



## Myocardial Infarction

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*Revised by:*

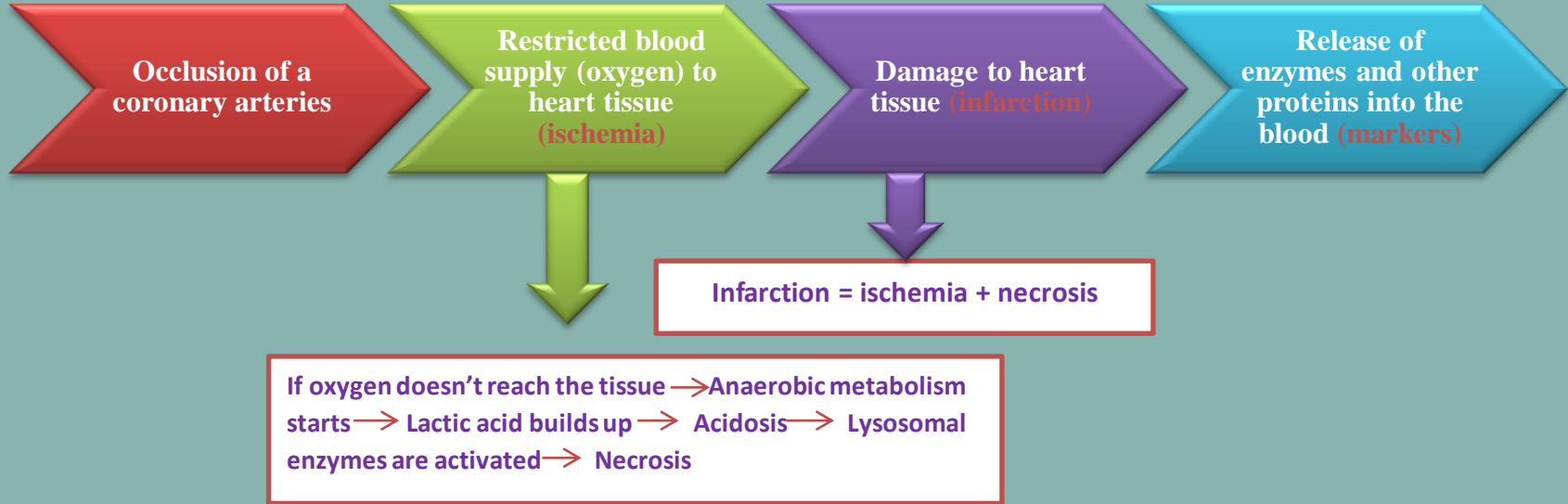
*Mazen AlOtaibi & Saleh Alneghamishi*

### Overview:

- Myocardial infarction
- Time-course of plasma enzyme changes
- Cardiac troponins I and T
- Creatine kinase (CK-MB)
- Myoglobin



## Myocardial infarction is due to:



## Diagnosis of MI:

- Requires presence of at least two of the following characteristics:
  1. Typical heart attack symptoms (Radiating chest pain, sweating...)
  2. Characteristic rise and fall pattern of a cardiac marker in plasma
    - Rise and gradual fall of cardiac troponins
    - More rapid rise and fall of creatine kinase MB
  3. Typical ECG pattern



**Features of an ideal cardiac marker**

High concentration in the myocardium

Absence from non-myocardial tissue

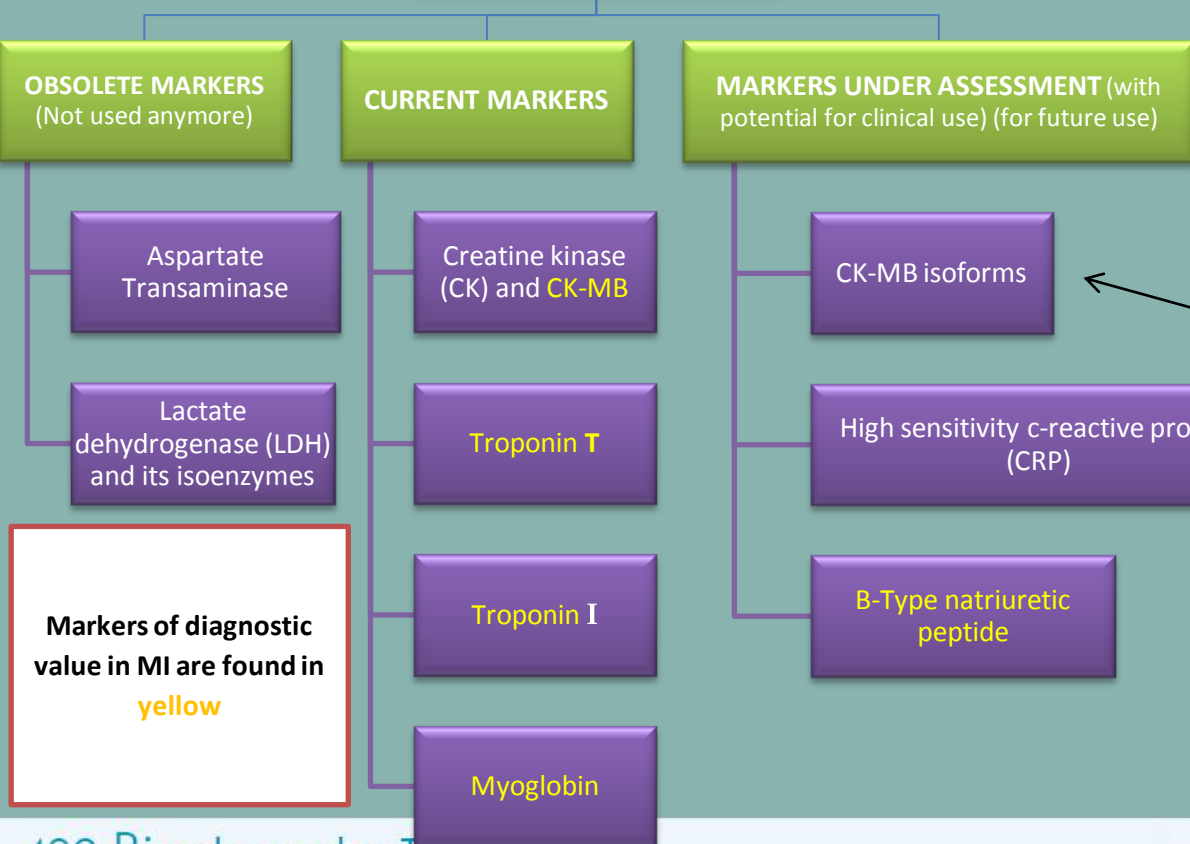
High sensitivity and specificity

Rapid release into plasma following myocardial injury

Correlation between plasma level and extent of myocardial injury for prognosis

Detectable by rapid, simple and automated assay methods

**Plasma MI markers**



Markers of diagnostic value in MI are found in yellow

CK-MB has two isoforms:  
 CK-MB<sub>1</sub> and CK-MB<sub>2</sub>  
 CK-MB<sub>2</sub> is the one that is considered as a marker, because it is released in MI while CK-MB<sub>1</sub> is always present in the plasma



### *Time-course of plasma enzyme changes:*

Plasma enzymes follow a pattern of activities after MI

The initial lag phase ← lasts for about 3 hours

Enzymes rise rapidly to peak levels in 18-36 hours

The levels return to normal based on enzyme half-life

Rapid rise and fall indicates diagnostic value

### *Blood samples collected after MI:*

Baseline (upon admission)

Between 12 to 24 hours after the onset of symptoms

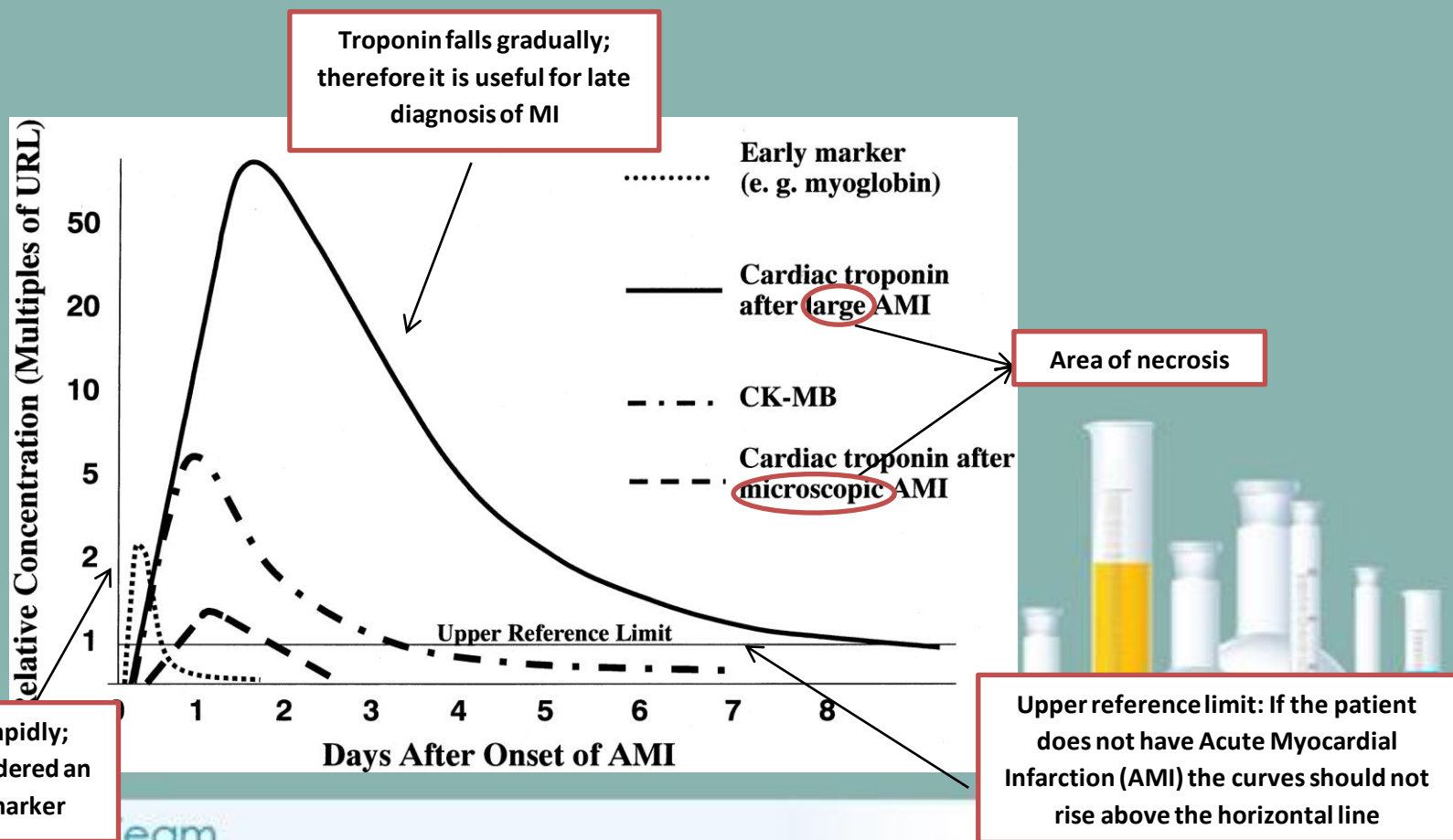
**Lag Phase= The initial phase in which you cannot detect the activity of a marker (Myoglobin has the shortest lag phase therefore it rises rapidly and is considered as an early diagnostic marker)**



Enzyme / Protein (Types of markers)	Troponin	B-type natriuretic peptide (BNP)
	Highly specific markers for detecting MI	sensitive marker of cardiac damage
Detectable (hours)	Appear in plasma in 3-4 h after MI	--
Duration (days)	Up to 10 days	Half-life is ~ 20 min
Advantages	<ul style="list-style-type: none"> <li>cardiac troponins (cTn) are structurally different from muscle troponins (we can differentiate between a myocardial infarction and a skeletal muscle damage)</li> <li>Highly specific</li> </ul>	It causes vasodilation, sodium and water excretion and reduces blood pressure
Disadvantages	--	--
More information	<ul style="list-style-type: none"> <li>Troponins are structural proteins in cardiac myocytes and in skeletal muscle</li> <li>Involved in the interaction between actin and myosin for contraction</li> <li>cTn are mainly bound to proteins, with small amount soluble in the cytosol ("BYPHASIC" After a MI, cytosolic troponins are released rapidly into the blood (first few hours)</li> </ul> <p>Structurally bound troponins are released later for several days</p> <p><b>Two main cardiac troponins (cTn):</b></p> <ul style="list-style-type: none"> <li>- cTnI: inhibitory protein</li> <li>- cTnT: binds to tropomyosin</li> </ul>	BNP is a peptide hormone produced by the ventricles of the heart in response to: Myocardial stretching and ventricular dysfunction after MI

Enzyme / Protein (Types of markers)	CK-MB	Myoglobin
	more sensitive and specific for MI <u>than total CK</u>	sensitive marker of cardiac damage
	rises and falls transiently after MI	rises very rapidly after the MI
<b>Detectable (hours)</b>	Appears in blood within 4-6 hours of heart attack	Appears within 1-4 hours
<b>Peak value (hours)</b>	Peak 12 - 24 hours	—
<b>Duration (days)</b>	1.5-3 days	—
<b>Advantages</b>	<ul style="list-style-type: none"> <li>early diagnosis of MI</li> <li>diagnosis of re-infarction</li> </ul>	Early marker
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>Not significant if measured after 2 days of MI (delayed admission)</li> <li>Not highly specific (elevated in skeletal muscle damage)</li> </ul>	<ul style="list-style-type: none"> <li>non-specific because it is elevated in: <ul style="list-style-type: none"> <li>Muscle disease/injury</li> <li>Acute and chronic renal failure</li> </ul> </li> </ul>
<b>More information</b>	<ul style="list-style-type: none"> <li>Relative index = <math>\text{CK-MB mass} / \text{Total CK} \times 100</math> More than 5 % is indicative for MI</li> <li>Returns to normal within 2-3 days</li> </ul>	—

Type	Composition	Comment
Skeletal Muscle	98% CK-MM 2% CK-MB	Elevated in muscle disease
Cardiac muscle	70-80% CK-MM 20-30% CK-MB	Cardiac muscle has highest amount of CK-MB
Brain	CK-BB	Doesn't cross Blood Brain Barrier (BBB)
Plasma	Mainly CK-MM	



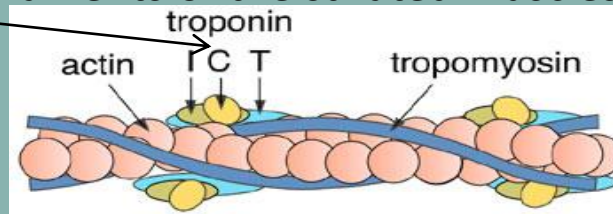
## MI Marker Recommendations:

- Measurement of plasma MI markers
  - Upon admission of patient
  - Serially thereafter
- Use of fast and robust test methods for marker detection
- **Types of markers:**
  - Early markers (myoglobin)
  - Highly specific markers (cardiac troponins)
  - CK-MB is the second choice after troponins

## Extra Notes!

- Troponin is a sensitive, specific, prognostic (The amount of it in the plasma correlates with the severity of the injury) marker
- Troponin is in the actin of thin filaments of the striated muscles

Troponin C  
binds to  
Calcium



- We cannot differentiate between the myoglobin of the cardiac muscle and the skeletal muscle, therefore Myoglobin is used only for ruling out not for diagnosis (If myoglobin is not elevated we know for sure there is no MI, if elevated it could be MI or not)



## MCQs:

- **Which one of these markers is considered as an obsolete marker :**

A- Myoglobin  
B- CRP  
C- LDH and its isoenzymes  
D- Troponin T

Answer : C

- **For how much time does the initial lag phase last :**

A- 18-36 hours  
B- 3 h  
C- up to 10 days  
D- 12-24 h

Answer: B

- **Troponins appear in plasma in..... after MI and remain for .....:**

A- 3-10 h - 1.5-3 days  
B- 4-6 h – 2-3 days  
C- 5-12 h - 2-5 days  
D- 3-4 h - up to 10 days

Answer: D

- **Which MI marker is more specific?**

A) Total CK  
B) Troponin  
C) Myoglobin  
D) LDH

Answer: B



- **Which type of the following markers is the earliest marker?**

A- cardiac troponins  
B- CK-MB  
C- Myoglobin  
D- BNP

Answer: C

- **Which one of the following markers reduces blood pressure?**

A- BNP  
B- Troponins  
C- Creatine kinase  
D- Myoglobin

Answer: A

- **A patient came to the clinic complaining from chest pain that started a week ago, which one of the following markers would you measure?**

A- BNP  
B- Troponins  
C- Creatine kinase  
D- Myoglobin

Answer: B

- **Which of the following starts first to rise ?**

A) Troponin  
B) Myoglobin  
C) CK-MB  
D) LDH

Answer: B