QA DEVELOPMENTS - EXAMPLES FOR MODERN TECHNOLOGIES

Geoffrey S. Ibbott, Ph.D.
June 22, 2017
My institution holds Strategic Partnership Research Agreements with Varian, Elekta, and Philips

I will be discussing devices that are not currently available for sale, and that do not have FDA clearance.
OBJECTIVES

- Other speakers will discuss QA recommendations
- All new technologies require appropriate QA
- Offer opinions and speculate about QA needs as technology and requirements of radiation therapy evolve
INDEPENDENT VERIFICATION

Critical first step: No new treatment unit or treatment technique should be released to the clinic until an independent verification has been performed.

In order of value:

1. Complete End-to-End audit by IAEA, IROC or other independent authority
2. Independent measurement of beam calibration by national authority or colleague from different institution
3. Independent measurement of beam calibration by colleague from same institution, using different equipment
4. Review of procedures by another member of physics team, using independent methods
How are we doing?

IROC data show especially important for IMRT, VMAT, SRS and SBRT

What procedures are needed?

- Routine QA
- Patient-specific pre-treatment QA
Image, plan and treat as if a patient
# IROC Phantom Results

Comparison between institution’s plan and delivered dose.

<table>
<thead>
<tr>
<th>Phantom</th>
<th>H&amp;N</th>
<th>Liver</th>
<th>Lung</th>
<th>Prostate</th>
<th>Spine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irradiations</td>
<td>2125*</td>
<td>175</td>
<td>1186</td>
<td>575</td>
<td>349</td>
</tr>
<tr>
<td>Passing</td>
<td>1824</td>
<td>127</td>
<td>991</td>
<td>492</td>
<td>271</td>
</tr>
<tr>
<td>Pass Rate</td>
<td>86%</td>
<td>73%</td>
<td>84%</td>
<td>86%</td>
<td>78%</td>
</tr>
<tr>
<td>Criteria</td>
<td>7%/4mm</td>
<td>7%/4mm</td>
<td>5%/5mm</td>
<td>7%/4mm</td>
<td>5%/3mm</td>
</tr>
</tbody>
</table>

*Represents 1328 institutions

G. Ibbott, ICARO2, 2017
PATIENT-SPECIFIC QA

★ IROC data show value

★ US national recommendations for pre-treatment QA

★ Controversy over technique to be used
  ➡ Measurement
  ➡ Calculation
WHEN IS MEASUREMENT NOT PRACTICAL?

✦ Urgent treatments (e.g., painful bone metastases)

➡ IMRT used more often as patients live longer

➡ US/Canadian institutions have pioneered rapid QA using Monte Carlo calculations
  • Patient can be simulated, planned and treated in ~2 hours

✦ When patient remains on table for entire process

➡ Urgent/rapid treatments

➡ Novel image-guided daily adaptive treatments
DAILY IMAGE-GUIDED ADAPTIVE TREATMENTS
Complications for Dosimetry and QA

- Magnetic field can influence performance of linac
- Presence of rotating gantry and linac components can affect MR image quality
- Lorenz forces cause "electron return effect"
Influence of Magnetic Fields: Electron Return Effect

Meijsing et al. PMB 54 (2009) p2993

G. Ibbott, ICARO2, 2017
Small Air Gaps

Cannot avoid small air gaps in plastic phantoms

O’Brien et al. PMB (2015)

G. Ibbott, ICARO2, 2017
Reference Calibration

- Practical with ion chamber in water
- Positioning is difficult
  - Use MV image
  - Consider orientation
- How to determine beam quality?

G. Ibbott, ICARO2, 2017
Measurements of beam profile

- Plastic scintillator
- Diode
- microDiamond
- Ion chamber array
Initial Testing of MR-Compatible ArcCheck QA Device

- Power supply moved away from detector
- Must use MV beam to position at isocenter
- Must calibrate in MR Linac beam
PATIENT-SPECIFIC QA:

• Requires measurement, at least to evaluate process

• Calculation-based QA requires an independent calculation method

• When calculation method used, measurement-based QA necessary for validation of process

• Robust QA requires numerous components
THANK YOU FOR YOUR ATTENTION

QA  Q&A