Contrast Medium Induced Nephrotoxicity (CIN): Precautions and policies in patients with decreased renal function

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Precautions and policies in patients with decreased renal function

i.v. Contrast Agents for CT

- non-ionic iodinated contrast media (CM) (low- or iso-osmolar)
- all CM are extracellular fluid markers after i.v. injection, complex early arterial dynamics (pharmacokinetics)
- slightly variable physicochemical properties come at different concentrations similar safety profiles

Physicochemical Properties Contrast Media Used for CTA
(non-ionic, low- and iso-osmolar)

Idiosyncratic
- allergy-like reactions
- delayed cutaneous reaction

Dose dependent
- local pain, nausea, vomiting
- nephrotoxicity
- cardiovascular effects

Extravasation Injury
Thyroid function
Drug interactions
- metformin, β-blockers, IL-2, hydralazin

Adverse Effects and Precautions
(overall: 1.31%; severe: 0.04%)

References / Guidelines

→ need institutional guidelines/policy (and good judgement)
http://radportal.stanfordmed.org

• ACR guidelines
American College of Radiology (ACR) Manual on Iodinated Contrast Media

• ESUR guidelines

Adverse Effects and Precautions
(overall: 1.31%; severe: 0.04%)

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No Gadolinium:
only for iod.-CM allergy, hyperthyroid
Normal Kidney Function

- 20% of cardiac output in kidneys (~1000 mL/min)
- Filters off 20% of renal plasma flow (~125 mL/min) = GFR
- Reabsorption up to 99% (active/pass.)
  - Proximal tubule
  - Loop of Henle
  - Distal loop/collection ducts
- Urine 1.25 mL/min (1.5L/day)

GFR: glomerular filtration rate

Chronic Kidney Disease (CKD): Stages

Normal kidney function: GFR > 90 mL/min/1.73 m² and no evidence of kidney damage (e.g. proteinuria)

Serum creatinine (Cr) is filtered in the kidneys, and neither re-absorbed nor excreted. Can be used to calculate renal function (GFR) [Creatinine clearance]

Serum creatinine (Cr) concentration rises with decreasing renal function, however

Serum creatinine (Cr) is NOT a good marker for renal function (depends on e.g. muscle mass, etc)

Chronic Kidney Disease (CKD) Stages

<table>
<thead>
<tr>
<th>Stage</th>
<th>GFR (mL/min/1.73 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>II mild CKD</td>
<td>60-90</td>
</tr>
<tr>
<td>III moderate CKD</td>
<td>30-59</td>
</tr>
<tr>
<td>IV severe CKD</td>
<td>15-29</td>
</tr>
<tr>
<td>V kidney failure</td>
<td>&lt;15</td>
</tr>
</tbody>
</table>

Values based on 4-parameter MDRD formula: GFR (mL/min/1.73 m²) = 186 (Scr x 0.011)^1.154 x (age)^-0.203 x (1.21 if black) x (0.742 if female).

Contrast Medium Induced Nephrotoxicity (CIN)

- Acute impairment of renal function
- Incr. serum Creatinine 0.5 mg/dl (44.2 µmol/l) or >25%
- Typically peaks 2 to 3 days after CM admin., then returns to baseline within 2 weeks: If not, contributes to increased risk of death
- <1-2% in general population
- 12-50% in pts. w. renal impairment ± diabetes

Contrast Medium induced Nephrotoxicity Pathophysiology

Mechanism not fully understood
- Vascular effect (?)
- Chemotoxicity on tubular epithelium (?)
- Well known Risk factors


GFR = glomerular filtration rate,
Scr = serum creatinine in µmol/L, age is given in years
Contrast Medium Induced Nephrotoxicity (CIN) Patients at Risk

- decreased renal function (Cr>1.5 mg/dL)
- particularly in pts with diabetes, on nephrotoxic drugs, volume depletion
- hypertension
- hypotension
- gout, proteinuria, myeloma, ...

Contrast Medium Induced Nephrotoxicity (CIN) Practical Consequences for CT

- (1) screen for patients at risk to develop CIN
  - all inpatients need Cr
  - all outpatients > 70 y, pts. w diabetes, history of kidney disease (single kidney, renal mass, myeloma)
- (2) for patients at risk, take measures to reduce risk
  - hydration !!
  - less contrast (300 mg I/mL instead of 370 mg I/mL)

Contrast Medium Induced Nephrotoxicity (CIN) Prevention in Patients at Risk

- Hydration (volume expansion)
  - 3 mL/kg BW / hour, for one hour (+/- bicarbonate)
  - oral hydration probably ok in outpatients if necessary
- Acetylcystein (Mucomyst)
  - may be helpful, cheap
  - 2x 600-1200 /d, 24h before until 48 after CM
- Radiologist may chose to use less CM
  - clinical decision (cannot risk diagnostic quality)
  - use less concentration (volume remains the same), or use less volume (e.g protocol for 'smaller' patient)

Contrast Medium Induced Nephrotoxicity (CIN) Patients with eGFR <60 mL/min/1.72 m²

- there is no absolute contraindication of CM injection based on renal function
- risk of not obtaining CT may exceed risk of nephrotoxicity. This remains clinical decision, usually together /w referring service
- IF INDICATED, this needs to be documented in protocol
- nurses/technologists can inject

Integrated Scanning-Injection Protocol

64-channel CTA of the abdominal Aorta

- Scantime: 10s for ALL patients (pitch variable) (automated tube current modulation)
- Inj. duration: 18s for ALL patients
- Delay: 'care-bolus' w/ 8s delay (tCM+8)

<table>
<thead>
<tr>
<th>weight</th>
<th>flow</th>
<th>volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;121 lb</td>
<td>4.0 mL/s</td>
<td>72 mL</td>
</tr>
<tr>
<td>121-145</td>
<td>4.5 mL/s</td>
<td>81 mL</td>
</tr>
<tr>
<td>(average)</td>
<td>146-185</td>
<td>5.0 mL/s</td>
</tr>
<tr>
<td>186-209</td>
<td>5.5 mL/s</td>
<td>99 mL</td>
</tr>
<tr>
<td>&gt;210 lb</td>
<td>6.0 mL/s</td>
<td>108 mL</td>
</tr>
</tbody>
</table>

+ saline flush
**Contrast Medium and Hemodialysis**

- Synchronization of contrast administration and hemodialysis is not necessary.
- Nephrologists often prefer dialysis before contrast medium administration.
- When protocoling, state that patient is on dialysis and CM injection ok (as with all CM injections in pts /w renal insufficiency).

Thank You!!