How to actively reduce radiation exposure in venous interventions

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Radiation- who cares?

• Unlike most arterial interventions, most venous patients are
  – Young (anyone younger than me obviously ha ha 😊)
  – Female (70/30)
  – Often do not have a “critical limb”
**Deterministic** (Cause and effect)

- Examples of deterministic effects (doses are given as *entrance skin dose*:)
  - skin erythema: 2-5 Gy
  - irreversible skin damage: 20-40 Gy
  - hair loss: 2-5 Gy
  - sterility: 2-3 Gy
  - cataracts: 5 Gy
  - lethality (whole body): 3-5 Gy
  - fetal abnormality: 0.1-0.5 Gy

**Stochastic** (Chance effect)

- At zero dose there is zero risk
- At 6000 mSv (6 Sv); for 50% of population, death is almost certain.
- 10,000 mSv (10Sv), 100% die.
- A dose of 10 µSv (ie daily background radiation dose in Ireland) will increase lifetime risk of cancer by 1 in 2,000,000.
- Lifetime risk of cancer is ¼
- Some degree of perspective is required!!
Stochastic (chance) effect

Excess Cancer Incidence

Supra-Linear Model

Linear No-Threshold Model

Sub-Linear (Linear-Quadratic) Model

Hormesis Model

Radiation Dose
There is no actual dose (in general medical imaging/intervention) which will “cause” cancer, but Risk of Exposure Induced Death (REID) is real.
Risk of Exposure Induced Death (REID)

- 159 Haemodialysis patients
- 3 year follow up; 486 patient years
- Mean cumulative organ doses in mSv ranged between 103 and 58 mSv per organ
- Caused by
  - CT 90%; Nuclear 4.5%; Interventional 5.5%
- The average REID was 0.99% (i.e. odds 1 in 100) and the median REID was 0.45%
- Increased risk with younger age

Brambilla
Radiation doses

- CXR: 0.1 mSv
- 10h airline flight: 0.05 mSv (5 uSv/hr)
- Background radiation: 2.8 mSv/annum (Galway)
- CT Thorax: 7 mSv
- CT Periph. Angiogram: 7.2 mSv
- CT Abdo Pelvis: 8.7 mSv
- PET/CT: 30 mSv
IMAGING INTERVENTION FOLLOW-UP
Venous patients may need life-long imaging—so we should be using method(s) which do not use ionising radiation.
Imaging methods pre and post op

• Ultrasound- should be first modality; and excellent for follow up; limited above the groin; can usually see stents following placement though

• MRV- no radiation; sequences getting faster; pacemakers probably soon no longer a contraindication; availability an issue; highly dependent upon radiographer/radiologist

• CTV- significant radiation dose; useful for IVC and iliacs especially obese patients- but quick and very repeatable
# Imaging methods during endovascular procedures

<table>
<thead>
<tr>
<th>Fluoroscopy</th>
<th>IVUS</th>
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</thead>
<tbody>
<tr>
<td>• Radiation</td>
<td>• No radiation</td>
</tr>
<tr>
<td>• Short learning curve but subtleties easy to miss</td>
<td>• Moderate learning curve; excellent for subtle stuff</td>
</tr>
<tr>
<td>• Repeatable but dose++</td>
<td>• Repeatable</td>
</tr>
<tr>
<td>• More difficult to quantify</td>
<td>• Easily quantifiable</td>
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Just how much radiation can a “venous patient” potentially receive?

- Actual doses Galway Univ. Hospital 2017
  - CTPA: 6.7 mSv
  - CT Periph. Venogram: 9.6 mSv
  - Cone Beam CT Pelvis: 7.4 mSv
  - DSA High spatial res: 2.8 mSv/min
  - DSA Low spatial res: 1.04 mSv/min

- Current Galway Acute DVT protocol
  - Pre-op:
    - US; CTPA/CTV
  - Intra op: Fluoro average 14 mins
  - +/- CBCT
  - US day 1; CTV 6 weeks
  - TOTAL dose: ~ 40 mSv
## Imaging protocols: Current v Ideal

### Acute DVT
- Acute DVT
  - US
  - CTPA
  - CTV
  - Fluoro
  - CBCT
  - IVUS
  - US Day 1
  - CTV post op

### Acute DVT
- US
- Echo
- MRV
- IVUS (minimal fluoro)
- US
## Imaging protocols: Current vs Ideal

### Chronic Venous Occlusions
- Direct CTV
- Fluoro
- IVUS
- CBCT
- US Day 1
- CTV 6 weeks

### Chronic Venous Occlusions
- MRV
- IVUS (minimal fluoro)
- US Day 1
- US follow up thereafter
So what is to stop us doing this tomorrow?

- CTPA/CTV takes 8 minutes - I control it
- Echo + MRV takes 2+ days
- Lack of MRV availability and expertise
- IVUS - not widely available (yet)
What am I going to practically do to reduce my patients doses:

• Lobby for more time on the MRI.. (mission impossible)
• Assess how difficult performing echo would be
  – Do I need new probes for my US machine?
  – How long would training take?
  – (All I want is Pul. A pressure and RV motion)
• Try and switch all follow up to US not CTV
Available on Amazon

Read the chapters on:

US
MRV
IVUS
Thank you for your attention

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