An overview of TG-180:
Image Guidance Doses Delivered During Radiotherapy

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TG-180: Image Guidance Doses Delivered During Radiotherapy:
Quantification, Management, and Reduction

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AAPM TG-180

- provides typical image doses resulting from different modalities
- recommends a dose threshold beyond which imaging dose be accounted for: 5% of therapeutic target dose
- reviews available techniques for reducing the dose to organs at risk
- provides guidelines for imaging dose dosimetry
- gives guidelines and methods for imaging dose calculations
- describes methods of accounting for imaging dose when it is needed
  • Patient specific imaging dose calculations,
  • Non-patient specific imaging dose estimations
Dose from Different Imaging Modalities

- Megavoltage beam imaging
  - 2D: portal images
  - 3D: MVCT, MV-CBCT
- Kilovoltage beam imaging
  - 2D: digital radiograph
  - 3D: kV-CBCT

Electronic Portal Imaging Device (EPID)

Varian Clinac 21EX

Dose to patients: from MV-CBCT

2-12 cGy depending on imaging procedures

Miften et al., Med Phys, 34, 3760-3767, 2007

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**MVCT on Tomotherapy unit**

<table>
<thead>
<tr>
<th>Acquisition protocols</th>
<th>Dose (cGy)</th>
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<tbody>
<tr>
<td>Fine pitch (4mm)</td>
<td>2.5 cGy</td>
</tr>
<tr>
<td>Normal pitch (8mm)</td>
<td>1.2 cGy</td>
</tr>
<tr>
<td>Coarse pitch (12mm)</td>
<td>0.8 cGy</td>
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Tomo MVCT dose at the center of a 30 cm water phantom dependency on acquisition protocols.

Courtesy of Edward Chao, Accuray Incorporated and T. Rock Mackie, UW, Madison, WI.

**Other Imaging Modalities**

Head imaging dose from a pair of kV radiographs (OBI system).

(Shig and Muto, Radiat Oncol, vol 98, 15.4, 2013)

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Chest imaging dose from a pair of kV radiographs (OBI system)

Head imaging dose from a pair of kV radiograph (ExacTrac System)

Dose to eye from single projection: 0.008 cGy - 0.025 cGy depending on the cranial image protocols selected. (Ding, Med. Phys., vol. 42, p. 3268, 2015)

Head imaging dose from kV-CBCT

OBI 1.3 vs 1.4
Dose differences in Head scan

(Ding et al., Radiother Oncol, vol.97, 585-592, 2010)
Chest and pelvic imaging dose from kV-CBCT

Techniques to reduce imaging dose: software upgrade

Techniques to reduce imaging dose: imaged volume
Techniques to reduce imaging dose: select low dose protocol

The image dose can be further reduced by selecting "Low Dose Head" XE-CBCT scan protocol in OBI if the diameter of imaged volume is < 25 cm.

Techniques to reduce imaging dose: select beam entry angle

Methods to account for the imaging doses

- Patient specific imaging dose calculations
  - Individual patient CT based imaging dose calculation
  - Accurate organ dose calculations from imaging procedures
- Non-patient specific imaging dose estimations
  - Estimate organ doses from tabulated values based on imaging procedures
  - Dose uncertainty is acceptable
Summary of imaging dose

MV imaging:
- EPID: 1 - 5 cGy /pair of orthogonal portals
- MVCT (TOMO): 1 - 3 cGy typical
- MV-CBCT: 2-12 cGy typical

kV imaging:
- kV DR: 0.1 - 1.0 cGy /pair of orthogonal beams
- kV-CBCT: Soft tissue: 0.1 - 3 cGy /acquisition Bone: 0.3 - 6 cGy /acquisition
- kV-CBCT(4D): differs from (3D), depends on protocol used

Recommendations

- **ALARA principle** should be applied:
  - Create local imaging protocols with image modality and techniques
  - Develop protocols that are specific for pediatric patients
  - Physicists should communicate to the physicians that imaging doses are being delivered to patients
  - Use available techniques to reduce dose to organs at risk
  - Consider the type of imaging needs (2D vs. 3D)
  - kV imaging dose is much lower than MV imaging dose

- 5% of the target dose to be the threshold beyond which imaging dose should be accounted for

- Methods to account image dose if it is needed:
  - Patient-specific imaging dose calculations
  - Non-patient-specific imaging dose estimations
Next two talks:

Parham Alaei, PhD
Accounting for kV imaging dose

Ryan Flynn, PhD
Accounting for MV imaging dose and the future of MV imaging