Impact of point-of-care creatinine and eGFR testing on the risk of contrast-induced acute kidney injury for patients with ST segment elevation myocardial infarction undergoing primary PCI

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Disclosures

• I have no conflicts of interest to report.
What is an ST segment elevation myocardial infarction (STEMI)?

• Most serious kind of heart attack / MI.
• Caused by a total occlusion of a coronary artery and ischaemia to myocardium.
• Gives a characteristic pattern on an electrocardiogram / ECG
• Is a medical emergency and needs urgent treatment (30% mortality or more if untreated)
What is Primary PCI (PPCI)

• Percutaneous Coronary Intervention
• The treatment of choice for STEMI (<12hrs)
• Provided at tertiary cardiac centres
• Involves imaging the coronary arteries – with x-ray and contrast
• Aim is to restore flow to myocardium by restoring flow through coronary artery (stenting/balloon/thrombus aspiration)
However...

• On average primary PCI uses 100-200mls of contrast media.

• And most commonly, patients are brought directly to the centre. Lab blood results are not available.
Incidence of CI-AKI

• < 3.5% in elective percutaneous coronary intervention (PCI) procedures

• 15-19 % in primary PCI for STEMI

• up to 40% in patients with pre-existing CKD (eGFR < 60 ml/min) undergoing primary PCI for STEMI

Background

Contrast induced AKI definition:

- an absolute increase of serum creatinine $\geq 0.5$ mg/dL (44mmol/L)
- or a relative increase $\geq 25\%$ from baseline value within the first 72 hours after intervention

Predictors of CI-AKI after PCI

Mehran CI-AKI score:

- Hypotension: 5
- IABP: 5
- CHF: 5
- Age > 75 years: 4
- Anemia: 3
- Diabetes: 3
- Contrast media volume: 1 for each 100 cc
- Serum creatinine > 1.5 mg/dL: 4
- eGFR < 60 ml/min/1.73 m²:
  - 2 for 40 - 60
  - 4 for 20 - 40
  - 6 for < 20

Risk of CIN and Dialysis:

- Score
  - ≤ 5: 7.5% (CIN), 0.04% (Dialysis)
  - 6 to 10: 14.0% (CIN), 0.12% (Dialysis)
  - 11 to 16: 26.1% (CIN), 1.09% (Dialysis)
  - ≥ 16: 57.3% (CIN), 12.6% (Dialysis)

Differences in hospital length of stay associated with CI-AKI

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Mean difference (95% CI) days</th>
<th>CI-AKI N, mean (SD) days</th>
<th>No CI-AKI N, mean (SD) days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marenzi, 2004</td>
<td>5.00 (2.78, 7.22)</td>
<td>40, 13 (7)</td>
<td>168, 8 (3)</td>
</tr>
<tr>
<td>Dangas, 2005, +CKD</td>
<td>4.50 (3.78, 5.22)</td>
<td>381, 6.0 (7.1)</td>
<td>1599, 2.3 (2.5)</td>
</tr>
<tr>
<td>Dangas, 2005, -CKD</td>
<td>1.60 (1.41, 2.19)</td>
<td>688, 3.6 (5.1)</td>
<td>4562, 1.8 (2.4)</td>
</tr>
<tr>
<td>Brown, 2008</td>
<td>3.20 (2.31, 4.09)</td>
<td>308, 5.1 (7.9)</td>
<td>7081, 1.9 (4.1)</td>
</tr>
<tr>
<td>Patti, 2008</td>
<td>0.50 (0.25, 0.75)</td>
<td>55, 2.7 (9)</td>
<td>379, 2.2 (6)</td>
</tr>
<tr>
<td>Roy, 2008</td>
<td>2.30 (1.06, 3.54)</td>
<td>70, 4.5 (5.2)</td>
<td>500, 2.2 (2.9)</td>
</tr>
<tr>
<td>Uyarel, 2009</td>
<td>0.90 (0.36, 1.44)</td>
<td>630, 8 (5.9)</td>
<td>1891, 7.1 (6.1)</td>
</tr>
<tr>
<td>Wickenbrock, 2009</td>
<td>6.00 (2.72, 9.28)</td>
<td>45, 15 (11)</td>
<td>347, 9 (6)</td>
</tr>
<tr>
<td>Zaytseva, 2009</td>
<td>8.30 (7.92, 8.68)</td>
<td>61, 16.4 (1.4)</td>
<td>90, 10.1 (7.7)</td>
</tr>
<tr>
<td>Cho, 2010</td>
<td>5.60 (2.50, 8.70)</td>
<td>74, 14.7 (12.1)</td>
<td>436, 9.1 (15.2)</td>
</tr>
<tr>
<td>Caruso, 2011</td>
<td>1.90 (0.81, 2.99)</td>
<td>14, 6.1 (1.9)</td>
<td>136, 4.2 (2.6)</td>
</tr>
</tbody>
</table>

Prognosis of CI-AKI in STEMI patients

CI-AKI in STEMI

CI-AKI in STEMI undergoing PPCI:

• happens often
• carries a worse prognosis
• carries a burden for the healthcare system

So... prevention is imperative!
Prevention of CI-AKI during PCI (1)

Tested strategies:

- hydration with sodium chloride
- hydration with sodium bicarbonate
- administration of N-acetylcysteine
- administration of ascorbic acid
- use of different contrast agents
- use of various haemofiltration protocols
- administration of statins
- use of automated contrast injectors
- hydration-forced diuresis automated systems (eg, RenalGuard system)
- contrast media removal from coronary sinus (eg, CINCOR system)
- recombinant B-type natriuretic peptide
- Ischemic preconditioning
- phosphodiesterase type 5 inhibitors

Prevention of CI-AKI during PCI (2)

Recommendations for prevention of CI-AKI:

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydration with isotonic saline is recommended.</td>
<td>I A</td>
</tr>
<tr>
<td>Use of low-osmolar or iso-osmolar contrast media is recommended.</td>
<td>I A</td>
</tr>
<tr>
<td>Short-term, high-dose statin therapy should be considered.</td>
<td>IIa A</td>
</tr>
<tr>
<td>Iso-osmolar contrast media should be considered over low-osmolar contrast media.</td>
<td>IIa A</td>
</tr>
<tr>
<td>Volume of contrast media should be minimized.</td>
<td>IIa B</td>
</tr>
</tbody>
</table>

Patients undergoing cardiac catheterization with contrast media should receive adequate preparatory hydration. In patients with CKD (creatinine clearance <60 mL/min), the volume of contrast media should be minimized.

Aim

To assess the impact of point-of-care pre-PPCI creatinine and eGFR testing with immediate feedback to the operator, for patients presenting with ST segment elevation myocardial infarction (STEMI).
Hypothesis

Pre-procedure POC renal function testing would identify patients with pre-existing renal impairment, leading to less contrast media use in this group and subsequently to a decreased incidence of CI-AKI.
Study design

• 160 STEMI prospectively recruited (STATCREAT group)
• All-comers, cardiogenic shock only exclusion criterion
• Cr and eGFR tested pre-procedure with POC miniaturised device
• Results were available in 30”’ and feedback to the operator

• STATCREAT group compared with a similar retrospective cohort of STEMI patients (n=294) (Control group)
• For the Control group the operator was unaware of baseline Cr and eGFR at the time of PPCI
• Finger prick test
• 1.2µL of blood
• Creatinine and eGFR in 30 seconds
Validation of POC testing results in 130 STEMI patients

Scatter Plot with Passing & Bablok Fit

Nova STATSENSOR POC Creatinine umol/L vs. Laboratory Cobas Creatinine umol/L

- Identity
- Allowable bias (25%)
- Passing & Bablok (I) fit (-5.29 + 1.08x)
## Baseline characteristics

<table>
<thead>
<tr>
<th></th>
<th>Control (n=294)</th>
<th>STATCREAT (n=160)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>64 (13)</td>
<td>64 (12)</td>
<td>p=0.830</td>
</tr>
<tr>
<td>Age &gt;75 (%)</td>
<td>59 (20.0)</td>
<td>33 (20.6)</td>
<td>p=0.903</td>
</tr>
<tr>
<td>Men (%)</td>
<td>215 (73.1)</td>
<td>114 (71.2)</td>
<td>p=0.662</td>
</tr>
<tr>
<td>Diabetes mellitus (%)</td>
<td>36 (12.2)</td>
<td>17 (10.6)</td>
<td>p=0.649</td>
</tr>
<tr>
<td>Hypertension</td>
<td>119 (40.5)</td>
<td>53 (33.1)</td>
<td>p=0.130</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>103 (35.0)</td>
<td>44 (27.5)</td>
<td>p=0.115</td>
</tr>
<tr>
<td>Smoker/ex-smoker</td>
<td>165 (56.1)</td>
<td>89 (55.6)</td>
<td>p=0.922</td>
</tr>
<tr>
<td>Previous Myocardial Infarction</td>
<td>34 (11.6)</td>
<td>18 (11.2)</td>
<td>p=1.000</td>
</tr>
<tr>
<td>Previous PCI</td>
<td>28 (9.5)</td>
<td>11 (6.9)</td>
<td>p=0.384</td>
</tr>
<tr>
<td>Previous CABG</td>
<td>8 (2.7)</td>
<td>7 (4.4)</td>
<td>p=0.412</td>
</tr>
<tr>
<td>LAD infarct</td>
<td>113 (38.4)</td>
<td>67 (43.1)</td>
<td>p=0.367</td>
</tr>
<tr>
<td>Baseline Creatinin (mmol/L)</td>
<td>89 +/-35</td>
<td>86 +/-25</td>
<td>p=0.556</td>
</tr>
<tr>
<td>eGFR &lt; 60 (%)</td>
<td>56 (19.0)</td>
<td>34 (21.3)</td>
<td>p=0.622</td>
</tr>
<tr>
<td>Heamoglobin (g/dL)</td>
<td>140+/−18</td>
<td>148+/−110</td>
<td>p=0.161</td>
</tr>
</tbody>
</table>
STATCREAT group

n=160

- non-CKD
  - n=128 (78.7%)
    - non CI-AKI
      - n=107 (83.3%)
    - CI-AKI
      - n=21 (16.7%)

- CKD
  - n=34 (21.3%)
    - non CI-AKI
      - n=34 (94.1%)
    - CI-AKI
      - n=2 (5.9%)
Control group

Control
---
n=294

---

non-CKD
---
n=238 (81%)

- non CI-AKI
  - n=206 (86.6%)

- CI-AKI
  - n=32 (13.4%)

---

CKD
---
n=56 (19%)

- non CI-AKI
  - n=46 (82.1%)

- CI-AKI
  - n=10 (17.9%)
Contrast volume used

<table>
<thead>
<tr>
<th></th>
<th>CKD</th>
<th>non-CKD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contrast volume used (ml)</td>
<td>124.6</td>
<td>172.4</td>
</tr>
<tr>
<td></td>
<td>152.3</td>
<td>158.4</td>
</tr>
</tbody>
</table>

p=0.015
p=0.067
Incidence of CI-AKI

![Bar chart showing incidence of CI-AKI in CKD and non-CKD patients with p-values of 0.12 and 0.4.](chart.png)
Number of lesions treated, number of stents, procedure duration and fluoroscopy time (1)

Results in patients with **pre-procedure chronic kidney disease (CKD)**.

<table>
<thead>
<tr>
<th></th>
<th>STATCREAT</th>
<th>Control</th>
<th>Difference in mean values</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lesions treated</td>
<td>1.118</td>
<td>1.196</td>
<td>-0.078</td>
<td>p=0.643</td>
</tr>
<tr>
<td>Number of stents used</td>
<td>1.176</td>
<td>1.246</td>
<td>-0.074</td>
<td>p=0.78</td>
</tr>
<tr>
<td>Procedure duration (minutes)</td>
<td>46.3</td>
<td>44.4</td>
<td>1.9</td>
<td>p=0.694</td>
</tr>
<tr>
<td>Fluoroscopy time (minutes)</td>
<td>10.27</td>
<td>9.87</td>
<td>0.4</td>
<td>p=0.779</td>
</tr>
</tbody>
</table>
Number of lesions treated, number of stents, procedure duration and fluoroscopy time (2)

Results in patients with **NON pre-procedure chronic kidney disease (CKD)**.

<table>
<thead>
<tr>
<th></th>
<th>STATCREAT</th>
<th>Control</th>
<th>Difference in mean values</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lesions treated</td>
<td>1.167</td>
<td>1.164</td>
<td>0.003</td>
<td>p=1.00</td>
</tr>
<tr>
<td>Number of stents used</td>
<td>1.214</td>
<td>1.168</td>
<td>0.046</td>
<td>p=0.611</td>
</tr>
<tr>
<td>Procedure duration (minutes)</td>
<td>45.83</td>
<td>41.36</td>
<td>4.47</td>
<td>p=0.027</td>
</tr>
<tr>
<td>Fluoroscopy time (minutes)</td>
<td>10.78</td>
<td>9.27</td>
<td>1.52</td>
<td>p=0.029</td>
</tr>
</tbody>
</table>
Conclusion (1)

Pre-PPCI point-of-care renal function testing was associated with:

- A statistically significant reduction of contrast volume used in patients with CKD by 27.87 ml
- Numerical reduction of CI-AKI by 67% in patients with CKD
- A trend for more contrast in patients without CKD, without any effect in the incidence of CI-AKI

Number of lesions treated and stents used was not affected in any of the groups.
• Pre-PPCI point-of-care renal function testing is a simple and safe intervention

• It showed promising results in this retrospective observational study

• An RCT is merited to investigate further whether it can result in better outcomes for STEMI patients undergoing PPCI.
Thank you!

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