Pathophysiology
Ischemic Heart Disease (IHD)

IHD (CAD, CHD, CVD)

- **Ischemic heart disease (IHD), also known as coronary artery disease (CAD) is:**

A lack of oxygen (ischemia), and decreased or no blood flow to the myocardium, resulting from coronary artery **narrowing** or **obstruction**.

- **IHD** is a condition of **recurring chest pain** or **discomfort** that occurs when a part of the heart does ***not receive enough blood***.

IHD

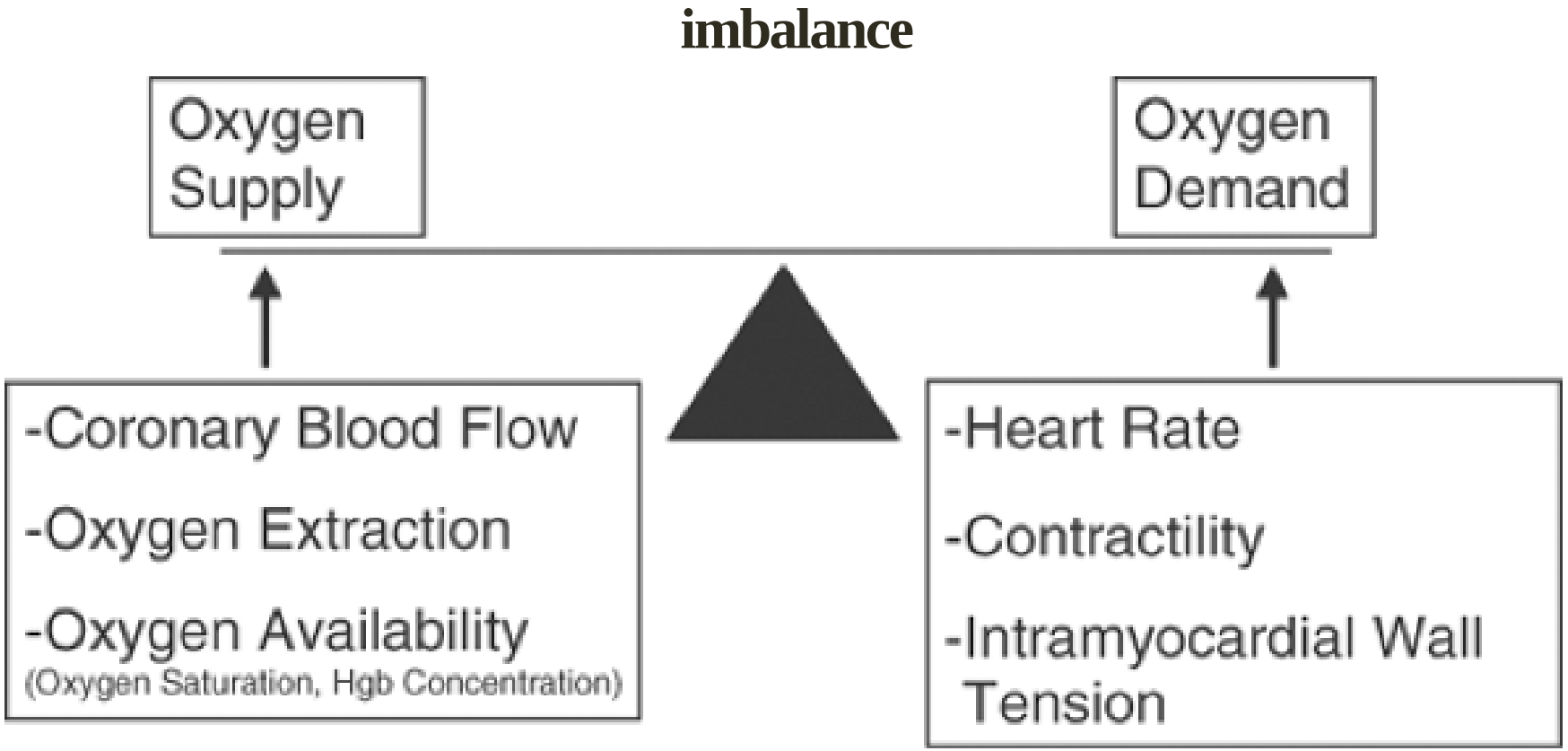
- **IHD** occurs most often during ***exertion*** or ***excitement***, when the heart requires greater blood flow.

- **IHD** also called **coronary heart disease (CHD)**, is common in the United States and is a leading cause of death worldwide.

IHD

- **IHD** is the leading cause of death for both men and women in the United States.
- As an estimate, 2,400 Americans die of CVD each day
- The incidence of **IHD** is *higher in middle-aged men* compared with women.
- The rate of **IHD** increases ***twofold to threefold*** in women after menopause…why?

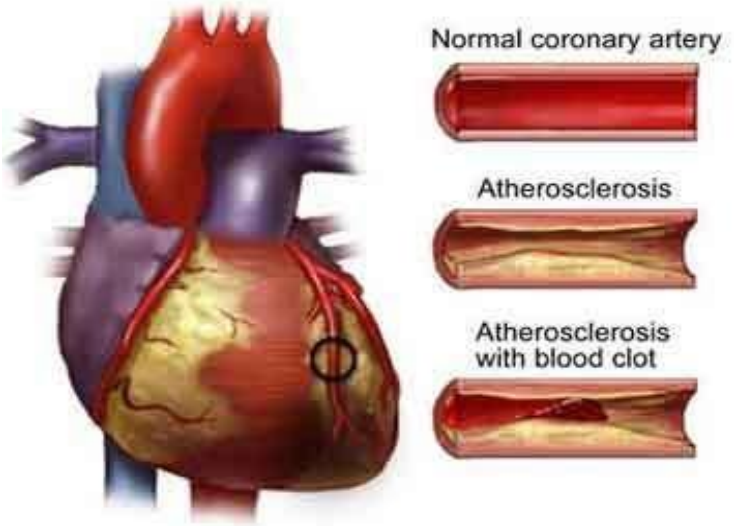
IHD is a result of increased demand in the face of a fixed supply of oxygen in most situations



Atherosclerotic plaque

- When atherosclerotic disease is present, the artery lumen is narrowed and vasoconstriction is impaired

- Coronary blood flow cannot increase in the face of increased demands and ischemia may result



IHD

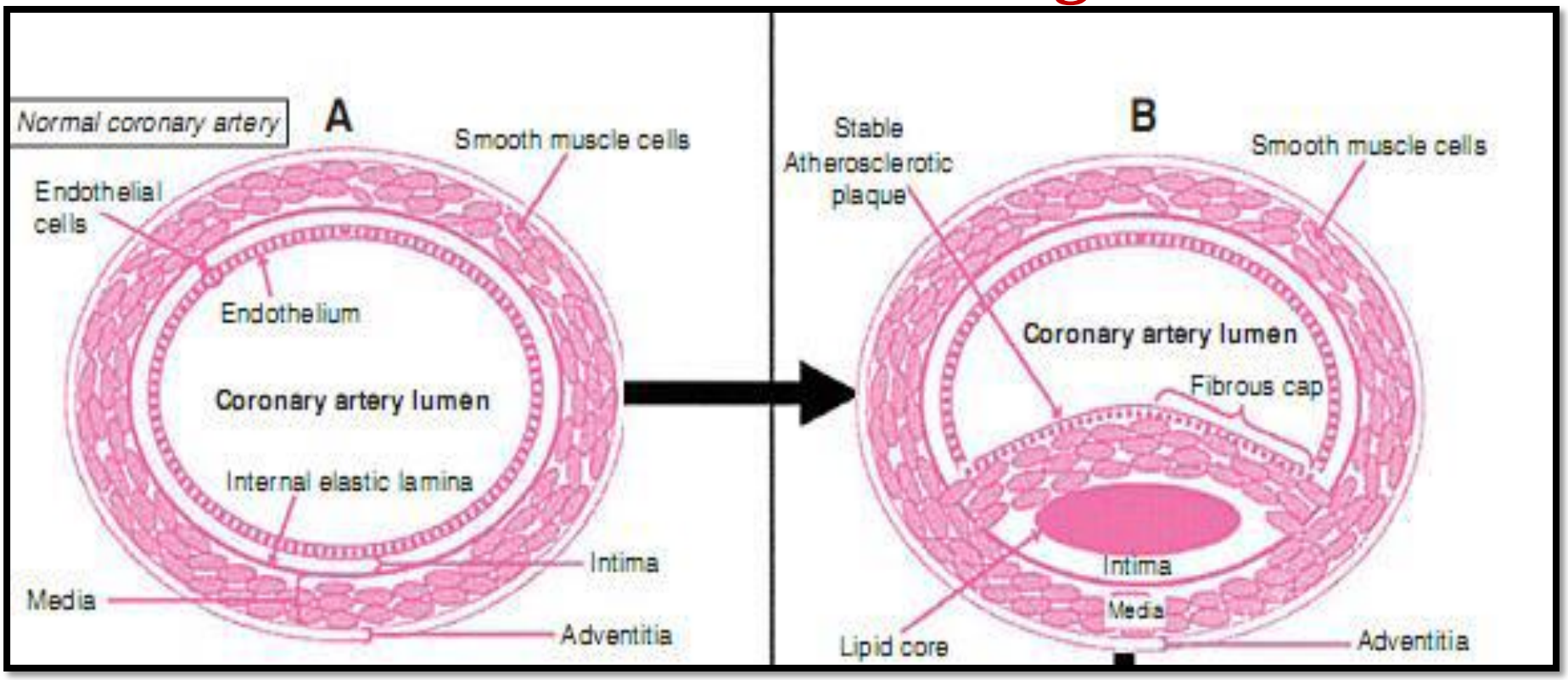
- ***IHD presents as***:

A) chronic stable angina (CSA); angina upon exertion.

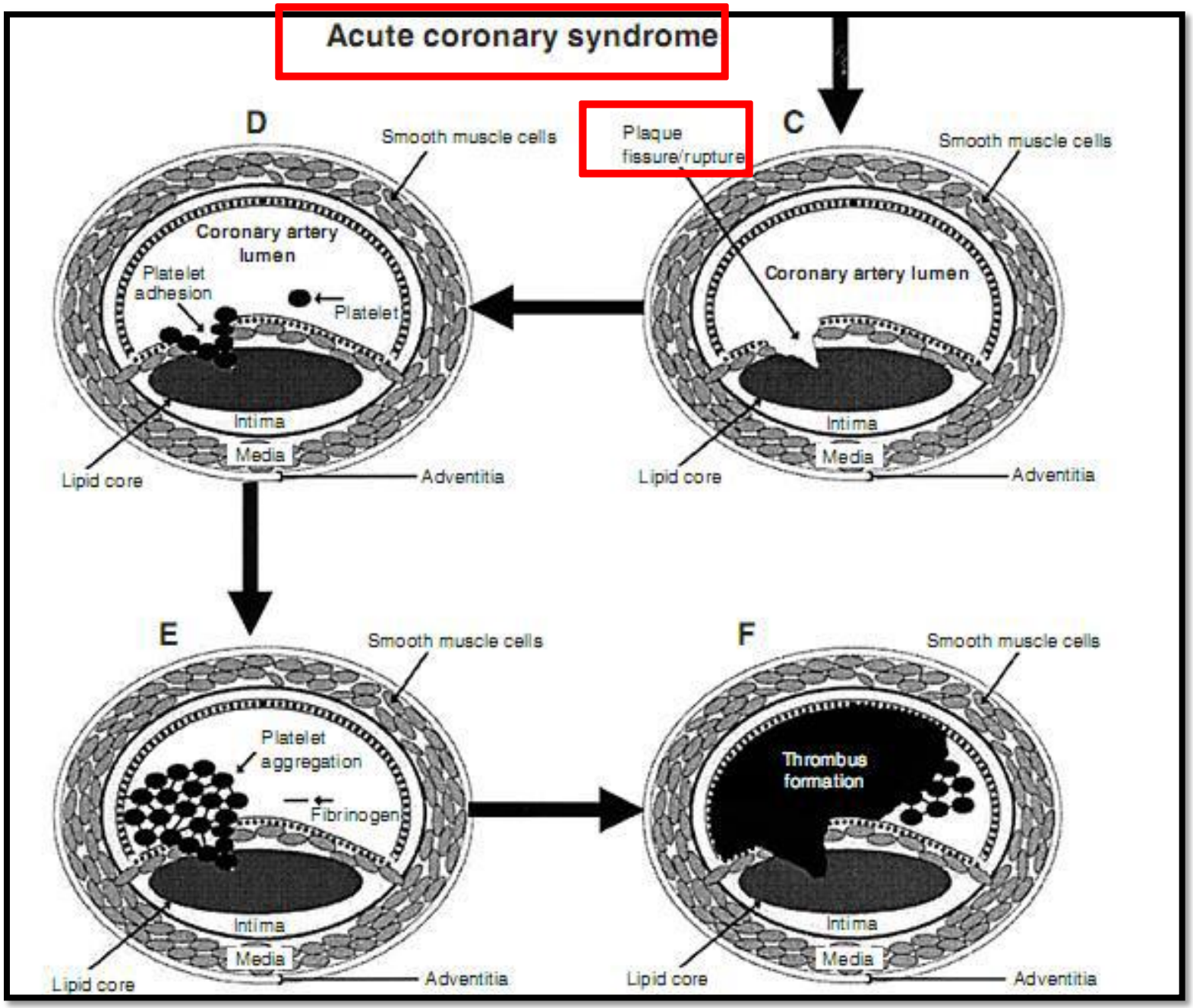
B) acute coronary syndrome (ACS); angina at rest:

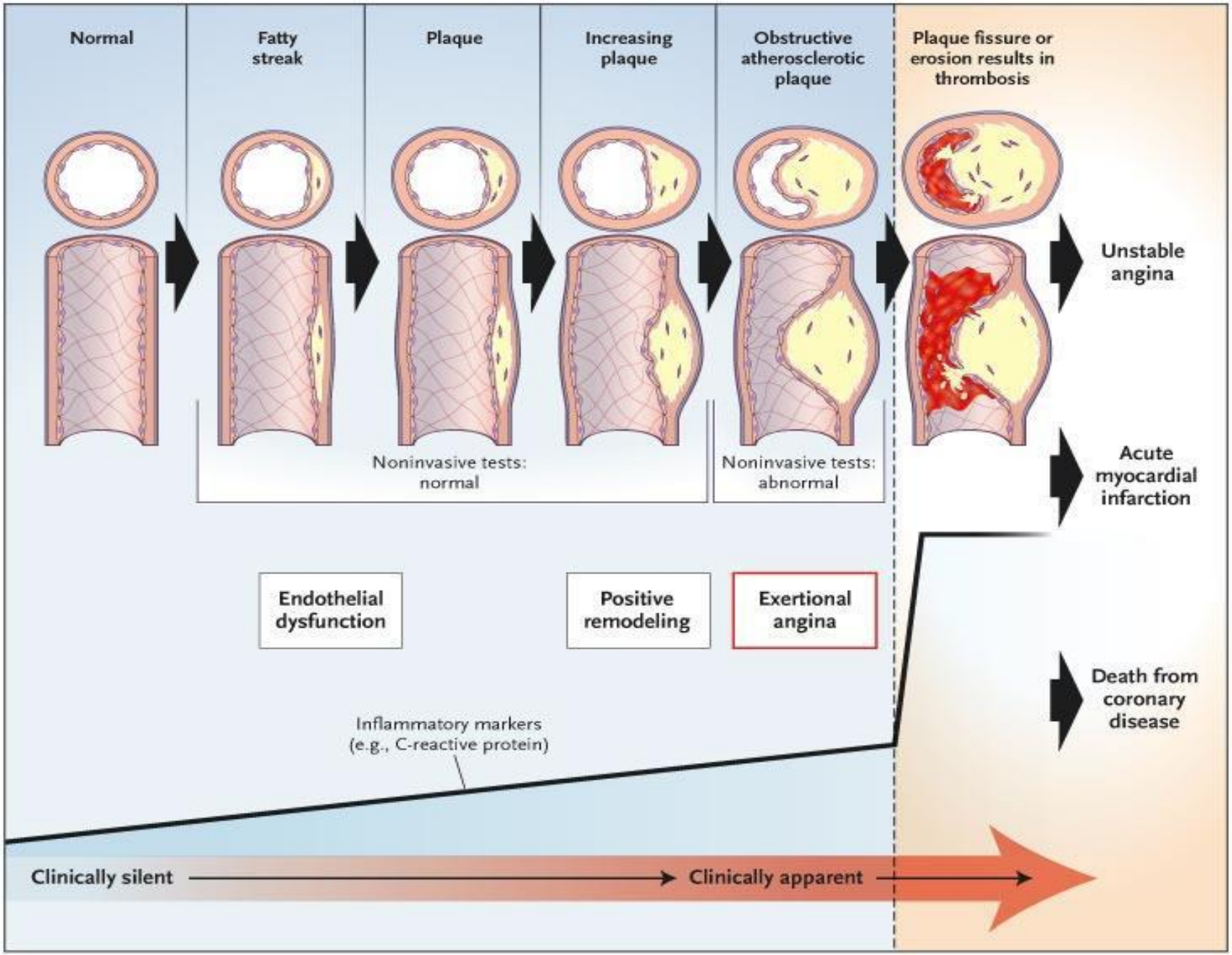
  - Unstable Angina (UA)
  - Myocardial Infarction (MI)

Coronary Atherosclerosis leads to the formation of stable angina



Panel A depicts the cross-section of a normal coronary artery.
Panel B depicts the cross-section of a coronary artery with a stable atherosclerotic plaque. Note that the lipid core is relatively small in size and the fibrous cap is made up of several layers of smooth muscle cells.

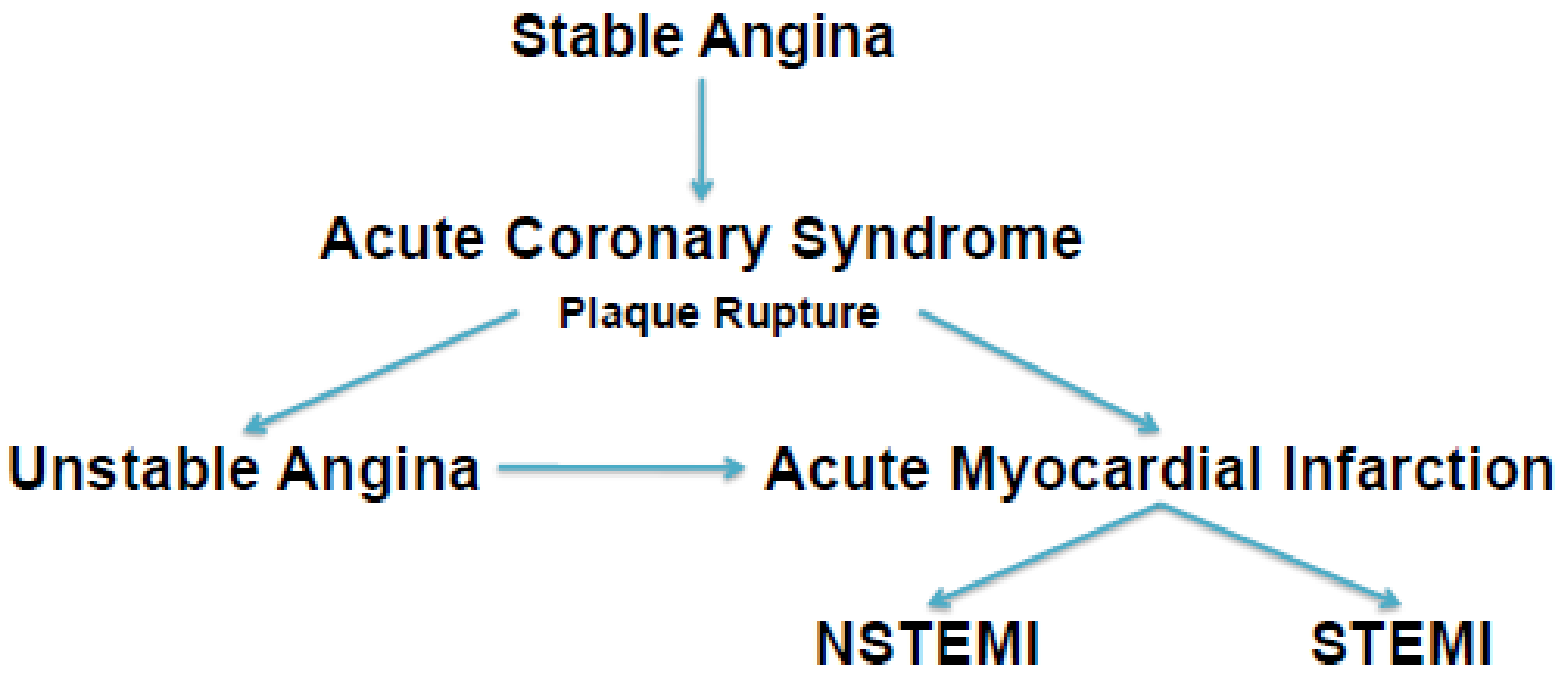

Acute coronary syndrome
D
Smooth muscle cells
Coronary artery lumen
Platelet adhesion
Platelet
Intima
Media
Lipid core
Adventitia
Plaque fissure/rupture
C
Smooth muscle cells
Coronary artery lumen
Intima
Media
Lipid core
Adventitia
E
Smooth muscle cells
Platelet aggregation
Fibrinogen
Intima
Media
Lipid core
Adventitia
F
Smooth muscle cells
Thrombus formation
Intima
Media
Lipid core
Adventitia


Normal
Fatty streak
Plaque
Increasing plaque
Obstructive atherosclerotic plaque
Plaque fissure or erosion results in thrombosis
Unstable angina
Noninvasive tests: normal
Noninvasive tests: abnormal
Acute myocardial infarction
Endothelial dysfunction
Positive remodeling
Exertional angina
Death from coronary disease
Inflammatory markers (e.g., C-reactive protein)
Clinically silent
Clinically apparent

IHD

- In **chronic stable angina**, atherosclerotic plaques are the most common cause of coronary artery narrowing and reductions in coronary blood flow.
- In contrast, in **ACS**, disruption of an atherosclerotic plaque with subsequent thrombus (blood clot) formation causes abrupt reductions in coronary blood flow and oxygen supply.

Cardiovascular Event Pathway



Angina

- **Most common angina types**:

1) Stable Angina.

2) Unstable Angina.

3) Prinzmetal’s (Variant) Angina.

Chronic Stable Angina (CSA)

- **Chronic stable angina** also known as **'effort angina**', this refers to the classic type of angina related to **myocardial ischemia**.

- **Typical presentation of stable angina** is that of chest discomfort and associated symptoms precipitated by some activity (running, walking, etc.)
- Relief of symptoms happens with rest or after administration of **sublingual nitroglycerin**.

Chronic Stable Angina (CSA)

- **Symptoms** typically *decline several minutes after activity and happen again when activity resumes*.
- Other recognized precipitants of stable angina include cold weather, heavy meals, and emotional stress.

Chronic Stable Angina (CSA)

- The patient has occasional periods of anginal symptoms, which are usually **predictable and related to the amount of the heart work (**Myocardial oxygen consumption (MVO_2) **).**
- Underlying pathology is **usually atherosclerosis**
- Anginal episodes can be precipitated by **exercise, cold, stress, emotion, or eating.**
- Often a **chronic condition**
- Characterized by the need for **chronic and/or prophylaxis medication (???) to prevent chest pain/discomfort.**

Unstable angina (UA)

- **Unstable angina** is defined as angina pectoris that changes or worsens.

- **UA** may occur ***unpredictably at rest***, which may be *a serious indicator of an impending heart attack*.

- What differentiates *stable angina from unstable angina* (other than symptoms) is the **pathophysiology of the atherosclerosis**.

- The *pathophysiology of unstable angina* is the reduction of coronary flow due to transient platelet aggregation on apparently normal endothelium, coronary artery spasms, or coronary thrombosis.

Unstable Angina (UA)

- Caused by *recurrent episodes of small platelet clots* at the site of a ruptured atherosclerotic plaque which can also *precipitate local vasospasm*.
- Associated with a *change in the character*, *frequency*, and *duration of angina in patients with stable angina* and *when there are prolonged episodes of angina at rest*.
- **Urgent medical condition**
  - Requires ***aggressive medical management to prevent MI***
- part of the clinical spectrum of acute coronary syndrome

Prinzmetal's (Variant) Angina.

- **Prinzmetal's angina, Variant angina, *and less commonly* vasospastic angina**, **angina inversa**, **coronary vessel spasm**, or **coronary artery vasospasm**

- It is a syndrome typically consisting of **angina** (cardiac chest pain) that unlike classical angina, which is triggered by exertion or exercise, commonly occurs in individuals at rest or even asleep.

- **Prinzmetal's angina** almost always occurs ***when a person is at rest, usually between midnight and early morning***. These attacks can be *very painful.*

- It is caused by **vasospasm**, a ***narrowing of the coronary arteries*** due to *contraction of the smooth muscle tissue in the vessel walls*.

Assessment of IHD risk factors

- **Age / gender**
  - M > 45yrs, F > 55yrs*
- **Family history** of premature **IHD**
  - **M < 55yrs, F < 65yrs**
- **Hypertension**
  - BP > 140/90 or on anti-hypertensive therapy
- **Smoking**
- **Hyperlipidemia**
  - **HDL** < 40 mg/dL (**> 60 (subtract one risk factor**)
- **Diabetes**
- **Obesity**
  - BMI >30 kg/m2
- Sedentary lifestyle
- **CVD**
- **PAD**

Table 7–2

Major Risk Factors for Ischemic Heart Disease

Modifiable	Nonmodifiable
Cigarette smoking	Age ≥ 45 years for men, age ≥ 55 years for women
Dyslipidemia • Elevated LDL or total cholesterol • Reduced HDL cholesterol	Gender (men and postmenopausal women)
Diabetes mellitus	Family history of premature cardiovascular disease, defined as cardiovascular disease in a male first-degree relative (ie, father or brother) < 55 years or a female first-degree relative (ie, mother or sister) < 65 years
Hypertension	
Physical inactivity	
Obesity (body mass index ≥ 30 kg/m^2)	
Low daily fruit and vegetable consumption	
Alcohol overconsumption	

IHD

- Early detection and aggressive modification of risk factors are among the ***primary strategies for delaying IHD progression and preventing IHD-related events including death***.

- Patients with multiple risk factors, particularly those with **diabetes**, are at the **greatest risk for IHD**, experiencing **fivefold to sevenfold** higher risk compared *to individuals without risk factors.*

IHD

- The **five components** commonly used to characterize chest pain are ***quality***, ***location***, and ***duration*** of pain; ***factors that provoke pain***; and ***factors that relieve pain***:
  - **Typical pain**: sensation of pressure, heaviness, or squeezing in the anterior chest area. **Sharp pain** is **not** a typical symptom of **IHD**.
  - **may radiate** to the **neck**, **jaw**, **shoulder**, **back**, or **arm**.
  - may be accompanied by **dyspnea**, **nausea**, **vomiting**, or **diaphoresis**.

IHD

- Symptoms of stable angina are often provoked by ***exertion*** (e.g., walking, climbing stairs, and doing yard work or housework), **emotional stress, exposure to cold temperatures** and **heavy meals. *Symptoms relieved within minutes*** by **rest** or **sublingual nitroglycerin**.

- Symptoms of ***ACS***: *pain* occurs **at rest** (without provocation) that is ***prolonged*** and ***unrelieved by sublingual nitroglycerin***.

IHD

	Stable Angina	Unstable Angina	MI
Character of pain	Exertional pain	Rest pain	Rest pain
Relievers	Responds to GTN	No GTN effect	No GTN effect
Enzymes	Normal	Normal	Elevated

Diagnosis and evaluation

- A thorough **medical history, physical exam, and laboratory analysis** are necessary to ascertain cardiovascular risk factors.

- Laboratory analyses should assess for **glycemic control** (i.e., fasting glucose, glycosylated hemoglobin), **fasting lipids**, **hemoglobin**, and **organ function** (i.e., blood urea nitrogen, creatinine, liver function tests, thyroid function tests).

Diagnosis and evaluation

- Electrocardiogram (ECG): A 12-lead **ECG recorded** during rest is often normal in patients with ***chronic stable angina*** in the *absence of active ischemia*.
  - should be done within 10 minutes of presentation to the emergency department in patients with symptoms of ischemia.

Diagnosis and evaluation

- Cardiac troponins T and I are the preferred markers for **myocardial injury** as they have the highest sensitivities and specificities for the diagnosis of **acute myocardial infarction (more sensitive than CK-MB)**.
- **Serum levels increase within 3-12 hours from the onset of chest pain, peak at 24-48 hours, and return to baseline over 5-14 days**

The risk of death from an ACS is directly related to troponin level and patients with no detectable troponins have a good short-term prognosis.

- **CK-MB levels increase within 3-12 hours of onset of chest pain, reach peak values within 24 hours, and return to baseline after 48-72 hours**

Systemic Hypertension

Definition: Systolic ≥ 140 mm Hg and diastolic ≥ 90 mm Hg , or both of them.

- It is caused by increases in cardiac output, total peripheral resistance or both. Bp=CO X PR
- **The cardiac output (CO)** depends on

✓ heart rate

✓ stroke volume

- **Peripheral resistance (PR)** depends on

✓ blood viscosity

✓ vessel diameter

Classification:

1. Primary hypertension (idiopathic, essential)=**can not be cured!!!** so the patient need to take treatment always. It is the most common more than **95%** of systemic hypertension is primary hypertension.
2. Secondary hypertension

1. Primary hypertension

Risk factors

- family history
- age
- race
- high intake of sodium and low intake of K+, Ca++, Mg++
- glucose intolerance
- smoking
- obesity
- heavy alcoholism

2. Secondary hypertension

- **Causes:**

✓ **Renal diseases** e.g. glomerulonephritis(inflammation not infection).Notice:Renal failure leads to hypertension andd hypertension leads to renal failure

✓ **Endocrine diseases** e.g. hyperaldosteronism, primary hyperparathyrodism, **pheochromocytoma**

✓ **Vascular** e.g. renal artery stenosis

✓ **neurological** e.g. brain tumor

✓ **(iatrogenic)** Drugs e.g. NSAIDs

Systemic Hypertension

- According to the Seventh Report of the Joint National Committee on Detection, Evaluation, and Treatment of High blood pressure, hypertension can be categorised into:

Category	Systolic		Diastolic
Optimal	< 120	And	< 80
Normal	< 130	And	< 85
High-normal (pre-HTN)	130-139	OR	85-89
Hypertension			
Stage 1	140-159	OR	90-99
Stage 2	160-179	OR	100-109
Stage 3	>180	OR	≥ 110

Systemic Hypertension

- **Malignant Hypertension** is when the **diastolic** blood pressure is above 140 mmHg associated **with end-organ damage** such as:
  Encephalopathy
  - **Unstable angina**
  - **Pulmonary edema**
  - **Severe retinopathy Renal failure**
- It occurs in a rapidly deteriorating course.
- It is an **emergency condition**. It is hypertensive emergency