Elevations of Cardiac Troponin not due to Ischemic Heart Disease

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Most STE MIs and NSTE MIs diagnosed by troponin and/or CKMB

- ROC cut off (Mayo value = 0.1 ng/ml)
  Value most likely to equate troponin with CKMB.

Mostly NSTE MIs diagnosed with troponin

- 10% CV cut off (Mayo value = 0.03 ng/ml)
  Value where confounding due to analytic issues is minimized.

Area where diagnostic information may be limited due to assay variability

- 99th percentile (Mayo value = <0.01 ng/ml)
  ESC/ACC recommended cut off value with total precision of <10% as eventual goal.

Apple, Wu, Jaffe: AHJ 144:981, 2002
Troponin T Levels and Outcomes in GUSTO IV ACS


Sens=88%  Sens=81%  Sens=65%

Death or myocardial infarction at 30 days (%)

77  2257  0.01 microg/L
128  2891  0.03 microg/L
550  5298  0.1 microg/L
447  3866

Below Cutoff  Above Cutoff

499th perc.
Outcomes in Relation to Troponin Values: The Issue of Assay Sensitivity

Rapid Troponin I Assay

<table>
<thead>
<tr>
<th></th>
<th>Neg</th>
<th>Pos</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR 1.80; 1.30-2.54</td>
<td>56</td>
<td>98</td>
<td>1.80</td>
</tr>
<tr>
<td>1.47; 1.12-1.93</td>
<td>92</td>
<td>130</td>
<td>2.54</td>
</tr>
<tr>
<td>1.64; 1.31-2.06</td>
<td>132</td>
<td>205</td>
<td>3.20</td>
</tr>
</tbody>
</table>

Troponin T (0.1 μg/L)

<table>
<thead>
<tr>
<th></th>
<th>Neg</th>
<th>Pos</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR 3.20; 2.22-4.59</td>
<td>41</td>
<td>113</td>
<td>3.20</td>
</tr>
<tr>
<td>1.82; 1.38-2.40</td>
<td>86</td>
<td>136</td>
<td>4.59</td>
</tr>
<tr>
<td>2.26; 1.79-2.85</td>
<td>116</td>
<td>221</td>
<td>3.42</td>
</tr>
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</table>

Troponin T (0.01 μg/L)

<table>
<thead>
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<th></th>
<th>Neg</th>
<th>Pos</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR 4.55; 2.66-7.78</td>
<td>15</td>
<td>139</td>
<td>4.55</td>
</tr>
<tr>
<td>3.42; 2.57-5.98</td>
<td>25</td>
<td>197</td>
<td>6.09</td>
</tr>
<tr>
<td>4.29; 3.02-6.09</td>
<td>36</td>
<td>301</td>
<td>4.55</td>
</tr>
</tbody>
</table>

Int J Cardiol 93:113, 2004
cTnT Determinants of Elevation in the Community*

% with elevated cTnT

Risk determinants present (no.)

<table>
<thead>
<tr>
<th>No.</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>&gt;3</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>2,087</td>
<td>478</td>
<td>120</td>
<td>22</td>
</tr>
</tbody>
</table>

P < 0.0001

## Prevalence of Detectable cTnT & levels ≥ 99th percentile URL

<table>
<thead>
<tr>
<th>Group</th>
<th>Sample Size, No.</th>
<th>Sample Weight-Adjusted Size, No. (%)</th>
<th>cTnT Level, ng/mL 95% Cl</th>
<th>Sample Weight-Adjusted Prevalence, % (95% Cl)</th>
<th>No. (%)</th>
<th>cTnT Level, ng/mL ≥ 0.003 95% Cl</th>
<th>Sample Weight-Adjusted Prevalence, % (95% Cl)</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall population</td>
<td>3546</td>
<td>957 (27.0)</td>
<td>25.0 (22.7 – 27.4)</td>
<td>25.0 (22.7 – 27.4)</td>
<td>122 (3.4)</td>
<td>2.0 (1.5 – 2.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restricted population</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without CHD</td>
<td>3428</td>
<td>891 (26.0)</td>
<td>24.2 (21.8 – 26.5)</td>
<td>24.2 (21.8 – 26.5)</td>
<td>103 (3.0)</td>
<td>1.8 (1.2 – 2.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without cardiovascular disease</td>
<td>3277</td>
<td>813 (24.8)</td>
<td>23.7 (21.3 – 26.1)</td>
<td>23.7 (21.3 – 26.1)</td>
<td>82 (2.5)</td>
<td>1.9 (1.0 – 2.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without cardiovascular disease or CKD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3222</td>
<td>773 (24.0)</td>
<td>23.1 (20.7 – 25.5)</td>
<td>23.1 (20.7 – 25.5)</td>
<td>65 (2.3)</td>
<td>1.2 (0.8 – 1.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without cardiovascular disease, CKD, subclinical heart disease, diabetes, or hypertension&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2554</td>
<td>510 (20.0)</td>
<td>19.3 (16.8 – 21.8)</td>
<td>19.3 (16.8 – 21.8)</td>
<td>43 (1.7)</td>
<td>1.1 (0.6 – 1.7)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Elevations of Troponins without Overt Ischemic Heart Disease

- Trauma (including contusion, ablation, pacing, ICD firings including atrial defibrillators, cardioversion, endomyocardial biopsy, cardiac surgery, after interventional closure of ASDs)
- Congestive heart failure—acute and chronic
- Aortic valve disease and HOCM with significant LVH
- Hyper and hypotension, especially with arrhythmias
- Postoperative noncardiac surgery patients who seem to do well
- Renal failure
- Critically ill patients, with respiratory failure, gastrointestinal bleeding, sepsis, heat stroke
- Drug toxicity, eg adriamycin, 5 FU, herceptin, snake venoms, carbon monoxide poisoning
- Hypothyroidism
- Abnormalities in coronary vasomotion, including coronary vasospasm
- Apical ballooning syndrome
- Inflammatory diseases eg. myocarditis, eg. Parvovirus B19, Kawasaki disease, sarcoid, smallpox vaccination, or myocardial extension of BE
- Post PCI patients who appear to be uncomplicated
- Pulmonary embolism, severe pulmonary hypertension
- Sepsis
- Burns, esp if TBSA > 30%
- Cardiomyopathies including Infiltrative diseases such as amyloidosis, hemachromatosis, sarcoidosis and scleroderma, non compaction syndrome
- Acute neurological disease, including CVA, subarchnoid bleeds
- Rhabdomyolysis with cardiac injury
- Transplant vasculopathy
- Vital Exhaustion
Comparison of Normals Detected With Various Assays

hsTnl Values at ED Presentation Among Subjects With Non-Elevated Standard cTnl in Initial Sample

Korley, Jaffe, AEMJ 2014
Relationship of hsc-TnT and Mortality by Diagnosis in Swedeheart

All-Cause Mortality by Cardiac Troponin T (n=733)

Cumulative survival (%)

Time since blood draw (years)

Patients at risk (no.)

<table>
<thead>
<tr>
<th>cTnT &lt;0.01 μg/L</th>
<th>Baseline</th>
<th>1 yr</th>
<th>2 yr</th>
<th>2.5 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>132</td>
<td>106</td>
<td>25</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>cTnT ≥0.01 to &lt;0.04 μg/L</td>
<td>214</td>
<td>166</td>
<td>41</td>
<td>15</td>
</tr>
<tr>
<td>cTnT ≥0.04 to &lt;0.10 μg/L</td>
<td>239</td>
<td>180</td>
<td>63</td>
<td>18</td>
</tr>
<tr>
<td>cTnT ≥0.10 μg/L</td>
<td>148</td>
<td>93</td>
<td>20</td>
<td>8</td>
</tr>
</tbody>
</table>

Circulation 106:2944, 2002
Relationship of Elevated Marker Proteins and Pathology in Patients


- No Myocardial Pathology
  - CK: 20%
  - MB: 0%
  - cTnI: 0%
  - cTnT: 0%

- Old MI or Patchy Fibrosis
  - CK: 29%
  - MB: 0%
  - cTnI: 14%
  - cTnT: 22%

- Recent MI
  - CK: 19%
  - MB: 19%
  - cTnI: 48%
  - cTnT: 67%

- Healing MI
  - CK: 33%
  - MB: 17%
  - cTnI: 50%
  - cTnT: 43%

- CHF
  - CK: 40%
  - MB: 10%
  - cTnI: 20%
  - cTnT: 42%

- Other Cardiac Pathology
  - CK: 13%
  - MB: 25%
  - cTnI: 25%
  - cTnT: 63%
cTnT Values in Patients with ESRD Over Time

Recognized vs Unrecognized Myocardial Injury

Guest, Jaffe, JAMA 1995
Mortality

Guest, Jaffe, JAMA 1995
Mortality in Patients with Detectable Levels of cTnI (Critically Ill Group)

Wright, Jaffe, AJC 2002
Short-Term Prognosis of Critically Ill Patients in the MICU

Survival distribution function

Follow-up (days)

Normal troponin <0.01 ng/mL
cTnT <0.01

Elevated troponin >0.01 ng/mL
$cTnT \geq 0.01$

P<0.001

Babuin, Jaffe, CCM 2008
Mortality at 30 Days By cTnT Level

Mortality at 30 days (% of patient)

- <0.01: 12.8%, 359 patients
- ≥0.01-0.03: 26.4%, 178 patients
- >0.03-0.1: 31.1%, 206 patients
- >0.1: 41.4%, 186 patients

Risk ratio
- <0.01: 1
- ≥0.01-0.03: 2.10
- >0.03-0.1: 2.66
- >0.1: 3.58

95% CI
- <0.01: --
- ≥0.01-0.03: 1.40-3.15
- >0.03-0.1: 1.82-3.88
- >0.1: 2.48-5.16

Babuin, Jaffe, CCM 2008
Long-Term Prognosis of Critically Ill Patients in the MICU

Survival distribution function

Normal troponin <0.01 ng/mL
cTnT < 0.01

Elevated troponin >0.01 ng/mL
cTnT ≥ 0.01

Follow-up (days)

P < 0.0001

P < 0.001

Babuin, Jaffe, CCM 2008
Probability of Death Based on cTnT Values on Admission in Patients With GI Bleeding

*Critical Care Medicine 37:140, 2009

Patients at risk

<table>
<thead>
<tr>
<th></th>
<th>0 day</th>
<th>15 days</th>
<th>30 days</th>
<th>31 days</th>
<th>2.5 years</th>
<th>5 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>cTnT negative</td>
<td>425</td>
<td>371</td>
<td>361</td>
<td>361</td>
<td>143</td>
<td>16</td>
</tr>
<tr>
<td>cTnT positive</td>
<td>329</td>
<td>282</td>
<td>254</td>
<td>252</td>
<td>57</td>
<td>8</td>
</tr>
</tbody>
</table>

Log-rank test:
Chi-square = 11.2
P-value = 0.001

Log-rank test:
Chi-square = 64.0
P-value < 0.001
Hs-cTnI and hs-cTnT Concentrations Before and After Exercise Dobutamine

<table>
<thead>
<tr>
<th></th>
<th>Troponin I (ng/L)</th>
<th>Troponin T (ng/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong> (n=106/24/15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediately after test (n=112/26/16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 h after test (n=113/27/17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.5 h after test (n=123/31/17)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Clinical Chemistry 58:11, 2012**

- No ischemia, no prev MI (n=146)
- No ischemia, but prev MI (n=33)
- Reversible ischemia (n=19)
Probability of Death Based on cTnT Values on Admission in Patients With Acute Respiratory Failure*

![Graph showing the probability of death based on cTnT values on admission in patients with acute respiratory failure.](image)

- **Patients at risk**:
  - 0 day
  - 15 days
  - 30 days
  - 31 days
  - 2.5 years
  - 5 years
  - cTnT negative:
    - 96
    - 496
    - 492
    - 492
    - 475
    - 244
  - cTnT positive:
    - 36
    - 323
    - 273
    - 269
    - 113
    - 69

*The American Journal of Medicine: 123(11):1049, 2010*
Probability of Death Based on cTnT Values on Admission in Patients With Sepsis

Relationship Between hscTnT and Diastolic and RV Echo Measures

- Log (hs-troponin-T) vs. Longitudinal strain-rate e’-wave: $r = -0.356$, $P < 0.0001$
- Log (hs-troponin-T) vs. Right ventricular end-systolic volume index: $r = 0.383$, $P < 0.0001$

Crit Care Med 42:790, 2014
Outcomes in Patients With AF Stratified by CHA$_2$DS$_2$-VASc Score and hs-TnT

12,892 Patients ARISTOTLE Trial

**Stroke and Systemic Embolism**

- CHA$_2$DS$_2$-VASc score
- hs-Troponin-T (ng/L)
  - ≤1.5
  - >1.5-6.8
  - >6.8-13
  - >13

**Cardiac Death**

- CHA$_2$DS$_2$-VASc score
- hs-Troponin-T (ng/L)
  - ≤1.5
  - >1.5-6.8
  - >6.8-13
  - >13

Hijazi: JACC
Outcomes in Patients With AF Stratified by CHA<sub>2</sub>DS<sub>2</sub>-VASc Score and hs-TnT
12,892 Patients ARISTOTLE Trial

**Major Bleeding**

<table>
<thead>
<tr>
<th>hs-Troponin-T (ng/L)</th>
<th>≤1.5</th>
<th>&gt;1.5-6.8</th>
<th>&gt;6.8-13</th>
<th>&gt;13</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4CH&lt;sub&gt;2&lt;/sub&gt;DS&lt;sub&gt;2&lt;/sub&gt;-VASc score&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hijazi JACC 2013
Event Rates in Relation to Levels of hs-Troponin I and CHA₂DS₂-VASc Risk Score

Stroke or systemic embolism (%)

Cardiac death (%)

Major bleeding (%)

BMI and Elevated hscTnT

Adjusted Odds Ratio (95% CI)

BMI (kg/m²)

Ndumele et al: JACC: Heart Failure 2:600, 2014
Incidence of HF by hscTnT and BMI

- Undetectable hs-cTnT
- Measureable hs-cTnT
- High hs-cTnT

HR of incidence HF

P value for interaction term = .010

Ndumele et al: JACC: Heart Failure 2:600, 2014
Relationship of OSA to hs-cTnT

![Bar graph showing the relationship between OSA categories and hs-cTnT levels.](image)

- **None (904)**: Hs-cTnT = 0.004 (0.003, 0.006)
- **Mild (475)**: Hs-cTnT = 0.005 (0.003, 0.009)
- **Moderate (166)**: Hs-cTnT = 0.005 (0.003, 0.009)
- **Severe (100)**: Hs-cTnT = 0.006 (0.004, 0.01)

Roca et al: Am J Respir Crit Care Med188:1460, 2013
Changing hscTnl (Nanosphere) and Mortality in Acute Heart Failure

Survival

Days

Increasing troponin (41 subjects)
Stable or decreasing troponin (65 subjects)

Euro J Hrt Failure, Jan 2011
Prognosis with hscTnl (Nanosphere) and BNP in Acute Heart Failure

![Graph showing event free survival over days for different combinations of high and low BNP and Tnl levels.]

- **High BNP & high Tnl** (56 subjects)
- **High BNP & low Tnl** (26 subjects)
- **Low BNP & high Tnl** (28 subjects)
- **Low BNP & low Tnl** (34 subjects)

Euro J Hrt Failure, Jan 2011
Death and Hospitalization and hsTnT at Baseline

Hazard ratio (95% CI)

Mortality
Hospitalization for HF

**Mortality Based on Change in hscTnT Values**

Val-HeFT

<table>
<thead>
<tr>
<th>Year</th>
<th>I</th>
<th>S</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1,009</td>
<td>1,409</td>
<td>1,056</td>
</tr>
<tr>
<td>1</td>
<td>929</td>
<td>1,349</td>
<td>1,006</td>
</tr>
<tr>
<td>2</td>
<td>491</td>
<td>738</td>
<td>589</td>
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</tbody>
</table>

GISSI-HF

<table>
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<tr>
<th>Year</th>
<th>I</th>
<th>S</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>271</td>
<td>445</td>
<td>350</td>
</tr>
<tr>
<td>2</td>
<td>219</td>
<td>391</td>
<td>319</td>
</tr>
<tr>
<td>4</td>
<td>122</td>
<td>260</td>
<td>170</td>
</tr>
</tbody>
</table>

All cause mortality

<table>
<thead>
<tr>
<th>No. at risk</th>
<th>Year</th>
<th>I</th>
<th>S</th>
<th>D</th>
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<tbody>
<tr>
<td>I</td>
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<tr>
<td>D</td>
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<td>1,006</td>
<td>589</td>
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<th>D</th>
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<td>319</td>
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</tr>
<tr>
<td>D</td>
<td>350</td>
<td>322</td>
<td>216</td>
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</table>

HF mortality

<table>
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<tr>
<th>No. at risk</th>
<th>Year</th>
<th>I</th>
<th>S</th>
<th>D</th>
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<td>391</td>
<td>322</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>350</td>
<td>224</td>
<td>216</td>
<td></td>
</tr>
</tbody>
</table>

Log-rank test: P=0.002

Log-rank test: P=0.0005

Log-rank test: P=0.0007

Log-rank test: P=0.001

I = >15% increase, S = stable, D = > 15% decrease

Mason et al: AHA, 2011
hscTnT and Markers of Fibrosis

CITP = carboxyterminal telopeptide of type I collagen
PIIINP = amnioterminal propeptide of procollagen III
PIP = procollagen type I

*P<0.01 compared to each of the control groups

Kop et al: Circ Heart Fail 5:406, 2012
hscTnT Values and Fibrosis by MRI in Patients with HOCM

Journal of Cardiac Failure Vol. 16 No. 12, 2010
All Cardiovascular Events in Patients With HOCM by hs-cTnT Values

Kubo et al: JACC, 2013

Follow-up (years)

Event free rate (%)

Normal hs-cTnT (≤0.014 ng/mL)  
n=84

Abnormal hs-cTnT (>0.014 ng/mL)  
Lower (n=32)  
Middle (n=32)  
Upper (n=35)  
Whole cohort (n=183)  
P <0.001  
Abnormal hs-cTnT group (n=99)  
P = 0.020

Kubo et al: JACC, 2013
Total Mortality by cTnT Values

All-Cause Mortality

P<0.001 for all between-group comparisons by the log-rank test; detectable cardiac troponin T (cTnT) levels are 0.003 ng/mL or greater by the highly sensitive assay; Y-axes shown in blue indicate the range from 0% to 20%

JAMA 304(22):2503, 2010
Prognostic Value of hscTnT in Cardiovascular Health Study by hscTnT

Heart Failure

Cardiac troponin T
Category 1
Category 2
Category 3
Category 4
Category 5
P<0.001

Cardiovascular Death

Cardiac troponin T
Category 1
Category 2
Category 3
Category 4
Category 5
P<0.001

No. at risk
Follow-up (yr)

Proportion free of heart failure

0 3 6 9 12 15 18

0.0 0.2 0.4 0.6 0.8 1.0

No. at risk
Follow-up (yr)

Proportion without cardiovascular death

0 3 6 9 12 15 18

0.0 0.2 0.4 0.6 0.8 1.0

Cardiopulmonary: JAMA 304(22), 2010
Prognostic Value of Changes in hscTnT

Heart Failure

Cardiovascular Death

Baseline cTnT (pg/mL)

Incidence rate/100 person-years

>50% decrease

Change ≤50%

>50% increase

Baseline cTnT (pg/mL)

<3.00  3.00-5.44  5.45-8.16  8.17-12.94  >12.94

<3.00  3.00-5.44  5.45-8.16  8.17-12.94  >12.94

(18.1)

deFilippi: JAMA 304(22), 2010
Association of Moderate Physical Activity, Rise in Hs cTnT Level and Risk of New Onset Heart Failure

Composite score is a sum of walking pace and duration of moderate to intense leisure activities. A higher score is a faster pace and longer duration of activity.

deFilippi C: J Am Coll Cardiol 60:2539, 2012
Prevention of High-Dose Chemotherapy–Induced Cardiotoxicity in High-Risk Patients by Angiotensin-Converting Enzyme Inhibition

Daniela Cardinale, MD; Alessandro Colombo, MD; Maria T. Sandri, MD; Giuseppina Lamantia, MD; Nicola Colombo, MD; Maurizio Civelli, MD; Giovanni Martinelli, MD; Fabrizio Veglia, PhD; Cesare Fiorentini, MD; Carlo M. Cipolla, MD

Primary end-point:
LVEF decrease >10 percent units + <50%

![Graph showing the comparison between ACEI group and Controls](chart.png)
TnI Values in Both Groups

ACEI group
Control subjects

<table>
<thead>
<tr>
<th>Time</th>
<th>No.</th>
<th>ACEI group TnI (ng/mL)</th>
<th>Control subjects TnI (ng/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early</td>
<td>56</td>
<td>0.18±0.38</td>
<td>0.23±0.44</td>
</tr>
<tr>
<td>M1</td>
<td>56</td>
<td>0.15±0.34</td>
<td>0.14±0.31</td>
</tr>
<tr>
<td>M2</td>
<td>56</td>
<td>0.02±0.02</td>
<td>0.10±0.17</td>
</tr>
<tr>
<td>M3</td>
<td>56</td>
<td>0.01±0.01</td>
<td>0.09±0.29</td>
</tr>
<tr>
<td>M6</td>
<td>56</td>
<td>0.01±0.01</td>
<td>0.03±0.06</td>
</tr>
<tr>
<td>M12</td>
<td>55</td>
<td>0.00±0.01</td>
<td>0.01±0.02</td>
</tr>
</tbody>
</table>

Circ 114:2474, 2006
LVEF with and Without ACEI

Controls

ACEI Group

LVEF (%)

Pre-HDC 1 3 6 12

Pre-HDC 1 3 6 12

No TnI increase

No TnI increase

TnI increase

TnI increase

Circ 114:2474, 2006
## Secondary end-points

**follow-up 12 months**

<table>
<thead>
<tr>
<th>Event</th>
<th>ACEI n=54</th>
<th>Controls n=58</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudden death</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>NS</td>
</tr>
<tr>
<td>Cardiac death</td>
<td>2 (2%)</td>
<td>0 (0%)</td>
<td>NS</td>
</tr>
<tr>
<td>Acute pulmonary edema</td>
<td>4 (2%)</td>
<td>0 (0%)</td>
<td>NS</td>
</tr>
<tr>
<td>Heart failure</td>
<td>14 (12%)</td>
<td>0 (0%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Life-threatening arrhythmias</td>
<td>11 (10%)</td>
<td>1 (2%)</td>
<td>0.01</td>
</tr>
</tbody>
</table>

**CUMULATIVE EVENTS**

<table>
<thead>
<tr>
<th></th>
<th>ACEI</th>
<th>Controls</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>31 (28%)</td>
<td>1 (2%)</td>
<td>30 (52%)</td>
</tr>
</tbody>
</table>
Mortality of Patients With and Without Myocardial Injury

Mortality (%)

No. at risk

Time since hospitalization (yr)

Myocardial injury

No myocardial injury

No. at risk

P<0.001

JAMA 295(4):398, 2006
Change in Troponin Concentration at One Year and Risk Reduction

- Change in troponin concentration predicted MI and CHD death at 5 years independent of baseline LDL and change in LDL cholesterol (P<0.001)

- Participants with largest reduction in troponin (>40%) on pravastatin had a 4-fold greater reduction in primary endpoint (HR 0.21) than in those participants where troponin was unchanged (HR 0.82); P=0.001 for trend

* Adjusted for age, BMI, heart rate, SBP, DBP, HDL and LDL cholesterol, symptoms of angina, diabetes, Htn, FHx of premature CHD, minor ECG abnormalities, nitrate use and smoking status