Fourth Universal Definition of Myocardial Infarction (2018)

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History of Documents on the Definition of Myocardial Infarction

What’s New about the Universal Definition of Myocardial Infarction? (1)

New concepts

- Differentiation of myocardial infarction from myocardial injury; new Figure 2.
- Highlighting peri-procedural myocardial injury after cardiac and non-cardiac procedures as discrete from myocardial infarction.
- Consideration of electrical remodelling (cardiac memory) in assessing repolarization abnormalities with tachyarrhythmia, pacing, and rate-related conduction disturbances.
- Use of cardiovascular magnetic resonance to define aetiology of myocardial injury.
- Use of computed tomographic coronary angiography in suspected myocardial infarction.
Spectrum of Myocardial Injury, ranging from no Injury to Myocardial Infarction

Case vignette 1

- 36 years old male
- Since a couple of days heavy diarrhea, no bleeding
- This morning chest pain, radiation to the right arm for 4-5 hours. Patient presents himself in the ED painfree approx. 8 hours after the index event
- History: Ex-smoker, 15py; hypercholesterolemia, statin medication
- POC troponin T 1100ng/L [N: <17; cutoff < 30]; copeptin 9.14pmol/L [N: < 10]
- Acute echo: No regional wall abnormalities, but global EF slightly reduced (by eye ball assessment, not quantified)
ECG

Coronary angiography: No CAD, no occlusion
LV angiography: Normal LV function

MRI: Signs of acute myocarditis

Myocardial injury

What’s New about the Universal Definition of Myocardial Infarction? (2)

Updated concepts

• Type 1 myocardial infarction: Emphasis on the causal relationship of plaque disruption with coronary athero-thrombosis; new Figure 3.
• Type 2 myocardial infarction: Settings with oxygen demand and supply imbalance unrelated to acute coronary athero-thrombosis; new Figures 4 and 5.
• Type 2 myocardial infarction: Relevance of presence or absence of coronary artery disease. Differentiation of myocardial injury from Type 2 myocardial infarction; new Figure 6.
• Type 3 myocardial infarction: Clarify why Type 3 myocardial infarction is a useful category to differentiate from sudden cardiac death.
Myocardial Infarction Type 1

STEMI >> NSTEMI

- Plaque rupture/erosion with occlusive thrombus
- Plaque rupture/erosion with non-occlusive thrombus

NSTEMI >> STEMI

Myocardial Infarction Type 2

- Atherosclerosis and oxygen supply/demand imbalance
- Vasospasm or coronary microvascular dysfunction
- Non-atherosclerotic coronary dissection
- Oxygen supply/demand imbalance alone
Case vignette 2

- 64 years old male
- Since 3 hours heavy chest pain, radiation in the left arm, left shoulder and the back
- Cold sweating, dyspnea
- Presents himself walking in the ED

**EKG**
Coronary angiography und PCI

Type 1 MI, STEMI

Case vignette 3

- 36 years old male
- After a fall on a trampoline, pain in the left shoulder and arm. After orthopedic consultation and normal x-ray of the left shoulder, prescription of pain killer (ibuprofen)
- 2 weeks later presentation in the ED with fatigue, fever and respiratory modulated chest pain
Primary diagnostics: chest X-ray and echo

Pericardial effusion
LV thrombus at regional akinesia

Coronary angiography:
none atherosclerotic (OCT) LAD dissection

Pericardial drainage
LAD dissection

vor PCI
nach PCI

Dreger H, Haug M, Möckel M, DÄB 2018 in press

Type 2 MI
Framework for Type 2 MI considering Context and Mechanisms attributable to Acute Myocardial Ischaemia

- Main reason leading to clinical presentation (e.g. chest pain)
  - Coronary spasm
  - Coronary microvascular dysfunction
  - Coronary embolism
  - Coronary artery dissection +/- Intramural haematoma
  - Sustained tachyarrhythmia
  - Severe hypertension +/- Left ventricular hypertrophy
  - Severe bradyarrhythmia
  - Respiratory failure
  - Severe anaemia
  - Hypotension/Shock

A Model for interpreting Myocardial Injury and Myocardial Infarction (type 1 + 2)

- Elevated Cardiac Troponin Value(s) >99th percentile URL
  - Troponin rise and/or fall
    - With acute ischaemia
      - Atherosclerosis + thrombosis
        - Type 1 MI: triggers
          - Plaque rupture
          - Plaque erosion
        - Type 2 MI: examples
          - Severe hypertension
          - Sustained tachyarrhythmia
    - Acute myocardial infarction
      - Oxygen supply and demand imbalance
    - Chronic myocardial injury
      - Examples
        - Structural heart disease
        - Chronic kidney disease
  - Troponin level stable
    - Without acute ischaemia
      - Acute myocardial injury
      - Examples
        - Acute heart failure
        - Myocarditis
What’s New about the Universal Definition of Myocardial Infarction? (3)

Updated concepts (Contd)

• Consideration of new non-rate related right bundle branch block with specific repolarization patterns.
• Determination of the magnitude of the ST-segment shift with the onset of the QRS serving as the reference point; new Figure 8.
• ST-segment elevation in lead aVR with specific repolarization patterns, as a STEMI equivalent.
• ECG detection of myocardial ischaemia in patients with an implantable cardiac defibrillator or a pacemaker.
• Enhanced role of imaging including cardiac magnetic resonance imaging for the diagnosis of myocardial infarction; new Figure 9.

How to assess ST-segment elevation

Arrow 1 indicates the onset of the Q wave. Arrow 2 indicates the onset of the ST-segment or J-point. The difference between points 1 and 2 denotes the magnitude of the ST-segment elevation.
**Electrocardiographic Changes* suggestive of Acute Myocardial Ischaemia**

**ST-elevation**
New ST-elevation at the J-point in two contiguous leads with the cut points: ≥1 mm in all leads other than leads V_2–V_3 where the following cut points apply: ≥2 mm in men ≥40 years; ≥2.5 mm in men <40 years, or ≥1.5 mm in women regardless of age.

**ST-depression and T wave changes**
New horizontal or down-sloping ST-depression ≥0.5 mm in two contiguous leads and/or T inversion >1 mm in two contiguous leads with prominent R wave or R/S ratio >1.

*In absence of left ventricular hypertrophy and bundle branch block

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**Cardiac Magnetic Resonance Images**

Gadolinium-based contrasts wash out from myocardium with increased extracellular space such as fibrosis, thus enhancing areas of scar (white arrows).
What’s New about the Universal Definition of Myocardial Infarction? (4)

Updated concepts (Contd)

• Types 4-5 myocardial infarction: Emphasis on distinction between procedure-related myocardial injury and procedure-related myocardial infarction.
• Cardiac troponin: Analytic issues for cardiac troponins; new Figure 7.
• Emphasis on the benefits of high-sensitivity cardiac troponin assays.
• Considerations relevant to the use of rapid rule-out and rule-in protocols for myocardial injury and myocardial infarction.
• Issues related to specific diagnostic change (“delta”) criteria for the use of cardiac troponins to detect or exclude acute myocardial injury.

Conceptual Illustration of Troponin Kinetics after Acute Myocardial Injury and Infarction

Cardiac Troponin (cTn)

Very early sampling
- Rising cTn values from below to >99th percentile
- Delta is detectable

Early sampling
- cTn values >99th percentile
- Delta may not be seen over a short period

Later sampling
- Declining delta

Very late sampling
- Acute myocardial infarction
- Chronic myocardial injury

Time from onset of symptoms (hours)

URL: [Link]
Case vignette 4

- 38 years old male, moderate chest pain
- Diabetes mellitus, alcohol abuse
- Patient reports, that he takes no actual medication and a coronary angiography 3 weeks ago was „O.K.“
## Coronary angiography and PCI

Type 4b = subacute stent thrombosis (D1)

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### What’s New about the Universal Definition of Myocardial Infarction? (5)

<table>
<thead>
<tr>
<th>New sections</th>
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<tbody>
<tr>
<td>• Takotsubo syndrome.</td>
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<td>• MINOCA (myocardial infarction with non-obstructive coronary arteries).</td>
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<td>• Chronic kidney disease.</td>
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<td>• Atrial fibrillation.</td>
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<td>• Regulatory perspective on myocardial infarction.</td>
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<td>• Silent or unrecognized myocardial infarction.</td>
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Criteria for coronary procedure-related myocardial infarction (Types 4 and 5 MI)

- Percutaneous coronary intervention (PCI) related MI is termed Type 4a MI.
- Coronary artery bypass grafting (CABG) related MI is termed Type 5 MI.
- Coronary procedure-related MI ≤48 hours after the index procedure is arbitrarily defined by an elevation of cTn values >5 times for Type 4a MI and >10 times for Type 5 MI of the 99th percentile URL in patients with normal baseline values.

Criteria for coronary procedure-related myocardial infarction (Types 4 and 5 MI) (Contd)

- New ischaemic ECG changes (this criterion is related to Type 4a MI only).
- Development of new 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.
- Angiographic findings consistent with a procedural flow-limiting complication such as coronary dissection, occlusion of a major epicardial artery or graft, side-branch occlusion-thrombus, disruption of collateral flow or distal embolization.
Case vignette 5

- 78 years old male
- Patient was sent to the ED by his family physician; known lower back pain, currently worse and obstipation since a couple of days; severe abdominal pain despite 2 times daily intake of tramadol; no chest pain, no dyspnea, no palpitations, no syncope
- History: COPD, atrial fibrillation, lung carcinoma (>10 years before, curative surgery and radiochemotherapy), mitral regurgitation
- Vitals: BP 155/85mmHg, HR 102/min, RR 16/min, peripheral oxygen saturation 100%
- Medication: Digitalis, verapamil, rivaroxaban
- Initial POC troponin T: 16ng/L (N: < 17, cutoff 30)
- Hs troponin T 116ng/L (after 6h), 117ng/L (after 10h) (atypical sampling interval due to presentation with abdominal pain and no chest discomfort)

EKG
Koronarangiographie und PCI: Lesion RCA

Type 1 MI, NSTEMI

Pocket-Guideline und App

More information on www.escardio.org/guidelines
### Summary („highlights“)

- „Myocardial Injury“ more precisely defined, future ICD 10 code
- Prior concepts better specified
- New type 4c infarction = troponin rise with coronary restenosis after PCI
- New imaging techniques (cMRI und CTA) adopted
- Better definition of type 2 infarction and differentiation from injury
- ECG-criteria
- Still high complexity, further work needed for practical implementation