Prevention of Contrast Induced Nephropathy

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Nothing to disclose
Outline

▶ Definition of CIN
▶ Pathogenesis and disease burden
▶ Prevention strategies
▶ Novel approaches
▶ Conclusion
What is CIN?

- Contrast induced nephropathy (CIN) is defined as acute kidney injury resulting from exposure to contrast dye
- Increase in serum creatinine of 0.5mg/dL or 25% greater than baseline
- Increase in serum creatinine occurs at 48-72 hours after administration of contrast agent and persists for 2-5 days
- Alternative major injuries are ruled out

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>RIFE criteria</th>
<th>CIN criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum creatinine</td>
<td>Risk: increased 1.5times&lt;br&gt; Injury: increased 2 times&lt;br&gt; Failure: increased 3 times or level &gt;4mg/dL</td>
<td>&gt;0.5mg/dL or an increase &gt;25% greater than baseline</td>
</tr>
<tr>
<td>Glomerular filtration rate</td>
<td>Risk: decreased &gt;25%&lt;br&gt; Injury: decreased &gt;50%&lt;br&gt; Failure: decreased &gt;75%</td>
<td>Risk: &lt; 60mL/min per 1.73m²</td>
</tr>
<tr>
<td>Urine output</td>
<td>Risk: &lt;0.5mL/kg for 6hours&lt;br&gt; Injury: &lt; 0.5ml/kg for 12hours&lt;br&gt; Failure: &lt;0.5ml/kg for 12hours or anuria for 12hours</td>
<td>Not defined</td>
</tr>
<tr>
<td>Diagnostic period</td>
<td>Within 48 hours</td>
<td>48-72 hours</td>
</tr>
<tr>
<td>Persistent acute renal failure</td>
<td>Complete loss of renal function &gt; 4 weeks</td>
<td>48-72 hours</td>
</tr>
<tr>
<td>Failure</td>
<td>End-stage renal disease &gt; 3months</td>
<td>Not defined</td>
</tr>
</tbody>
</table>
Epidemiology and disease burden

- 3rd most common cause of hospital acquired renal failure

- Associated with extended length of stay, accelerated onset of end stage renal disease, need for dialysis, increased costs, and increased mortality

Major Risk Factors of CIN

Non-modifiable

- Pre-existing renal failure
- Age
- Diabetes
- CHF or LVEF < 40%
- Hemodynamic instability
- Nephrotic syndrome
- Renal transplant
Major Risk Factors of CIN

Modifiable

- Dehydration
- Contrast dye type and dose
- Hypotension
- Concomitant use of nephrotoxic agents
- Anemia
- Shock
- Sepsis
- Use of IABP
Mehran CIN Risk Score

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Integer Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>IABP</td>
<td>5</td>
</tr>
<tr>
<td>CHF</td>
<td>5</td>
</tr>
<tr>
<td>Age &gt; 75 years</td>
<td>4</td>
</tr>
<tr>
<td>Anemia</td>
<td>3</td>
</tr>
<tr>
<td>Diabetes</td>
<td>3</td>
</tr>
<tr>
<td>Contrast media volume</td>
<td>1 for each 100 cc³</td>
</tr>
<tr>
<td>Serum creatinine &gt; 1.5 mg/dl</td>
<td>4</td>
</tr>
<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>eGFR &lt; 60 ml/min/1.73m²</td>
<td>4</td>
</tr>
<tr>
<td>2 for 40 - 60</td>
<td></td>
</tr>
<tr>
<td>4 for 20 - 40</td>
<td></td>
</tr>
<tr>
<td>6 for &lt; 20</td>
<td></td>
</tr>
</tbody>
</table>

Risk Score | Risk CIN | Risk of Dialysis |
-----------|----------|------------------|
≤ 5        | 7.5%     | 0.04%            |
6 to 10    | 14.0%    | 0.12%            |
11 to 16   | 26.1%    | 1.09%            |
≥ 16       | 57.3%    | 12.6%            |

\[
eGFR (\text{mL/min/1.73 m}^2) = 186 \times (\text{Scr})^{-1.154} \times (\text{Age})^{-0.203} \\
\times (0.742 \text{ if female}) \times (1.210 \text{ if African American})
\]
The incidence of CIN is higher among patients with CKD and increases with the severity of renal dysfunction.
<table>
<thead>
<tr>
<th>Stage</th>
<th>Qualitative Description</th>
<th>Renal Function (mL/min/1.73 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kidney damage-normal GFR</td>
<td>≥90</td>
</tr>
<tr>
<td>2</td>
<td>Kidney damage-mild ↓ GFR</td>
<td>60-89</td>
</tr>
<tr>
<td>3</td>
<td>Moderate ↓ GFR</td>
<td>30-59</td>
</tr>
<tr>
<td>4</td>
<td>Severe ↓ GFR</td>
<td>15-29</td>
</tr>
<tr>
<td>5</td>
<td>End-stage renal disease</td>
<td>&lt;15 (or dialysis)</td>
</tr>
</tbody>
</table>

Prevention of CKD
What happens?

Stage 1
90% or more

Stage 2
60-89%

Stage 3
30-59%

Stage 4
15-29%

Stage 5
< 15%

There are no specific symptoms, but kidney function can slowly decline.

Kidney function is very low, and treatment for kidney failure may be needed soon.

Kidneys can no longer keep up with removing waste products and extra water. This is called kidney failure. Although there is no cure, treatment options are available.

Prevention of CKD
Among CKD patients, diabetic patients are at higher risk compared with non-diabetic CKD patients. In an analysis of data from a randomized trial that included 250 patients with serum creatinine >1.5 mg/dL (133 mmol/L), a higher incidence of AKI was observed among diabetic patients compared with non-diabetic patients (33 versus 12 percent).

Pathogenesis of CIN


Source: Chapter 12. Contrast-Induced Nephropathy, CURRENT Diagnosis & Treatment: Nephrology & Hypertension
Citation: Lerma EV, Berns JS, Nissenson AR. CURRENT Diagnosis & Treatment: Nephrology & Hypertension; 2009 Available at: http://accessmedicine.mhmedical.com/content.aspx?sectionid=39961148&bookid=372&Resultclick=2 Accessed: June 13, 2017

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Contrast viscosity increases 50x in kidney. Impedes filtration, delivery of $O_2$, & contrast. Toxic to nephrons. Combination impedes kidney function and kills nephrons. Takes up to 5 days to flush contrast unaided. Prevention of CIN 2017 Courtesy of Renal Guard.
Prevention strategies
1. Assess the risk for CI-AKI, screen for pre-existing impairment of kidney function

2. Use the lowest possible dose of contrast. Use iso-osmolar or low-osmolar iodinated contrast media (1B)

3. Intravenous volume expansion with either isotonic sodium chloride or sodium bicarbonate solutions (1A)

4. Use oral NAC (N-acetylcysteine) together with IV isotonic crystalloids (2D)

-Kidney Disease Improving Global Outcomes 2012 Work Group
Pooled RRs for development of CIN in studies of sodium bicarbonate, statins, and ascorbic acid in patients receiving contrast media.

CIN = contrast-induced nephropathy; IOCM = iso-osmolar contrast media; IV = intravenous; LOCM = low-osmolar contrast media; NAC = N-acetylcysteine; RR = risk ratio.
From: Effectiveness of Prevention Strategies for Contrast-Induced Nephropathy: A Systematic Review and Meta-analysis


Figure Legend:

Pooled RRs for development of CIN in comparisons of N-acetylcysteine plus IV saline versus IV saline in patients receiving contrast media. CIN = contrast-induced nephropathy; IOCM = iso-osmolar contrast media; IV = intravenous; LOCM = low-osmolar contrast media; NAC = N-acetylcysteine; RR = risk ratio.
### Table 1. Pooled RRs for CIN With NAC Compared With IV Saline

<table>
<thead>
<tr>
<th>Pooled Group</th>
<th>Studies, n</th>
<th>Pooled RR for CIN (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-dose NAC</td>
<td>18</td>
<td>0.78 (0.59-1.03)</td>
</tr>
<tr>
<td>IA administration</td>
<td>16</td>
<td>0.78 (0.55-1.12)</td>
</tr>
<tr>
<td>IV administration</td>
<td>2</td>
<td>0.55 (0.12-2.62)</td>
</tr>
<tr>
<td>Low-dose NAC</td>
<td>35</td>
<td>0.75 (0.63-0.89)</td>
</tr>
<tr>
<td>IA administration</td>
<td>30</td>
<td>0.77 (0.66-0.91)</td>
</tr>
<tr>
<td>IV administration</td>
<td>5</td>
<td>0.62 (0.18-2.10)</td>
</tr>
<tr>
<td>Oral NAC</td>
<td>40</td>
<td>0.77 (0.65-0.92)</td>
</tr>
<tr>
<td>IV NAC</td>
<td>14</td>
<td>0.90 (0.72-1.12)</td>
</tr>
<tr>
<td>NAC when LOCM are used</td>
<td>40</td>
<td>0.69 (0.58-0.84)</td>
</tr>
<tr>
<td>NAC when IOCM are used</td>
<td>7</td>
<td>1.12 (0.74-1.69)</td>
</tr>
</tbody>
</table>

CIN = contrast-induced nephropathy; IA = intra-arterial; IOCM = iso-osmolar contrast media; IV = intravenous; LOCM = low-osmolar contrast media; NAC = N-acetylcysteine; RR = risk ratio.
- Identification of risk factors and correction of modifiable factors
- Patient education
- Hydration
- Oral NAC (N-acetylcysteine)
- Choice of contrast agent
- Withholding nephrotoxic medications
Hydration is key
Renal Guard

Investigational study, not approved in US
Case Study

73 year old African American female with HTN, hyperlipidemia, NIDDM, CKD stage II, and known CAD s/p PCI to RCA 2014 now presenting with recurrent exertional angina CCS class II.

Takes sitagliptin-metformin. Baseline creatinine 1.0 (eGFR is 65ml/min per 1.73m2)

Scheduled for cath and +/- PCI tomorrow afternoon.

What would you to do to prevent her from having CIN?
Thank you