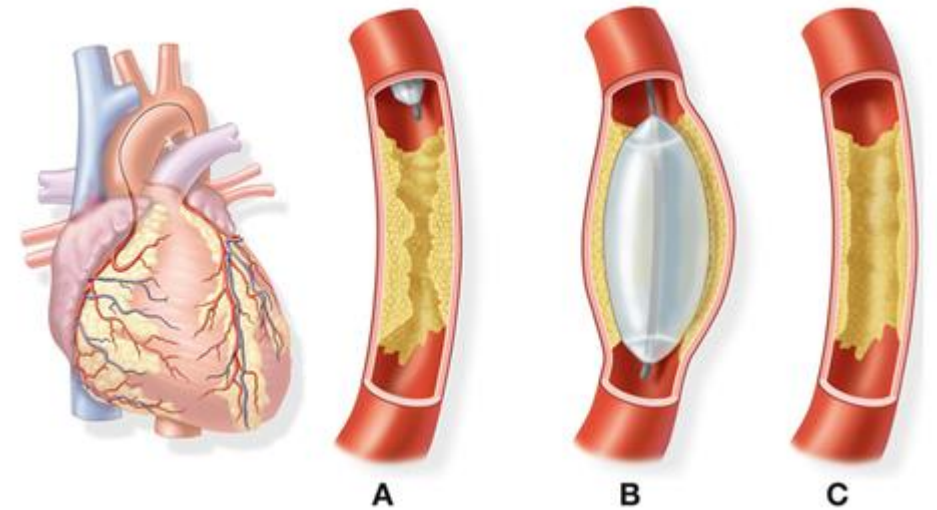
Intra-Coronary Stent Implantation

➤ Drug-eluting stents are placed within the artery

➤ Stents help prevent
  ◦ Abrupt closure of arteries shortly after PCI
  ◦ Re-stenosis
  ◦ Formation of thrombi
  ◦ Scar tissue within the coronary artery lesion
  ◦ Decrease the risks of artery spasm after PCI

https://rodnieoro.com/home/percutaneous-coronary-intervention-angioplasty
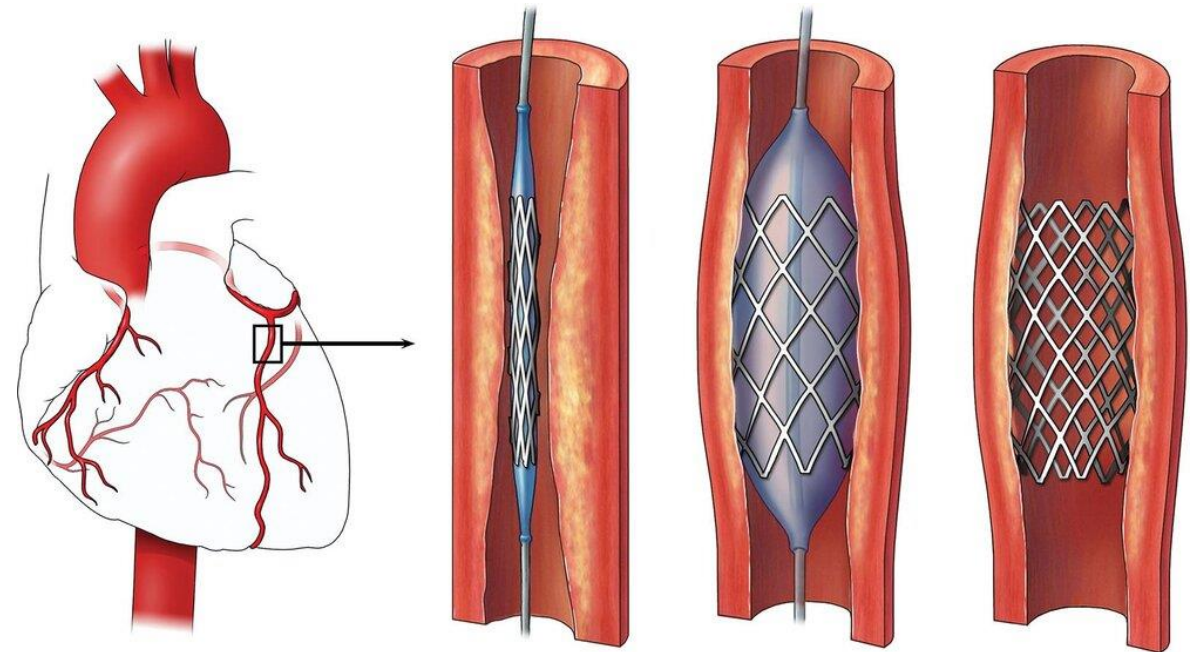
Double anti-platelet therapy: Patients with coronary artery stents are usually maintained on full doses of aspirin + anti-platelet drug for at least 1 year

Complications of PCI

- Acute arrhythmias
- Dissection, perforation of the artery
- Acute MI
- Bleeding, infection and pain from puncture site
- Allergic reaction to the dye used
- Damage to the kidneys caused by the dye used
- Blood clots that can trigger strokes, heart attacks or other serious problems

Nursing Interventions Before PCI

- Instruct the patient to *fast* (usually for 8 to 12 hours) before the procedure

- Inform the patient about the *expected duration* of the procedure & advise that it will involve lying on a hard table for < 2 hours

- Reassure the patient that *IV medications* are given to maintain comfort

- Explain that *palpitation* may be felt in the chest because of extra heartbeats that almost always occur

- Tell the patient that the *injection of a contrast* agent may produce a flushed feeling throughout the body

- Encourage the patient to *express fears* and anxieties

Nursing Interventions After PCI

- Observe the *catheter access site* for bleeding or hematoma formation

- Assess *peripheral pulses* and skin temperature in the affected extremity (dorsalis pedis & posterior tibial pulses in the lower extremity, **capillary refill** in the upper extremity)

- *BP & HR* Q1H X 4 then Q4H until discharge

- Assess the patient for affected *extremity pain, numbness*, or tingling sensations that may indicate arterial insufficiency

- Screen carefully for *arrhythmias* by observing the cardiac monitor

- *Femoral artery access:* the head of the bed elevated no greater than 30 degrees, bed rest >6 hours

- *Radial artery access:* bed rest 2-3 hours

- Observe for any *oozing from the hemostasis band* or pressure dressing

- No blood taking and blood pressure monitoring on the affect extremeity

- Administer *analgesic medication* as prescribed for discomfort

Hemostasis After PCI

https://www.hightidehealth.com/sureseal-bandages.html

Source from: https://thoracickey.com/arterial-and-venous-access-2/
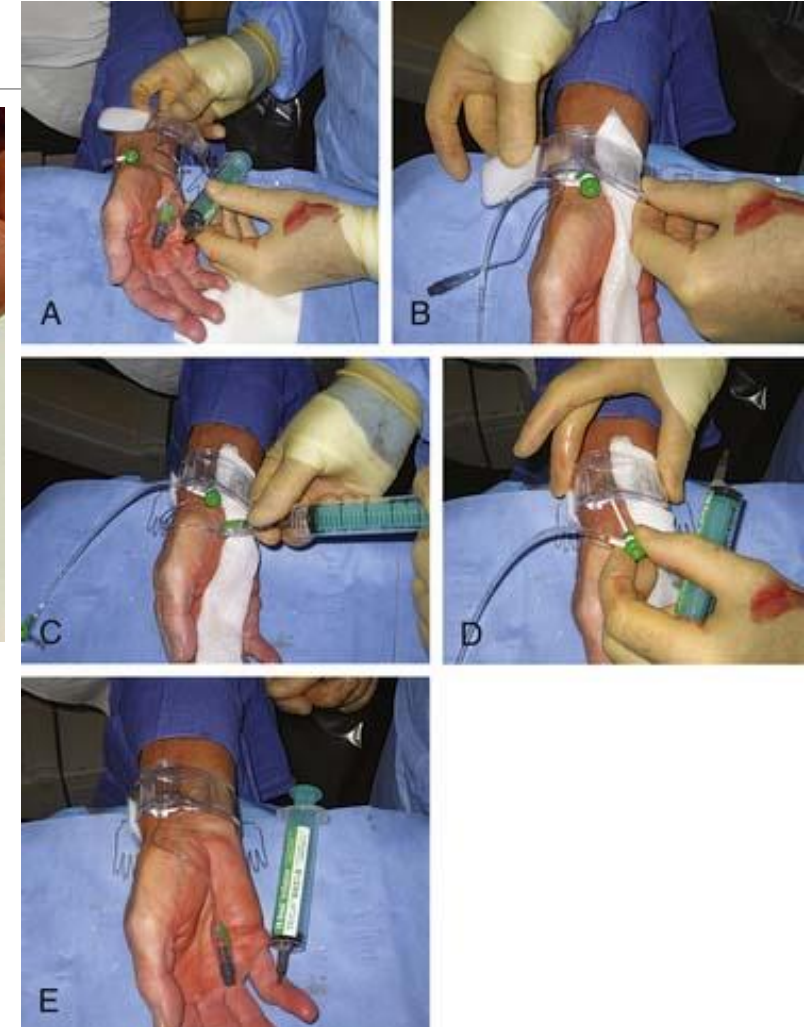
Thrombolytic Therapy

➢ Administer intravenously or directly into the coronary artery in the cardiac catheterization lab

Example: *Streptokinase, recombinant tissue plasminogen activator (rt-PA)*

➢ Thrombolysis to allow reperfusion

➢ Cardiac catheterization and other invasive procedures might be required if the thrombus is unable to dissolve

➢ Should not be used in patient with risk of bleeding

Thrombolytic Therapy

❖**Indications:**
- ◦ Chest pain for longer than 20 mins, **_unrelieved by nitroglycerin_**
- ◦ ST-segment elevation in at least two leads that face the same site of the heart
- ◦ 6-hours from onset of pain

❖**Absolute Contraindications:**
- ◦ Active bleeding
- ◦ Know bleeding disorder
- ◦ History of hemorrhagic stroke
- ◦ History of intracranial vessel malformation
- ◦ Recent major surgery or trauma
- ◦ Uncontrolled hypertension
- ◦ Pregnancy

Coronary Artery Bypass Grafting (CABG)

➤A procedure of bypass a blocked section of a coronary artery and to deliver oxygen to the heart

A blood vessel from another part of the body (e.g. **saphenous vein**, **left internal mammary artery-LIMA**) is grafted and bypass the obstruction

➤Indications:
  ➤Alleviation of angina that cannot be controlled with medication or PCI
  ➤For **multi-vessels CAD**
  ➤Treatment for complication from an unsuccessful PCI

Coronary artery bypass surgery

Before

After

Bypass graft

Coronary Artery Bypass Grafting

Mammary artery graft

Aorta

Saphenous vein graft

Hand stitched connection

Blockage in coronary artery
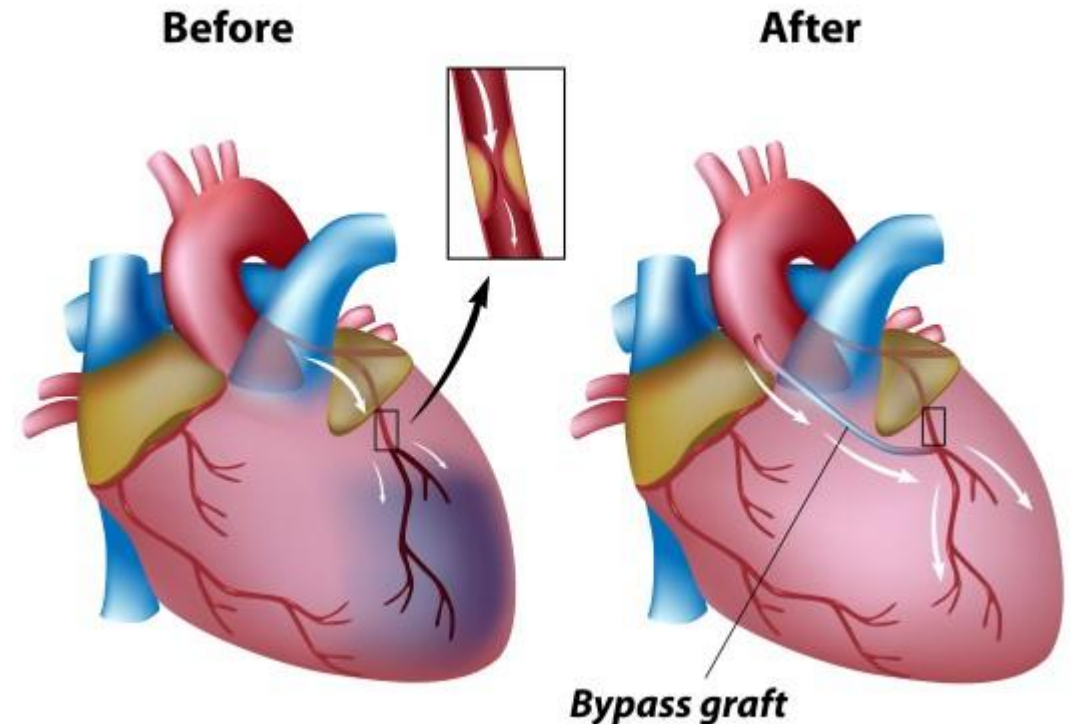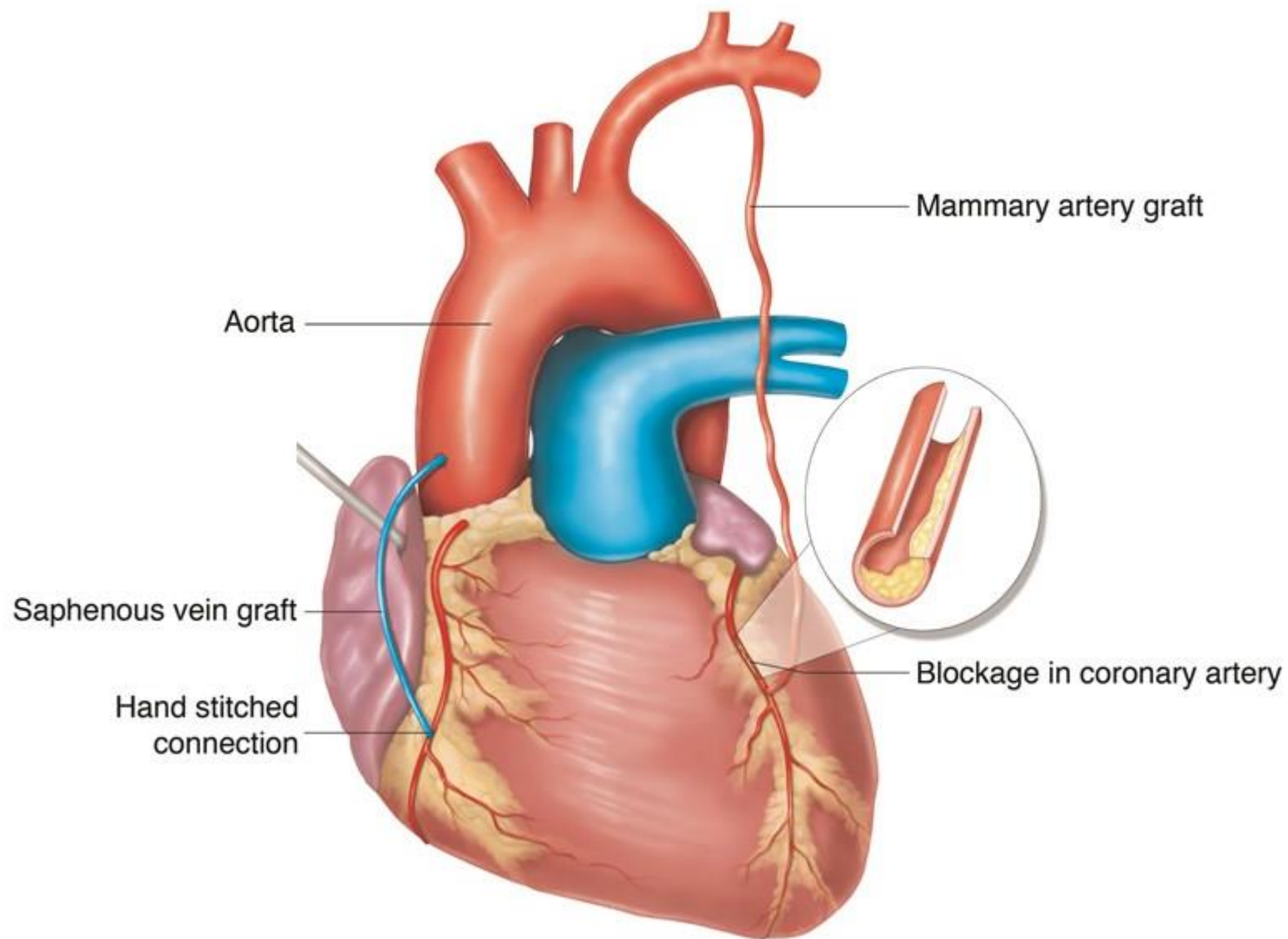
Nursing Diagnoses of ACS

- ✓ ***Decreased cardiac output*** related to altered contractility and altered heart rate and rhythm

- ✓ ***Acute pain*** related to an imbalance between myocardial oxygen supply and demand

- ✓ ***Anxiety*** related to perceived threats of death, pain and/or possible lifestyle changes

- ✓ ***Activity intolerance*** related to general weakness secondary to decreased cardiac output and poor lung and tissue perfusion

- ✓ ***Risk of ineffective peripheral tissue perfusion*** related to decreased cardiac output

- ✓ ***Ineffective self-health maintenance*** related lack of knowledge of disease process, risk factor reduction, rehabilitation, medication

Nursing Interventions of ACS

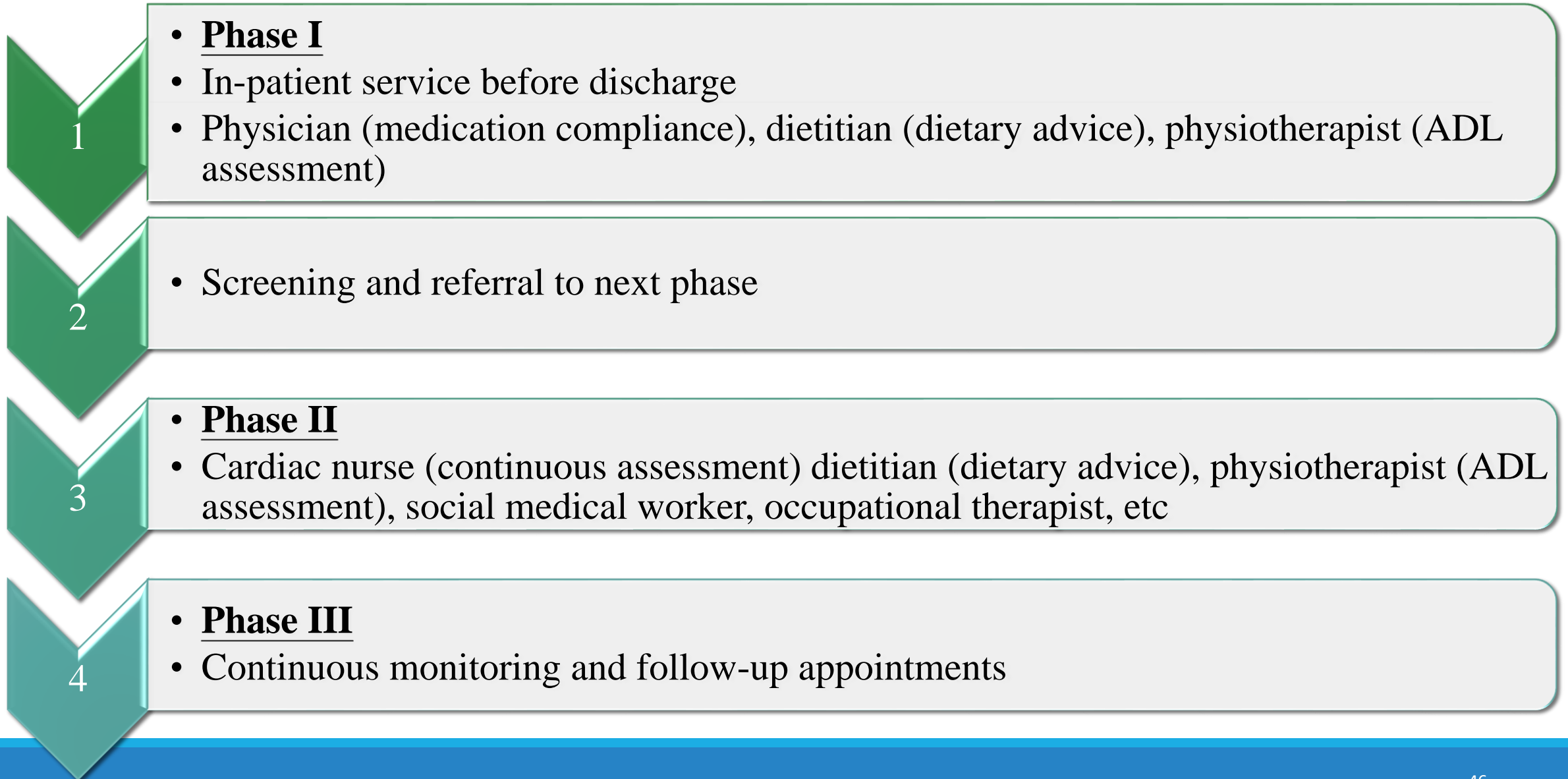| Nursing Diagnoses	Nursing interventions
Release pain	➢Assess and monitor pain severity ➢Obtain 12-lead ECG during pain episode ➢Administer medications to release the pain
Promote adequate tissue perfusion	➢Advice the patient to stop all activities ➢Administer oxygen as ordered ➢Administer thrombolytic drugs if applicable
Reduce anxiety	➢ Assess and monitor verbal & non-verbal signs of anxiety ➢ Encourage verbalization of feelings, perception and fear ➢ Provide factual information concerning diagnosis, treatment and prognosis
Balance physical activity with energy conservative activities	➢Assess patient's difficulty to perform ADL ➢Monitor patient's response to cardiac medication (BP & P) ➢Arrange exercise & rest period to avoid fatigue

Cardiac Rehabilitation

Cardiac Rehabilitation

➤ A process aiming to *reduce cardiovascular risk factors* and improve lifestyle

➤ For *secondary prevention* of cardiovascular complications such as mortality, heart failure, myocardial infarction, coronary artery disease

I. Exercise counseling and training

II. Education for heart-healthy living

III. Counseling to reduce stress

Local Cardiac Rehabilitation Programme

1
- **Phase I**
- In-patient service before discharge
- Physician (medication compliance), dietitian (dietary advice), physiotherapist (ADL assessment)

2
- Screening and referral to next phase

3
- **Phase II**
- Cardiac nurse (continuous assessment) dietitian (dietary advice), physiotherapist (ADL assessment), social medical worker, occupational therapist, etc

4
- **Phase III**
- Continuous monitoring and follow-up appointments

Education on Healthy Living

- Cardiac risk factor modification
  a. smoking cessation
  b. low fat diet
  c. exercise
  d. weight reduction
- Compliance of prescribed medication regime
- Self-care of chest pain (e.g taking TNG, take rest, seek emergency medical care)

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Thank You