Universal Definition of Myocardial Infarction

Guidelines for the Application of the Universal Definition of Myocardial Infarction

Organisation of the Global Task Force

Auspices of ESC- ACCF - AHA - WHF

Executive Group

ECG WG	Biomarker WG	Imaging WG	Clin. Invest. WG	Intervention WG

Global Perspective WG	Plenary Session	Implementation WG

Editing Group
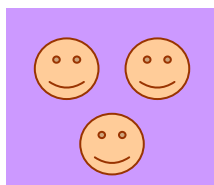
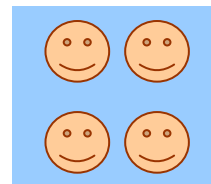Presentation   Publication   Implementation

Compositions of the Working Groups
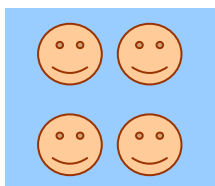
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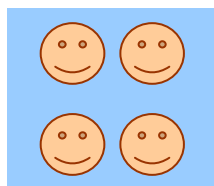HD White NZ

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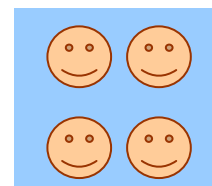LK Newby US
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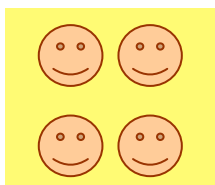EEVD Wall NL

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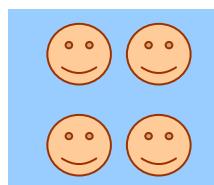
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EM Antman US
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CW Hamm DE
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Implementation Group
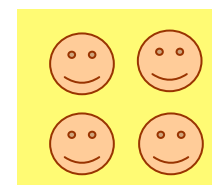
LC Wallentin SE
F Fernandez-Avilés ES
KM Fox UK
AN Parkhomenko UA
SG Priori IT
M Tendera PL
L-M Voipio-Pulkki FI

Definition of Myocardial Infarction Pathology

Acute myocardial infarction is defined as myocardial cell death due to prolonged myocardial ischemia

Death of heart tissue due to blocked coronary artery

Classification of Myocardial Infarction

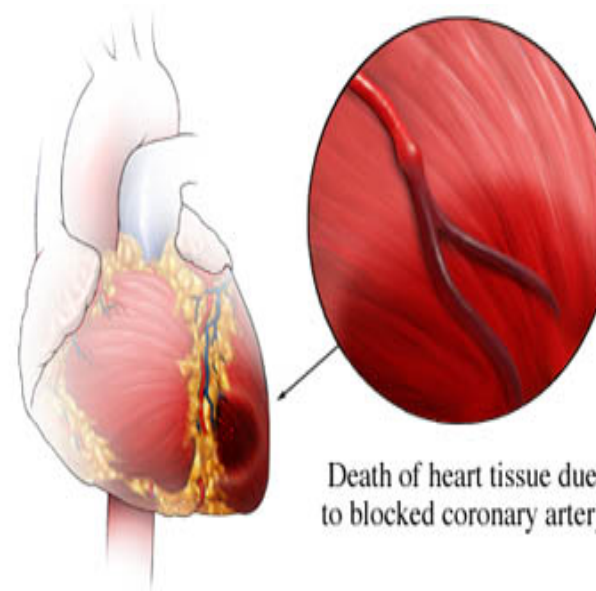**Type 1**   Spontaneous myocardial infarction related to ischemia due to a primary coronary event such as plaque erosion or rupture, fissuring or dissection

Type 2   Myocardial infarction secondary to ischemia due to imbalance between oxygen demand and supply e.g. coronary spasm, anemia, or hypotension

Type 3   Sudden cardiac death with symptoms of ischemia, accompanied by new ST elevation or LBBB, or verified coronary thrombus by angiography or autopsy, but death occurring before blood samples could be obtained

Type 4a Myocardial infarction associated with PCI
Type 4b Myocardial infarction associated with verified stent thrombosis

Type 5   Myocardial infarction associated with CABG

Myocardial Infarction Type 1

Spontaneous myocardial infarction related to ischemia due to a primary coronary event such as plaque erosion, fissuring, or dissection

Blocked Lumen in Branch of Left Coronary Artery

Anterior Infarct
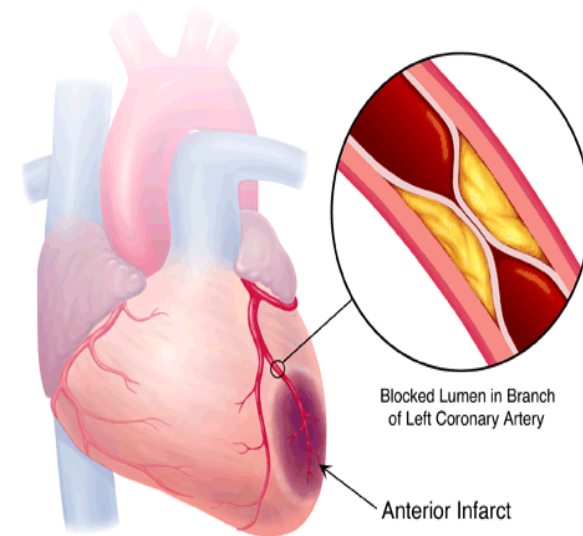
Myocardial Infarction Type 2

Myocardial infarction secondary to ischemia due to either increased oxygen demand or decreased supply e.g. spasm, anemia, arrhythmia, or hypotension

Blocked artery

Damaged heart muscle

Spasm
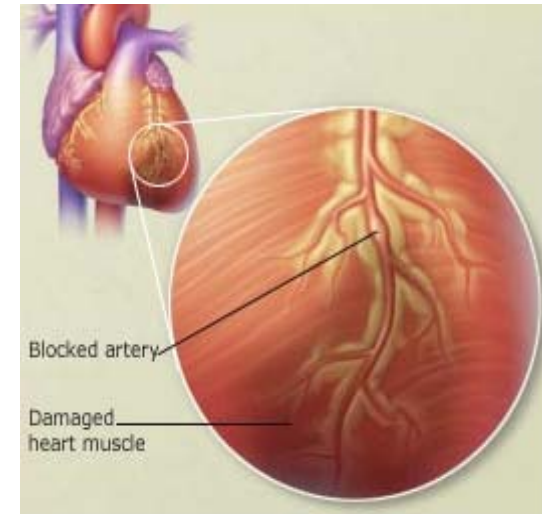
Criteria for Acute Myocardial Infarction Type 1 and Type 2

Detection of rise and/or fall of cardiac biomarkers (preferably troponin) with at least one value above the 99th percentile of the upper reference limit together with evidence of ischemia with at least one of the following:

- Symptoms of ischemia

- ECG changes of new ischemia (new ST-T changes or new LBBB)

- Development of pathological Q waves in the ECG

- Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality

Biomarkers for Detection of Myocardial Infarction

Preferably

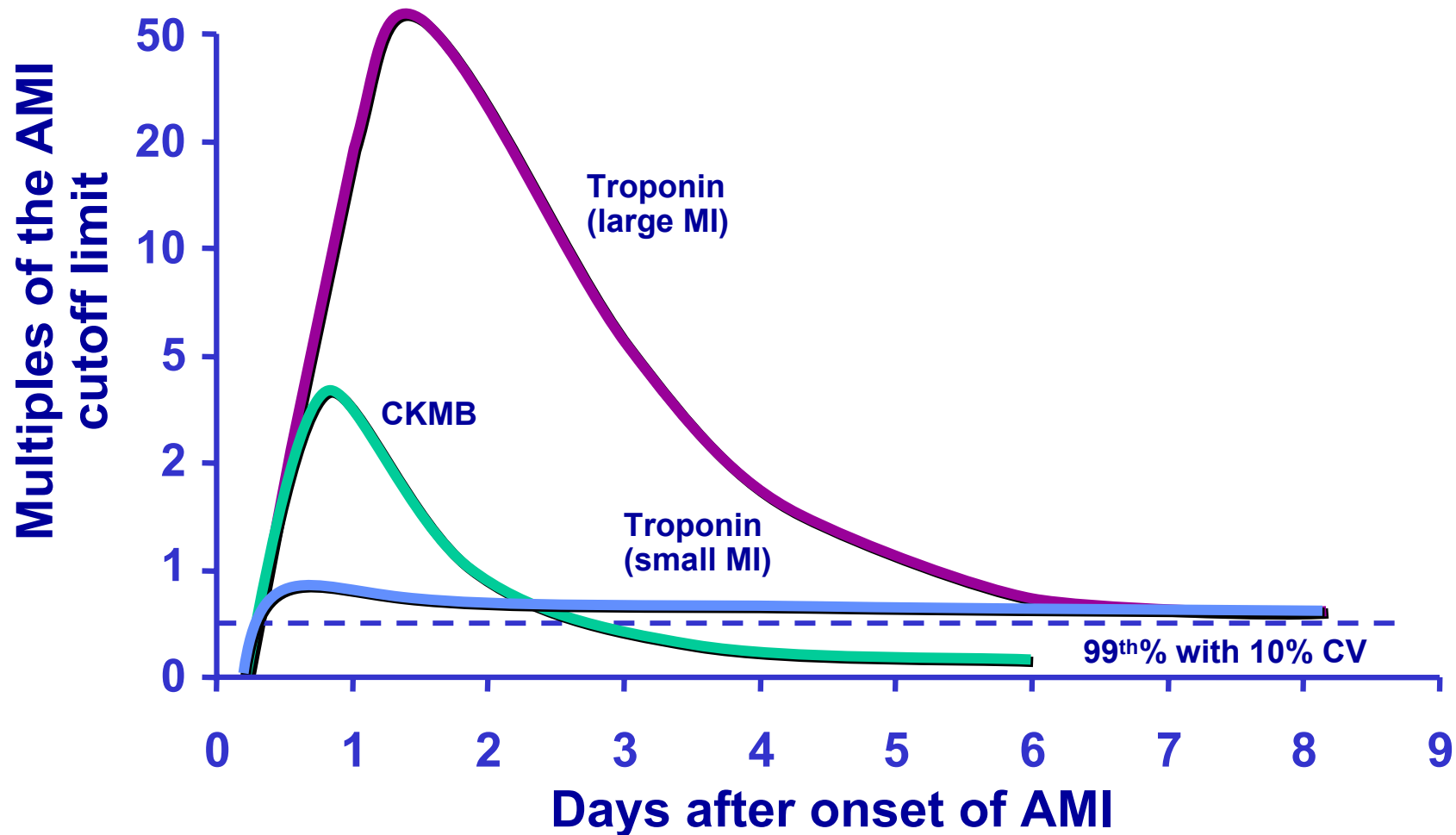Detection of rise and/or fall of Troponin (I or T) with at least one value above the 99th percentile of the upper reference limit measured with a coefficient of variation $\leq$ 10%

When Troponin is not available

Detection of rise and/or fall of CKMB mass with at least one value above the 99th percentile of the upper reference limit measured with a coefficient of variation $\leq$ 10%

Appearance of Biomarkers in Blood after Onset of Myocardial Infarction

Multiples of the AMI cutoff limit

Days after onset of AMI

Troponin (large MI)

CKMB

Troponin (small MI)

99th% with 10% CV

Elevations of Troponin in the Absence of Overt Ischemic Heart Disease

- Cardiac contusion, or other trauma including surgery, ablation, pacing etc
- Congestive heart failure – acute and chronic
- Aortic dissection, aortic valve disease
- Hypertrophic cardiomyopathy
- Tachy- or bradyarrhythmias, or heart block
- Apical ballooning syndrome
- Rhabdomyolysis with cardiac injury
- Pulmonary embolism, severe pulmonary hypertension
- Renal failure
- Acute neurological disease, including stroke, or subarachnoid hemorrhage
- Infiltrative diseases, e.g., amyloidosis, hemochromotosis, sarcoidosis or scleroderma
- Inflammatory diseases, e.g., myo/pericarditis or myocardial extension of endocarditis
- Drug toxicity or toxins
- Critically ill patients, especially with respiratory failure, or sepsis
- Burns, especially if affecting > 30% of body surface area
- Extreme exertion
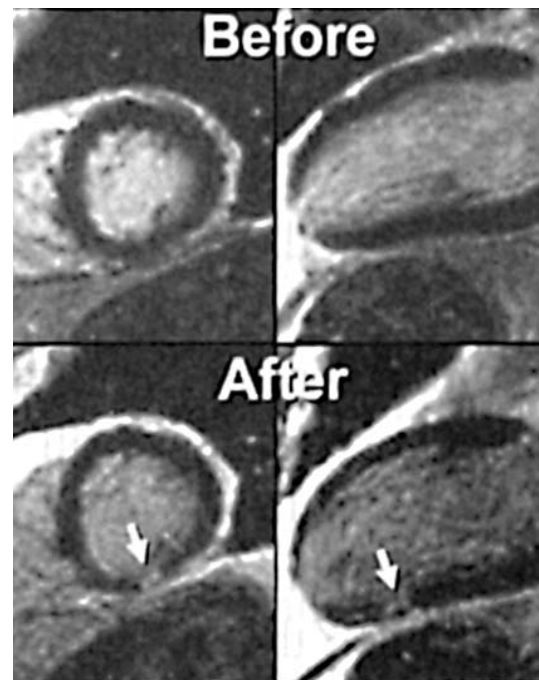
Myocardial Infarction Type 3

Sudden cardiac death, often with symptoms of myocardial ischemia, accompanied by new ST elevation or new LBBB, or verified coronary thrombus by angiography and/or autopsy, but death before blood samples are obtained, or before appearance of biomarkers in blood
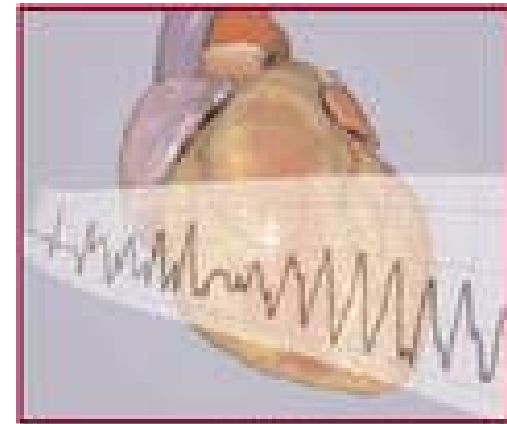
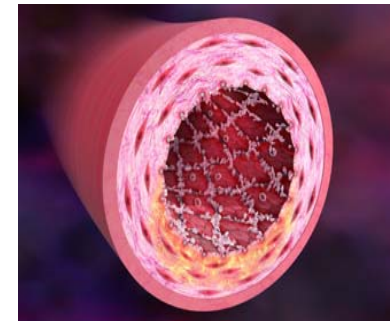# Myocardial Infarction Type 4a

PCI-related increase of biomarkers (assuming a normal troponin baseline) > 3 X 99th percentile of the upper reference limit (URL) is by convention defined as myocardial infarction
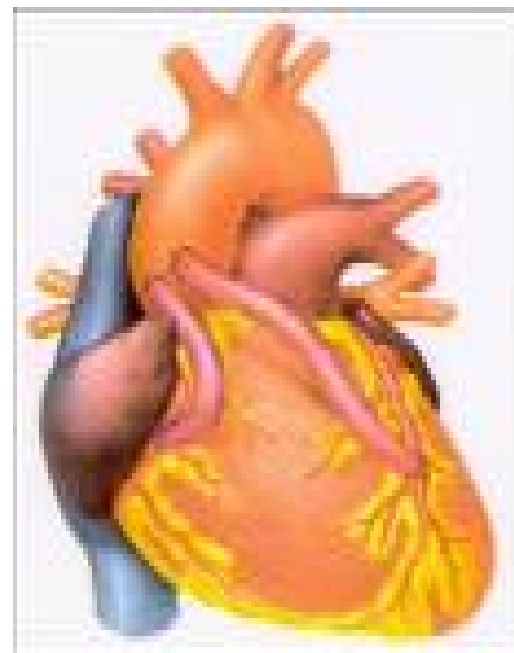
Myocardial Infarction Type 4b

Stent-thrombosis, documented by coronary angiography or autopsy and in addition, meeting the criteria for spontaneous myocardial infarction

Myocardial Infarction Type 5

CABG-related increase of biomarkers > 5 X 99th percentile URL plus either new Q waves or new LBBB, or angiographically verified new graft or native coronary occlusion, or imaging evidence of new loss of viable myocardium is by convention defined as myocardial infarction

Criteria for Prior Myocardial Infarction

➤ **Development of new pathological Q waves with or without symptoms**

➤ **Imaging evidence of a region of loss of viable myocardium that is thinned and fails to contract, in the absence of a non-ischemic cause**

➤ **Pathological findings post-mortem of a healed or healing myocardial infarction**
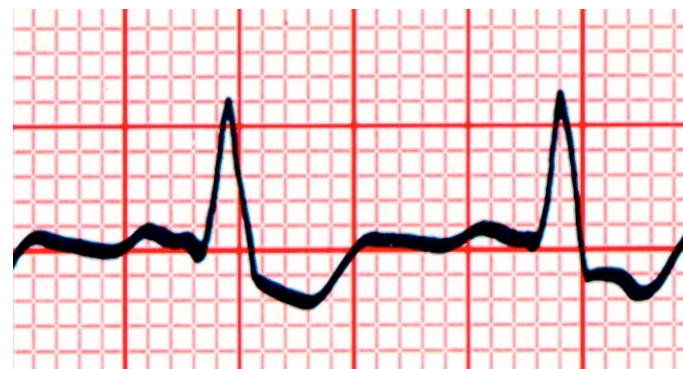
ECG Manifestations of Acute Myocardial Ischemia

New ST elevation at the J point ≥ 0.2 mV in men or ≥ 0.15 mV in women in V_2-V_3; and/or ≥ 0.1 mV in other leads in both genders

ECG Manifestations of Acute Myocardial Ischemia

New ST depression, horizontal or down-sloping ≥ 0.05 mV in two contiguous leads; and/or T inversion ≥ 0.1 mV in two leads with prominent R wave or R/S ratio > 1

ECG Manifestations of Prior Myocardial Infarction

Any Q wave in V_2-V_3 ≥ 0.02 sec or QS complex in V_2-V_3;

or Q-wave ≥ 0.03 sec and

≥ 0.1 mV deep or QS complex in any two contiguous leads of I, aVL, V_6; V_4-V_6; II, III, aVF

ECG Pitfalls in Diagnosing Myocardial Infarction

False positives

- Benign early repolarization
- LBBB
- Pre-excitation
- Brugada syndrome
- Peri-/myocarditis
- Pulmonary embolism
- Subarachnoid hemorrhage
- Metabolic disturbances such as hyperkalemia
- Failure to recognize normal limits for J-point displacement
- Lead transposition or use of modified leads configuration
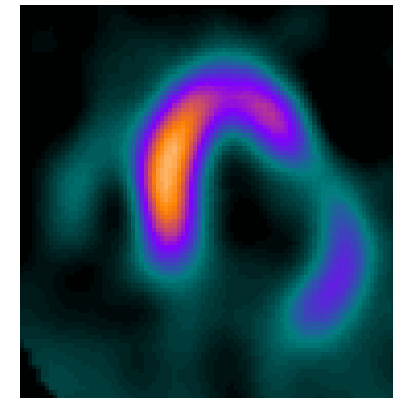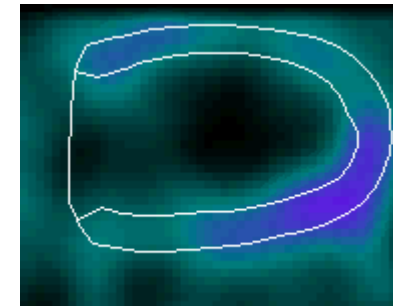- Cholecystitis

False Negatives

- Prior Q waves and/or persistent ST-elevation
- Paced rhythm
- LBBB

# Imaging Evidence of Acute Myocardial Infarction

Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality with biomarker criteria for myocardial infarction in the absence of a non-ischemic cause

Imaging Evidence of Prior Myocardial Infarction

Imaging evidence of a region of loss of viable myocardium that is thinned and fails to contract in the absence of a non-ischemic cause
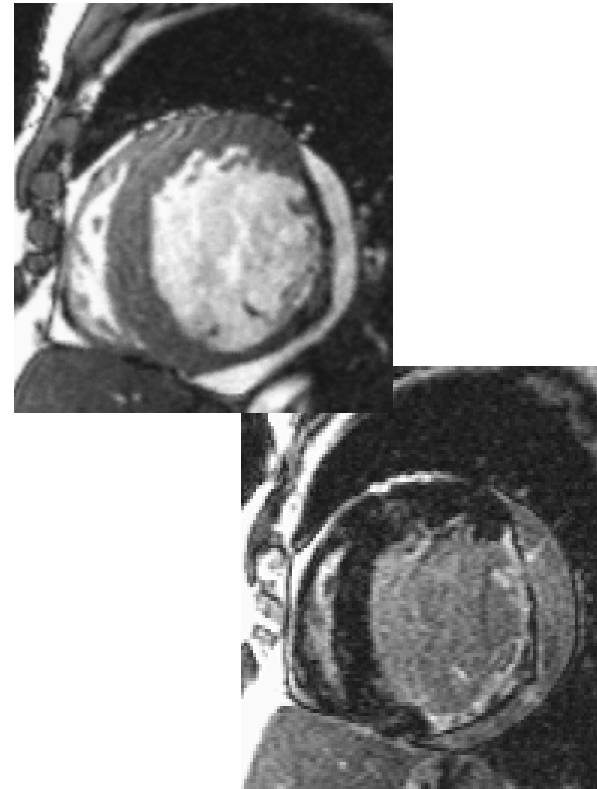
Criteria for Diagnosing Reinfarction

Recurrent ischemic symptoms and/or ECG changes following the initial infarction together with an increase ≥ 20% of biomarkers (preferably troponin) measured after the recurrent event with at least one value above the 99th percentile of the reference range

cTn μg/L

Recurrent Chest Pain

99th % Value

0   24   48   72   96   120   Hrs
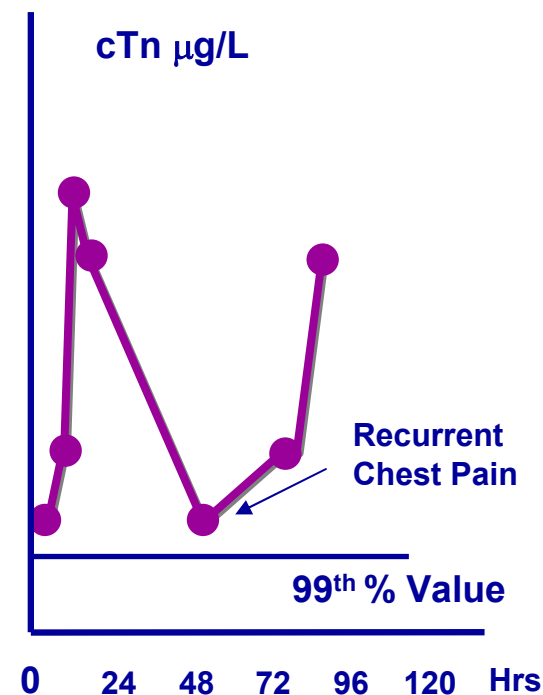
Tabulation of Myocardial Infarction by Multiples of the Decision Limit

Classification of the different types of myocardial infarction according to multiples of the 99th percentile URL of the applied cardiac biomarker

Multiples X 99%	MI Type 1 (spontaneous)	MI Type 2 (secondary)	MI Type 3* (sudden death)	MI Type 4a** (PCI)	MI Type 4b (stent thrombosis)	MI Type 5** (CABG)	Total Number
1-2 X							
2-3 X							
3-5 X							
5-10 X							
> 10 X							
Total number							

*Biomarkers are not available for this type of myocardial infarction since the patients expired before biomarker determination could be performed.

**For the sake of completeness, the total distribution of biomarker values should be reported. The hatched areas represent biomarker elevations below the decision limit used for these types of myocardial infarction.

Reporting Myocardial Infarction by Types in Clinical Trials

Sample clinical trial tabulation of randomized patients by types of myocardial infarction

Types of MI	Treatment A Number of patients	Treatment B Number of patients
MI Type 1		
MI Type 2		
MI Type 3		
MI Type 4a		
MI Type 4b		
MI Type 5		
Total number		