Effective and efficient radiotherapy dosimetry audit: Where to next?

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Dosimetry audit

• Important role in the quality and safety of radiotherapy both for established and new technologies and techniques.

• Helps to reduce delivered dose variability and is mandatory in many multi-institutional trials.

• National and large scale audits are able to:
  – set, maintain and improve standards
  – identify issues which may cause harm to patients
Dosimetry audit

• Support implementation of complex techniques

• Benchmark centres with similar equipment

• However they can also be costly and time consuming

• Important that:
  – design is efficient and effective
  – groups work together to maximise the benefit to the user.
Challenges in dosimetry audit

• Ever expanding horizon: new techniques, new equipment, do the same things still need auditing in the same way?

• Different types of audit have different advantages and disadvantages. What is appropriate for what we need to do?

• Very little or no funding

• What is it we actually need to check?
  o IROC review of poor performance indicators
  o Carson et al Med Phys Dec 2016
ESTRO support for dosimetry audit

• Strategy review identified as an important topic

• Workshop at ESTRO office in January 2017

• Discussion of future of dosimetry audit

• Role ESTRO could play to support
Attributes of ideal dosimetry audit

- Provides 3D dose distribution with high spatial resolution
- In a patient-like geometry/medium
- Follow patient radiotherapy care-path
- Efficient (*easy to use the equipment/ requires minimum time/automated?)
- Real time results
- Cheap (*manpower/ equipment)
- Independent
- Relevant
Approaches to dosimetry audit

- Postal
  - Suitable phantoms
  - TLD/OSLD/alanine/film
  - Local chamber

- Site visit
  - More complex phantoms
  - Arrays
  - Discussion

- Remote
  - Collect local planned and delivered data
Traditional detectors and phantoms

- TLD, OSLD, alanine, film
- IC, semiconductors, MOSFETs
- Wet or solid water or plastics
- Commercial anthropomorphic
Alternative detectors

- Pre-treatment QA devices
- On line dose monitoring devices
- Scintillators
- Portal image devices
- Gel dosimetry
- Graphite calorimetry
Alternative phantoms

- 4(5?)D phantoms
- 3D printing

Dynamic Thorax phantom, CIRS Inc.
Virtual methods for audit

• Could we check the plan and/or delivery remotely?
• Could the centre make the measurements themselves?
• How could this maintain independence?
• Efficient (cheaper)?
• As effective?
Virtual methods: Auditing the plan

- How good is the plan?
- Does it achieve what we want?
- Could it be (even) better?
- How should we rank plans?
- Against clinical constraint goals achieved?
  - Usual answer Yes/No (binary)
Virtual methods: Auditing the plan

• Plan quality depends on more than DVHs
  – plan complexity, robustness and deliverability.

• In depth plan analysis can provide useful information in comparisons, especially when multiple vendors are involved.

• Plan analysis could be incorporated in dosimetry audits and also in clinical trials.

• Identify plans which need measurement
Virtual methods: Auditing the delivery

- Log files
- Recording data – MLC, jaws, dose, gantry.....
- Delivery performance
- Actual dose recalculation

Schreibmann et al. Med Phys 2009

McGarry et al. BJR 2016
Virtual delivery methods: EPIID

- eg VESPA Greer et al. ESTRO 2017
- TPS and EPIID data transferred to audit group for dose reconstruction on virtual phantom comparison
- Planar or cylindrical virtual phantoms
- TPS dose vs dose reconstruction
- Proposed for a remote auditing method
Virtual methods: Virtual / local phantoms

- Virtual phantom

- Local QA
  - Weber et al. 2014: EORTC “virtual phantom project” in-house QA vs. RPC anthropomorphic audit phantom
  - Kry et al. 2014: Institutional patient-specific IMRT QA does not predict unacceptable plan delivery

Kry et al. IJROBP 2014
Virtual dosimetry audit: intercomparison

- Calculated ‘measured’ dose distribution
- Comparison of 6 international clinical trial QA groups
- Aim towards mutual understanding and acceptance

Hussein et al ESTRO 2017
How could ESTRO support dosimetry audit?

• Guidelines / recommendations for setting up audits in collaboration with IAEA

• Sharing solutions developed by members

• Support large scale participation in testing tools for auditing

• Help lobby EU regarding auditing need in RT - quality
Next steps

• Future workshop
  – November 17\textsuperscript{th}-18\textsuperscript{th} Glasgow
  – Special issue of Physics and Imaging in RO

• Task force
  – Aim of further exploring how ESTRO could contribute to this important field.

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