Quality in Radiation Therapy: what is it and how do you achieve it?

1. Overview of definitions and approaches to Quality
   Pawlicki
2. ROSIS
   Knöüs
3. Peer Review Quality Audits
   Halvorsen
4. The Regulator’s Viewpoint
   Zelac
5. QA in IGRT
   Bissonnette
6. Evidence Based QA
   Dunscombe

Objective

To quantify the dosimetric changes resulting from sub-optimal machine performance

Evaluation of Linear Accelerator Performance Standards using an Outcome Oriented Approach

Alejandra Rangel, Nicolas Ploquin, Ian Kay, Peter Dunscombe


Linac performance standards*

- Performance standards are stated in terms of tolerance & action levels
- Tolerance levels are considered not to compromise treatment quality
- Action levels require an intervention

Materials & Methods

Linac performance characteristics

- Output constancy
- Gantry angle readouts
- Collimator angle readouts
- Laser alignment (x3)
- Field size indicator
- Beam flatness

Materials & Methods

Evaluation of Levels of Performance

<table>
<thead>
<tr>
<th>Test</th>
<th>Tolerance</th>
<th>Action</th>
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</thead>
<tbody>
<tr>
<td>Output constancy</td>
<td>2%</td>
<td>3%</td>
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Simulation of a Linac performance deviation

Tolerance
- Positive deviation
- Negative deviation

Action
- Positive deviation
- Negative deviation

Materials & Methods

28 3DCRT plans

- 4-field conformal plans (15 MV beams)
- 4-field conformal plans (6 MV beams)
- 2-field tangential plans (6 MV beams)
- 3-8 field conformal plans (6 MV beams)

Materials & Methods

~900 Simulations

x 7 plans
x 8 Linac performance characteristics
x 2 levels
x 2 directions
6. Evidence Based Quality Assurance

Materials & Methods

Calculation of EUD

- 28 reference plans + ~900 test plans

Equivalent Uniform Dose

Results: Brain CTV

- Bars = Average ΔEUD per course of treatment
- Error bars = 1 Std dev for n = 7

Results: Brain OARs

- 1st bar in each section = Brain Stem effects
- 2nd bar in each section = Optic Chiasm effects

Results: Prostate CTV

- Bars = Average ΔEUD per course of treatment
- Error bars = 1 Std dev for n = 7
Results: Prostate OARs

- 1st bar in each section = Bladder effects
- 2nd bar in each section = Rectum effects

Sensitivity analysis

- The “a” value used in the calculation of the Equivalent Uniform Dose is not known accurately
- For a ±20% change in “a” our results vary by
  - <0.1 Gy for the organs at risk
  - <0.1% for the targets

Conclusions

- CAPCA Tolerance Levels are shown to maintain average EUD deviations to within 2% and 2 Gy.
- However they show markedly different effects over the range of 2% or 2 Gy.
- The efficiency with which resources are allocated within a linac quality control program can be enhanced by analyzing the relative importance of the various performance standards.

Final Thoughts

- Will these results provoke a re-write of TG 40? NO
- Will these results guide the distribution of QC resources? MAYBE
- Will there be more work on putting QA programs on an objective basis? HOPEFULLY
…radiation oncology researchers need to further develop methodology for critical assessment of health technologies as a complement to randomized controlled trials.

Søren Bentzen. “Randomized controlled trials in health technology assessment: Overkill or overdue?”
Radiotherapy and Oncology 86 (2008) 142-147

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Room 350
AAPM Annual Meeting
July, 2008