UQ Med Year 4

Critical care/Med spec/Surg spec
Orientation week

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Managing Editor, radiopaedia.org
Academic Lead of Clinical Radiology, University of Queensland

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Drugs in Radiology
  • types
  • complications
  • pregnancy and lactation
Radiation
MRI safety
Key concept: Drugs in Radiology

- Contrast - for the imaging study
- Others drugs - to help the patient during the imaging study
Key concept

Drugs in Radiology

- Contrast
  - why do we need it?
  - is it safe?
  - is it worth it?
Normal kidneys on 4-phase CT study

Dr Ian Bickle, rID: 25889

NOTES:
- Contrast
  - CT, fluoro
    - iodinated contrast
    - Iodine absorbs Xrays
• Contrast
  • CT, fluoro
    • iodinated contrast
      • Iodine absorbs Xrays
    • mode
      • IV, IA
    • enteric
    • direct injection into cavity or tube
  • excreted by kidneys (mostly, some hepatobiliary)
• metformin - precipitates lactic acidosis
  • cease metformin for 2 days, check eGFR
· SE
  · immediate - warm flush, metallic taste, feeling of wetting oneself
  · nausea, vomiting
  · allergic reaction
  · anaphylaxis
Key concept: Contrast induced nephrotoxicity

- Iodinated contrast excreted by kidneys
- Far less common now with non-ionic contrast agents
- Higher risk for existing renal impairment
- Pre and post hydration (IV fluids) helps
- NAC no longer used for prophylaxis
- Haemodialysis will remove it
The Royal Australian and New Zealand College of Radiologists

Policy Library

Iodinated Contrast Media Guideline, 2016 Edition

List of Recommendations only

Approved by: Faculty of Clinical Radiology Council
Date of approval: 22 April 2016
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Frequency of acute kidney injury following intravenous contrast medium administration: a systematic review and meta-analysis.

McDonald JS¹, McDonald RJ, Comin J, Williamson EE, Katzberg RW, Murad MH, Kallmes DF.

PURPOSE: To perform a systematic review and meta-analysis of controlled studies examining the incidence of acute kidney injury (AKI) and other outcomes in patients exposed to intravenous (i.v.) contrast medium compared with patients who underwent an imaging examination without contrast medium or were otherwise unexposed (control group).

MATERIALS AND METHODS: MEDLINE, EMBASE, Scopus, and the Cochrane Library were searched for all articles published through September 2011 that contained search terms related to nephrotoxicity following intravenous contrast medium administration. Two independent reviewers identified studies in which the incidence of AKI in patients exposed to i.v. contrast medium was directly compared with the incidence of AKI in unexposed patients through analysis of changes in serum creatinine level or estimated glomerular filtration rate 48-72 hours following imaging procedures or admission. Study characteristics and outcomes of AKI, dialysis, and mortality were extracted by using a standardized protocol. Relative risk (RR) was calculated by using random-effects models and was tested in subgroups of different patient comorbidities, contrast medium types, and AKI diagnostic criteria. RR results of less than 1.00 indicated that there was a higher incidence of these outcomes in the group that did not receive contrast medium (non-contrast medium group).

RESULTS: Of the 1489 studies originally identified, 13 nonrandomized studies (0.9%) representing 25,950 patients met inclusion criteria. In the group that received contrast medium (contrast medium group), risk of AKI (RR = 0.79; 95% confidence interval [CI]: 0.62, 1.02; P = .07), death (RR = 0.95; 95% CI: 0.55, 1.67; P = .87), and dialysis (RR = 0.88; 95% CI: 0.23, 3.43; P = .85) was similar, compared with the risk of AKI in the non-contrast medium group. This pattern was observed regardless of i.v. contrast medium type, diagnostic criteria for AKI, or whether patients had diabetes mellitus or renal insufficiency.

CONCLUSION: Controlled contrast medium-induced nephropathy studies demonstrate a similar incidence of AKI, dialysis, and death between the contrast medium group and control group.
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R6. The risk of intravenous contrast media related acute kidney injury (CI-AKI) is likely to be nonexistent for patients with eGFR greater than 45 mL/min/1.73m2. No special precautions are recommended in this group prior to or following intravenous administration of iodinated contrast media.

R7. The risk is of intravenous CI-AKI is also very likely to be low or nonexistent for patients with eGFR 30 - 45 mL/min/1.73m2. Universal use of periprocedural hydration in this group to prevent the theoretical risk of CI-AKI cannot be recommended but patients with impaired function in this range that is acutely deteriorating rather than stable may benefit from this intervention.

R8. In patients with severe renal function impairment (eGFR less than 30 ml/min/1.73m2) or actively deteriorating renal function (acute kidney injury) careful weighing of the risk versus the benefit of iodinated contrast media administration needs to be undertaken. Consideration should be given to periprocedural renal protection using intravenous hydration with 0.9% saline (see relevant section). However, severe renal function impairment should not be regarded as an absolute contraindication to medically indicated iodinated contrast media administration.
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R6. The risk of intravenous contrast media related acute kidney injury (Cl-AKI) is likely to be non-existent for patients with eGFR greater than 45 mL/min/1.73m2. No special precautions are recommended in this group prior to or following intravenous administration of iodinated contrast media.

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<thead>
<tr>
<th>eGFR</th>
<th>contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;45</td>
<td><img src="checkmark.png" alt="Green Check Mark" /></td>
</tr>
<tr>
<td>30-44</td>
<td><img src="question-mark.png" alt="Question Mark" /></td>
</tr>
<tr>
<td>&lt;30</td>
<td><img src="x-mark.png" alt="Red X" /></td>
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</tbody>
</table>
- Contrast
  - Barium
    - fluoro
    - just for GIT
    - can worsen GIT obstruction
    - extravasation causes fibrosis
    - aspiration risk
    - allergic reactions very rare
Normal barium swallow

Dr Ian Bickle, rID: 53859

NOTES:
Barium swallow aspiration

Dr M Sanal Kumar, rID: 36916

NOTES:
Aspirated barium swallow

Dr Derek Smith, rID: 34411

NOTES:
Normal barium enema

Assoc Prof Craig Hacking, rID: 41852

NOTES:
Apple core sign

Dr Roberto Rafael Ovalle, rID: 13612

NOTES:
• Contrast
  • MRI - Gadolinium (Gad, Gd)
    • paramagnetic agent - high signal on T1WI
  • Mode - IV
  • mostly excreted by kidneys (some hepatobiliary)
  • SE
    • headache, nausea
    • allergic reactions rare
  • NSF
Normal head MR angiogram

Dr Hidayatullah Hamidi, rID: 53690

NOTES:
Glioblastoma NOS

Assoc Prof Frank Gaillard, rID: 8771

NOTES:
Key concept: Nephrogenic systemic fibrosis

- NSF
  - rare! (only a few cases in Australia)
  - fibrosis - skin, joints, eyes, viscera
    - like scleroderma
  - < 5% mortality, no Rx known
  - only in pts with known renal disease (mainly ESRF)
  - more common after repeated doses of Gad
  - prevention - improve renal function, use low doses, haemodialysis
  - don’t use Gad is eGFR < 30.
CURRENT DEBATE

- not all is excreted => some Gad is retained
- in brain, bone, others
- increases with dose strength and repeated doses
- no know adverse effects as yet
- recommendation - use Gad appropriately

Gadolinium retention in the brain

Prof Alan Coulthard, rID: 38904

NOTES:
- Contrast
  - US
    - microscopic bubbles (1-4 microns) in thin shell
    - bubbles enhance the echoes of vascular structures
    - over time shell breaks, gas released, abs by RES
    - mode - IV
  - SE
    - most minor, skin, headache, N&V
    - anaphylactoid reaction
  - no effect on renal function
Hepatic hemangioma (contrast-enhanced ultrasound)
Dr Alexandra Stanislavsky, rID: 12989

NOTES:
Key concept

Contrast extravasation

- common, approx 1%
- mostly CT iodinated contrast
- more common with pressure contrast injectors
- most are minor - Rx with RICE
- major
  - rare
  - limb threatening from compartment syndrome
  - ulceration, necrosis
  - call gen surg or plastics
  - check hospital policy

CT scout

Dr Henry Knipe, rID: 48604
other drugs
  · sedation for procedures, claustrophobia
    · midazolam, fentanyl
  · antibiotics
  · analgesia
    · Subcut, IV for procedure
    · reason for procedure e.g. joint HCLA
  · steroids
    · joints, bursa, nerve roots
  · vasodilators - for neuro vasospasm
  · spasmolytics
    · buscopan, glucagon - MRE, CTE
• minor allergic reactions
  • skin - itch, urticaria
  • resp - wheeze
  • neuro - syncope
  • gastro* - N, V, D
• premedication
  • steroids
  • antihistamines
Key concept: Allergic reactions

- anaphylaxis
  - mainly CT iodinated contrast
  - approx 1 in 100,000
  - not dose dependant
  - most within 5 min of exposure
  - Sx - resp distress, laryngeal edema, hypotension, cardiac arrest
- Rx
  - call for help!
  - O2, IV fluids, adrenaline IM 1:1000
Key concept: Pregnancy and lactation

- XR and CT - Radiation
  - higher radiation sensitivity
    - breasts
    - fetus
  - use shields and gowns as needed
  - question its use
    - e.g. CTPA v VQ scan for PE

- US and MRI is safe
  - but not for prolonged time due to heating
Pregnancy and lactation

- Contrast
  - Iodinated contrast
    - FDA B1, B2 drug so safe
    - crosses placenta but not detrimental to fetus
    - check neonatal thyroid function
- In breast milk
  - OLD - express and discard for 24hrs
  - NEW - can continue breast feeding
Key concept: Pregnancy and lactation

- Contrast
  - Gadolinium
    - crosses placenta
    - little known about fetal effects
    - so best avoided in pregnancy

- in breast milk
- < 0.05% in breast milk & < 1% absorbed by fetal GIT so can breast feed
Key concept: Radiation
Key concept: Radiation

Penetrates Earth's Atmosphere?

Radiation Type
Wavelength (m)
Radio $10^3$
Microwave $10^{-2}$
Infrared $10^{-5}$
Visible $0.5 \times 10^{-6}$
Ultrasound $10^{-8}$
X-ray $10^{-10}$
Gamma ray $10^{-12}$

Approximate Scale of Wavelength
Buildings
Humans
Butterflies
Needle Point Protozoans
Molecules
Atoms
Atomic Nuclei

Frequency (Hz)
$10^4$ $10^8$ $10^{12}$ $10^{15}$ $10^{16}$ $10^{18}$ $10^{20}$

Temperature of objects at which this radiation is the most intense wavelength emitted
1 K $-272 ^\circ C$
100 K $-173 ^\circ C$
10,000 K 9,727 ^\circ C
10,000,000 K $-10,000,000 ^\circ C$

Key concept: Radiation

Penetrates Earth's Atmosphere?

Radiation Type
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- 1 K: $-272 \, ^\circ C$
- 100 K: $-173 \, ^\circ C$
- 10,000 K: 9,727 °C
- 10,000,000 K: $-10,000,000 \, ^\circ C$

- Inverse square rule

\[ \text{intensity} \propto \frac{1}{\text{distance}^2} \]

- i.e., the further away you are from the source, the much less radiation you receive
Key concept: Radiation

By Borb, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=3816716
Why so bad?
  - adult
  - cancer
  - sterility
  - cataracts
  - burns
  - fibrosis
  - fetal
  - miscarriage
  - teratogenic
  - neuro development - lower IQ
Deterministic effects

SEVERITY proportional to dose once threshold reached
causes cell death
  i.e. fibrosis, cataracts, marrow damage, burns, sterility
dead (high doses)

Stochastic effects

PROBABILITY proportional to dose
Severity independent of dose
causes cell modification
  i.e. cancer
ALARA

As Low As Reasonably Achievable

i.e. lowest dose that produces a diagnostic result
Key concept: Radiation
Key concept: MRI safety

- superconductor magnet i.e. magnet is always on!
- static field
  - heating, headache
- gradient fields
  - loud noise - headphones
  - skin sensation

claustrophobia
Key concept: MRI safety

metallic objects
Key concept MRI safety
**MEDICAL IMAGING REQUEST**

Royal Brisbane and Women's Hospital  
Level 3, Ned Hanlon Building, Herston 4029  
Phone: 3646 2606  Fax: 3646 5379


**Imaging Requested**

**The aim of this imaging is to** *(tick one and explain)*
- [ ] Confirm
- [ ] Exclude
- [ ] Define
- [ ] Progress of

**Clinical Details** *(include relevant surgery, imaging and pathology results)*

- Pregnant? [ ] Yes  [ ] No
- Infected? [ ] Yes  [ ] No
- Allergies? [ ] Yes  [ ] No

Specify

**Risk factors for CT, MRI, IVP, Angiography**

- [ ] Nil
- [ ] > 70 years
- [ ] Diabetic
- [ ] On Metformin

If yes to any of the above please complete

<table>
<thead>
<tr>
<th>Creatinine</th>
<th>eGFR</th>
<th>Date</th>
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</table>

**Obligatory MRI questionnaire**

- Aneurysm clip [ ] Yes  [ ] No
- Embolisation coils [ ] Yes  [ ] No
- Inner ear implant [ ] Yes  [ ] No
- Neuro/bistimulator [ ] Yes  [ ] No
- Heart surgery [ ] Yes  [ ] No
- Prosthetic cardiac valves [ ] Yes  [ ] No
- Cardiac pacemaker/wires [ ] Yes  [ ] No
- Vena cava filter [ ] Yes  [ ] No
- Programmable shunt [ ] Yes  [ ] No
- Metal prosthesis [ ] Yes  [ ] No
- Penetrating eye injury ever [ ] Yes  [ ] No
- Stent [ ] Yes  [ ] No
- Requires sedation/pain relief [ ] Yes  [ ] No
- Requires GA [ ] Yes  [ ] No
- Claustrophobia [ ] Yes  [ ] No
- Able to lie flat [ ] Yes  [ ] No

Declaration: I have assessed the above risks to the patient for this examination

**Requested by:********** Consultant Name

Signature:  

Pagar/Phone:  Date

**Radiologist protocol/initials..............**
- [ ] Today
- [ ] Next 2 days
- [ ] Next 5 days

**Radiographers comments**

Time:  

Date:  

Room:  

Initials:  

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Notice to the patient. For Medicare eligible examinations only. Your referrer has recommended that you use Queensland Health. You may choose another provider but please discuss this with your referrer first.

Version No: 3.1 Effective date: 05/2016 Review date: 05/2017
### Obligatory MRI questionnaire

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<tr>
<th>Item</th>
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<th>No</th>
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<td>Embolisation coils</td>
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<td>Inner ear implant</td>
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<td>Neuro/biostimulator</td>
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<td>Heart surgery</td>
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<td>Prosthetic cardiac valves</td>
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<td>Cardiac pacemaker/wires</td>
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<td>Vena cava filter</td>
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Summary

Safety in Radiology

- Drugs in Radiology
  - types
  - complications
  - pregnancy and lactation
- Radiation
- MRI safety
• RANZCR website
  • https://www.ranzcr.com/fellows/clinical-radiology/professional-documents/
• Diagnostic imaging pathway
• TGA
• Radiopaedia
• David A. Lisle. Imaging for Students Fourth ed. (2012)
Further reading

For all your Radiology needs...

Radiopaedia.org

IMAGING FOR STUDENTS
Fourth edition

David A Lisle
KEEP CALM
PRESENTATION IS OVER
ANY QUESTIONS?