An overview of CT protocol optimization process at Johns Hopkins

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Topics

- CT Usage at Hopkins
- CT Protocol Optimization Process
- CT Dose Audits

Background
Radiation exposure to US population

US 1982 (NCRP 93)

- Medical 0.54 mSv per capita
- Background 85%
- Medical 15%

US 2006 (NCRP 160)

- Medical 3.0 mSv per capita
- Background 50%
- Medical 50%

Total 3.6 mSv per capita

NCRP 160 published March 2009

Radiation Injuries in CT – Rare but Possible!

West Virginia Hospital Overradiated Brain Scan Patients, Records Show

2010

Radiation Boom, NY times

Number of CT procedures in US

Non-Hospital

Hospital

Total

MDCT

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**CT usage in US**

<table>
<thead>
<tr>
<th>CT Procedure Categories</th>
<th>Total 2015 CT Procedures (M)</th>
<th>% of All CT Procedures</th>
<th>% of CT Sites Performing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head &amp; Neck</td>
<td>23.2</td>
<td>30%</td>
<td>95%</td>
</tr>
<tr>
<td>Chest, Abdomen &amp; Pelvis</td>
<td>37.3</td>
<td>47%</td>
<td>97%</td>
</tr>
<tr>
<td>Calcium Scoring</td>
<td>1.2</td>
<td>2%</td>
<td>30%</td>
</tr>
<tr>
<td>CT Angiography</td>
<td>1.5</td>
<td>2%</td>
<td>27%</td>
</tr>
<tr>
<td>Total 2015 CT Procedures</td>
<td>78.7</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

**CT Usage at Hopkins**

- CT scanners in Radiology
  - Mostly single manufacturer scanners
  - 16 slice to 128 slice
- CT protocols are mostly uniform
- CT scanners in Cardiology
  - Single vendor
  - Facilitates optimization
- Hybrid Imaging systems
  - Limited number of CT protocols
**CT Safety Team**
- Technologists (manager & QA tech)
- Physicist
- Radiologist (Body CT Director)

**CT Physicist’s Role**
- Acceptance Tests
- Evaluation post major upgrade or repair
- CT Protocol Review with CT team
- CT Accreditation
- Quarterly Radiation Dose Audits
- Evaluation of high dose procedures such as CT Perfusion
- Evaluation of fetal dose for pregnant patients

**CT protocol review**
- 1st identify procedures that have high potential to cause injury and ensure the settings are ok
  - CT Perfusion – Brain or Cardiac, CT Fluoroscopy, …
- 2nd review protocols of most common CT studies
- 3rd review scan settings for all protocols
- Establish routine review of CT protocols
- Establish process to evaluate new CT protocols before setting up on scanner

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How request for protocol changes addressed?

- Request for protocol changes is reviewed by CT team
- CT Physicist review reason for such changes, its impact on CT dose
- Once approved CT Technologist (super user) is responsible for modifying changes
- Single point repository for any changes aid in avoiding surprises

CT Dose Check*

- "Radiation dose check feature will provide an alert to CT machine operators when recommendation radiation levels as determined by users are exceeded”
- CTDI_{vol} and DLP values can be set for each scan series so that when values exceed set levels, program will alert operator and if operator still wishes to continue with the changes then reasons are to be documented
- Program is capable of tracking changes for audit

* NEMA XR 25-2010

CT Dose Check and CT Dose Notification

- Regulatory requirements
  - Medicare reimbursements are reduced by 5% from January of 2016 and 15% a year after for CT scanner that are not in compliance regarding CT dose alert
- Refer to AAPM website* for notification values
  - User can modify according to their practice
- Check if scanner triggers by setting up test patient and modifying parameters to exceed alert values

* NEMA XR 25-2010

CT Dose Check

CT Dose Alert

• US FDA has suggested CT alert value for CTDI_vol of 1 Gy (1000 mGy)

CT Notification Values**

<table>
<thead>
<tr>
<th>CT Scan Region (of each individual scan in an examination)</th>
<th>CTDI_vol Notification Value (mGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult Head</td>
<td>80</td>
</tr>
<tr>
<td>Adult torso</td>
<td>50</td>
</tr>
<tr>
<td>&lt;2 years old</td>
<td>50</td>
</tr>
<tr>
<td>2-5 years old</td>
<td>60</td>
</tr>
<tr>
<td>Pediatric torso</td>
<td>25</td>
</tr>
<tr>
<td>&lt;10 years old (32-cm phantom)*</td>
<td>25</td>
</tr>
<tr>
<td>&lt;10 years old (32-cm phantom)†</td>
<td>50</td>
</tr>
<tr>
<td>Brain Perfusion**</td>
<td>600</td>
</tr>
<tr>
<td>Cardiac</td>
<td>150</td>
</tr>
<tr>
<td> Retrospectively gated (spiral)</td>
<td>150</td>
</tr>
<tr>
<td> Prospectively gated (sequential)</td>
<td>50</td>
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* NEMA XR 25-2010

** AAPM Dose Check Guidelines, 2011

CT Dose Audits

• Dose information recorded for every CT study
• In addition, CT Technologists randomly select up to five most commonly performed procedures on each scanner
• Record dose information of five patients for each identified procedure for review
• Also records all studies flagged under CT Dose Notification preset for respective protocols

CT Dose Audit

• Physicist review select cases regarding radiation information and image quality
• Review studies flagged under CT dose notification especially review technologists notes for such studies
### Reviewing CT Protocols

<table>
<thead>
<tr>
<th>Patient Name</th>
<th>Date</th>
<th>Time</th>
<th>Gender</th>
<th>Age</th>
<th>Body Part</th>
<th>Dose (mSv)</th>
<th>Protocol</th>
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<tbody>
<tr>
<td>John Doe</td>
<td>8/3/2016</td>
<td>10:00</td>
<td>Male</td>
<td>30</td>
<td>Chest</td>
<td>0.5</td>
<td>Standard</td>
</tr>
<tr>
<td>Jane Smith</td>
<td>8/3/2016</td>
<td>11:30</td>
<td>Female</td>
<td>40</td>
<td>Abdomen</td>
<td>0.8</td>
<td>Enhanced</td>
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### CT Dose Audit – Initial Setup

#### Dose Review Audit

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### CT Dose Audit Data

#### Siemens Somatom Force CT66 – JHOC

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CT Dose Audits
Review of Dose Notification Alerts

Quality Improvement Report

CT Technologists Role

- Meets regularly (typically monthly)
- Purpose is to discuss difficult studies
- Peer review each others work on select studies
- Communicate regularly with physicist regarding questions related to patient scans
**Conclusions**

- CT protocol optimization is best achieved with a team approach.
- Periodic review of the process is key to success.
- Communication between all participants is key.
- Irrespective of whether it is required by regulations or not, patient safety is our first priority—hence optimization is essential.
- CT protocol optimization should ensure that image quality is not jeopardized.