**MHIF FEATURED STUDY:**

**Tendyne MAC**

**DESCRIPTION:**

Early feasibility study of the Tendyne Mitral Valve System in Mitral Annular Calcification. This is a multi-center study with 10 sites participating to enroll 30 patients total.

**CRITERIA LIST/ QUALIFICATIONS:**

**Inclusion**

1) Symptomatic Severe MR; 2) MAC; 3) Noted to be Too High Risk for Surgery; 4) NYHA ≥ II

**Exclusion**

- Severe Stenosis not amenable to valvuloplasty
- LVEDD >7.0
- PAS > 70 mmHg
- EF < 25%
- Prior MV Intervention

- Carotid Stenosis > 70%
- LA or LV Thrombus
- CAD
- Severe TR
- COPD w/ Home O2

---

**NATIONAL PI:**

Paul Sorajja, MD

**RESEARCH CONTACT:**

Karlee Gebhart, RN

Karlee.Gebhart@allina.com | 612-863-7821

**SPONSOR:**

Tendyne Holdings

---

MHIF is the top enroller with 4 patients implanted! Please help us keep the momentum going!
Case Carousel:

Troponinitis

Rob Fraser, MD
Cardiology Fellow

April 29, 2019

No Disclosures
HPI: Acute shortness of breath

PMH - None
PSH - None
FMH - None
Social History - No tobacco

HR 135
BP 95/67
RR 22
SpO2 94%
What do we call the abnormal troponin?

A. NSTEMI
B. Type 2 MI
C. Myocardial injury
D. Myocardial necrosis
E. Demand ischemia
F. Elevated troponin
G. Troponinemia

And how will it be coded?
Objectives

- Review 2018 ACC/AHA/ESC 4th Universal Definition of Myocardial Infarction
- Review WHO ICD-10 codes for elevated troponin
- Apply 4th Universal Definition of MI and ICD-10 codes to clinical practice

<table>
<thead>
<tr>
<th>ACC/AHA/ESC</th>
<th>ICD-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. NSTEMI</td>
<td>A. NSTEMI</td>
</tr>
<tr>
<td>B. Type 2 MI</td>
<td>B. Type 2 MI</td>
</tr>
<tr>
<td>C. Myocardial injury</td>
<td>C. Myocardial injury</td>
</tr>
<tr>
<td>D. Myocardial necrosis</td>
<td>D. Myocardial necrosis</td>
</tr>
<tr>
<td>E. Demand ischemia</td>
<td>E. Demand ischemia</td>
</tr>
<tr>
<td>F. Elevated troponin</td>
<td>F. Elevated troponin</td>
</tr>
<tr>
<td>G. Troponinemia</td>
<td>G. Troponinemia</td>
</tr>
</tbody>
</table>
Myocardial Infarction

+ Troponin
(Rise or Fall)

Symptoms
EKG changes
Imaging changes
Angiographic findings

Myocardial Infarction
Myocardial Injury
+ Troponin
(Rise/Fall)

Symptoms
EKG
Imaging
Cath

Myocardial Infarction

Myocardial Injury

Myocardial Injury Type 1

Plaque rupture/erosion with occlusive thrombus

Plaque rupture/erosion with non-occlusive thrombus

JACC 2018 72(18)2231-2264
29F with acute shortness of breath found to have PE

HR 135
BP 95/67
RR 22
SpO2 94% 3L
+ Troponin
(Rise/Fall)

Symptoms
EKG
Imaging
Cath

Myocardial Infarction

1. ASCVD
2. Non-ASCVD
3. SCD
4. PCI
5. CABG

Myocardial Injury

ASCVD
Non-ASCVD
SCD
PCI
CABG
• I21 AMI
  • I21.0 STEMI (Anterior)
  • I21.1 STEMI (Inferior)
  • I21.2 STEMI (Other wall)
  • I21.3 STEMI (Unspecified)
  • I21.4 NSTEMI
  • I21.A1 Type 2 Myocardial Infarction
  • I21.A9 Other Myocardial Infarction

• R77 Other abnormalities of plasma proteins
  • R77.8 Other specified abnormalities of plasma proteins

1. Acute Myocardial Infarction
2. Demand Ischemia
3. Myocardial Necrosis
4. Troponinemia
5. Troponinitis

+ Troponin
(Rise/Fall)

Symptoms
EKG
Imaging
Cath

Myocardial
Infarction

Myocardial
Injury

ASCVD
STEMI I21.0-3
NSTEMI I21.4
Non-ASCVD
Type 2 MI I21.A1
SCD
PCI
CABG

Other Specified
Abnormal Blood
Protein R77.8

Other MI I21.A9

Elevated
Troponin

47F

HPI: Acute chest tightness

PMH
- Dilated NICM (EF 15%)
- Dual chamber ICD
- LBBB

PSH
- None

FMH
- Cardiomyopathy

Social History
- Unstable housing
- Tobacco use
Clinical Status

Treated
- VF: 0
- FVT: 0
- VT (Off): 0
- AT/AF (Monitor)

Monitored
- VT (171-200 bpm): 0
- VT-NS (<4 beats, >200 bpm): 0
- High Rate-NS: 0
- SVT: VT/VF Rx Withheld: 0
- V. Oversensing-TWave Rx Withheld: 0
- V. Oversensing-Noise Rx Withheld: 0
- AT/AF: 0

Time in AT/AF: 0.0 hr/day (0.0%)
Coronary Embolism

+ Troponin
  (Rise/Fall)

Symptoms
EKG
Imaging
Cath

Myocardial Infarction

1 ASCVD
STEMI I21.0-3
NSTEMI I21.4

2 Non-ASCVD
Type 2 MI I21.A1

Myocardial Injury

3 SCD

4 PCI

5 CABG

Other Specified Abnormal Blood Chemistry R77.8

Elevated Troponin

Prevalence, Clinical Features, and Prognosis of Acute Myocardial Infarction Attributable to Coronary Artery Embolism

Table 1. Proposed NCVC Criteria for the Clinical Diagnosis of Coronary Artery Embolism

<table>
<thead>
<tr>
<th>Criteria for CE</th>
<th>Definite CE (n = 32)</th>
<th>Probable CE (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major criteria</td>
<td>Two or more major criteria (n=17)</td>
<td>One major criterion plus one minor criterion (n=12)</td>
</tr>
<tr>
<td>Minor criteria</td>
<td>&lt;25% stenosis on coronary angiography, except for the culprit lesion</td>
<td>Presence of embolic risk factors: atrial fibrillation, cardiac myopathy, rheumatic valve disease, prosthetic heart valve, patent foramen ovale, atrial septal defect, history of cardiac surgery, infective endocarditis, or hypercoagulable state</td>
</tr>
</tbody>
</table>

Circulation. 2015;132(4)241-250
**Table 3. Clinical Characteristics of CE**

<table>
<thead>
<tr>
<th>Underlying cause of CE</th>
<th>CE (n=52)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AF</strong></td>
<td>38 (73)</td>
</tr>
<tr>
<td>Paroxysmal AF</td>
<td>13 (24)</td>
</tr>
<tr>
<td>Chronic AF</td>
<td>25 (48)</td>
</tr>
<tr>
<td>Nonvalvular AF</td>
<td>30 (58)</td>
</tr>
<tr>
<td><strong>Cardiomyopathy</strong></td>
<td>13 (25)</td>
</tr>
<tr>
<td>Idiopathic dilated cardiomyopathy</td>
<td>6 (12)</td>
</tr>
<tr>
<td>Hypertrophic cardiomyopathy</td>
<td>5 (10)</td>
</tr>
<tr>
<td>Hypertensive cardiomyopathy</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Alcoholic cardiomyopathy</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Valvular heart disease</td>
<td>8 (19)</td>
</tr>
<tr>
<td>Mitral valve stenosis</td>
<td>4 (40)</td>
</tr>
<tr>
<td>Aortic valve stenosis</td>
<td>4 (40)</td>
</tr>
<tr>
<td>Prosthetic valve</td>
<td>4 (40)</td>
</tr>
<tr>
<td><strong>Malignancy</strong></td>
<td>5 (10)</td>
</tr>
<tr>
<td>Lung</td>
<td>2 (40)</td>
</tr>
<tr>
<td>Stomach</td>
<td>1 (20)</td>
</tr>
<tr>
<td>Prostate</td>
<td>1 (20)</td>
</tr>
<tr>
<td>Breast (with tamoxifen therapy)</td>
<td>1 (20)</td>
</tr>
<tr>
<td><strong>Septic embol from IE</strong></td>
<td>2 (40)</td>
</tr>
<tr>
<td>Embolism from a deep vein thrombus through a ASD</td>
<td>2 (40)</td>
</tr>
</tbody>
</table>

Intracardiac embolic source

- Left atrium thrombus 16 (31)
- Aortic valve vegetation attributable to IE 2 (13)
- Mitral valve vegetation attributable to MSSE 1 (6)
- Valsalva sinus thrombus 1 (6)

---

**54M**

**HPI:** Chest pain for 16 hours

<table>
<thead>
<tr>
<th>PMH</th>
<th>PSH</th>
<th>FMH</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>- HTN</td>
<td>- None</td>
<td>- F: Heart disease</td>
<td>- Active smoker</td>
</tr>
<tr>
<td>- Chronic pain</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Acute Coronary Syndrome

+ Troponin
  (Rise/Fall)
  Symptoms
  EKG
  Imaging
  Cath

Myocardial Infarction

ASCVD
STEMI I21.0-3
NSTEMI I21.4
Non-ASCVD
SCD
PCI
CABG

Other Specified Abnormal Blood Protein R77.8
Elevated Troponin

Elevated Troponin

Other MI I21.A9

27F

HPI: Motor vehicle accident

PMH
- None

PSH
- Tonsillectomy

FMH
- None

Social History
- Employed
- Non-smoker
Myocardial Infarction

1. ASCVD
   - STEMI I21.0-3
   - NSTEMI I21.4

2. Non-ASCVD
   - Type 2 MI I21.A1

3. SCD

4. PCI

5. CABG

Other Specified Abnormal Blood Protein R77.8

Femur Fracture + Troponin

(Rise/Fall)

Symptoms
EKG
Imaging
Cath

Elevated Troponin

Circulation

ORIGINAL RESEARCH ARTICLE

Long-Term Outcomes in Patients With Type 2 Myocardial Infarction and Myocardial Injury

Circ 2018;137(12):1236–1245
### 29F

**HPI:** Stuttering chest tightness for 6 hours

<table>
<thead>
<tr>
<th>PMH</th>
<th>PSH</th>
<th>FMH</th>
<th>Social History</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1P1</td>
<td>POD#7 s/p LTCS</td>
<td>None</td>
<td>Married</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Groups</th>
<th>Time (Years)</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1 MI</td>
<td>1171</td>
<td>1020</td>
</tr>
<tr>
<td>Type 2 MI</td>
<td>429</td>
<td>333</td>
</tr>
<tr>
<td>Myocardial Injury</td>
<td>522</td>
<td>393</td>
</tr>
</tbody>
</table>

P <0.001 by log–rat test
MHIF CV Grand Rounds – April 29, 2019

Spontaneous Dissection

+ Troponin
  (Rise/Fall)
  Symptoms
  EKG
  Imaging
  Cath

Myocardial Infarction

1 ASCVD
  STEMI I21.0-3
  NSTEMI I21.1

2 Non-ASCVD
  Type 2 MI I21.A1

3 SCD

4 PCI

5 CABG

Myocardial Injury

Other Specified Abnormal Blood Protein 877.8

Elevated Troponin

STATE-OF-THE-ART PAPER

Acute Myocardial Infarction Associated With Pregnancy

Arie Roth, MD,* Um McKay, MD†
Tel Aviv, Israel, and Los Angeles, California

<table>
<thead>
<tr>
<th>Coronary anatomy available, n (%)</th>
<th>96 (93)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stenosis</td>
<td>41 (40)</td>
</tr>
<tr>
<td>Thrombus</td>
<td>8 (8)</td>
</tr>
<tr>
<td>Dissection</td>
<td>28 (27)</td>
</tr>
<tr>
<td>Spasm</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Embolus</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Normal</td>
<td>13 (13)</td>
</tr>
</tbody>
</table>

Type 2 MI

JACC 2008 52(3)171-180
43F

HPI: Severe sepsis due to streptococcal pneumonia, *pleuritic* chest pain hospital night 1

**PMH**
- HIV/AIDS
- ETOH use disorder
- Pancytopenia

**PSH**
- None

**FMH**
- M: Sickle Cell Trait

**Social**
- Unstable housing
- Tobacco Use

---

Image of a chest X-ray showing signs of pneumonia.
Stress Cardiomyopathy

Myocardial Infarction

1. ASCVD
   STEMI I21.0-3
   NSTEMI I21.4

2. Non-ASCVD
   Type 2 MI I21.A1

3. SCD
   Other MI I21.A9

4. PCI

5. CABG

+ Troponin
(Rise/Fall)

Symptoms
EKG
Imaging
Cath

Other Specified Abnormal Blood Protein R77.8

Elevated Troponin
The Case for Takotsubo Cardiomyopathy (Syndrome) as a Variant of Acute Myocardial Infarction

Scott W. Sharkey, Barry J. Maron and Robert A. Kloner

Spectrum and significance of electrocardiographic patterns, troponin levels, and thrombolysis in myocardial infarction frame count in patients with stress (tako-tsubo) cardiomyopathy and comparison to those in patients with ST-elevation anterior wall myocardial infarction.

Shtipkov S1, Lerner JA, Merson M, Panagiotakis M, Merson SJ, Merson SJ.

Mean Troponin
- Admit 4.2 ng/mL
- Peak 8.4 ng/mL

Figure 1. Distribution of ECG patterns on admission in 59 patients with SC. MI = myocardial infarction.

Long-Term Prognosis of Patients With Takotsubo Syndrome

FIGURE 1 Long-Term Mortality of Takotsubo Syndrome Compared With ACS

JACC 2018 72(8) 874-882
MHIF CV Grand Rounds – April 29, 2019

**FIGURE 2** Short- and Long-Term Mortality of Different Triggering Groups

<table>
<thead>
<tr>
<th>Triggering Group</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional Stress (Class I)</td>
<td></td>
</tr>
<tr>
<td>Physical Activities, Medical Conditions, or Procedures (Class IIa)</td>
<td></td>
</tr>
<tr>
<td>Neurologic Disorders (Class IIb)</td>
<td></td>
</tr>
<tr>
<td>No Stress Factor (Class III)</td>
<td></td>
</tr>
<tr>
<td>Acute Coronary Syndrome</td>
<td></td>
</tr>
</tbody>
</table>

P < 0.001

---

**52M**

HPI: 2 chest pains

**PMH**
- ADPKD s/p LURT 1999
- CKD3
- HTN
- Dyslipidemia

**PSH**
- Bilateral nephrectomy
- Renal transplant

**FMH**
- F: ADPKD

**Social History**
- Married
- Employed

*JACC 2018 72(8) 874-882*
Leaves AMA
Aortic Dissection

+ Troponin
  (Rise/Fall)

Symptoms
EKG
Imaging
Cath

Myocardial Infarction

1. ASCVD
   STEMI I21.0-3
   NSTEMI I21.4

2. Non-ASCVD
   Type 2 MI I21.A1

3. SCD
4. PCI
5. CABG

Myocardial Injury

Other Specified
Abnormal Blood
Protein R77.8

Elevated Troponin

Other MI I21.A9

Type 2 Myocardial Infarction
JACC Review Topic of the Week

CENTRAL ILLUSTRATION: Diagnostic Approach for Patients With Suspected Acute Myocardial Infarction

JACC 2019 73(14)1846-60
Objectives

• Review 2018 ACC/AHA/ESC 4th Universal Definition of Myocardial Infarction

• Review WHO ICD-10 codes for elevated troponin

• Apply 4th Universal Definition of MI and ICD-10 codes to clinical practice
Thank You

Robert.Fraser@allina.com