IMRT Audit in Portugal: results of an IAEA national supported project

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IAEA supported national IMRT audit

• An audit to review the physics aspects of IMRT H&N treatments through on-site visits, was carried out in Portugal in 2018, with the IAEA assistance.
National characterization

10.3 million inhabitants, 92 212 km²

24 RT centres (2018)
52 LINACs
1 Tomotherapy
1 Cyberknife
1 Gamma Knife

• All 20 centres performing IMRT have voluntarily participated in the audit project.
• **Beam energy:** 18/20 centres used 6 MV and two 6FFF MV (Tomo + 1 linac).
• **Dose calculation algorithms:** AAA (12), AXB (1), MC (5), fast superposition (1), and CCC superposition (1).
Audit methodology

• As per the audit methodology, the CIRS SHANE phantom and a set of structures representing PTVs and OARs, were used to simulate all steps of an H&N IMRT treatment - from CT images acquisition, and treatment planning to dose delivery, following the local protocols, as if it were a typical patient.
Audit methodology

• The dosimetric verification of the created IMRT H&N plan was done using a small volume ion chamber placed at 4 positions inside the SHANE phantom corresponding to PTVs and spinal cord, and an EBT3 film positioned in a coronal plane.
Audit methodology

• Additionally, a set of TPS calculations and measurements was performed to check:
  - small beam dosimetry - output factors and 2×2 cm² MLC shaped field profiles;
  - MLC performance (EPID/film);
  - machine calibration.
Results - Output factors

- OF calculated on TPS for 5 MLC shaped fields were compared with the IROC-Houston reference dataset\textsuperscript{1,2}, being the differences generally within the tolerances.

Results - Profiles

• Differences between FS and penumbra widths of the measured inplane and crossplane profiles for the 2×2 cm² field and the ones calculated in TPS were within ±2 mm.
Results - **MLC performance test**

- MLC test results were within ±0.5 mm for the leaf positioning bias in all centres.
Results – SHANE measurements: IC

- The differences between calculated and measured doses were within the established tolerances of ±5% for PTVs and ±7% for the spinal cord, in all centres.
Results - SHANE measurements: film

- Regarding film analysis, for global gamma 3%/3mm with 20% threshold, passing rates ranged from 90.3% to 99.1%, again all above the limit of acceptability of 90%.
Results - SHANE measurements

- To further investigate the correlation between IC deviations and film γ passing rates, an average IC % deviation was calculated.
Results - SHANE measurements

Some common issues either *per se* or in combination may have contributed for the results of the centres with film $\gamma$ pass rate $< 95\%$ and average dose diff in PTVs $> 2\%$:

- Suboptimal plan dose distribution;
- Inclusion of treatment couch (3 of these centres did not account for the couch in treatment planning);
- Phantom positioning verification (alignment according to the lasers only/planar MV imaging);
- Equipment age (audited linac was more than 10 years old in 3 of the 4 institutions);
- Small beam dosimetry modelling in TPS.
Conclusions

• The IMRT audit supported by the IAEA carried out in Portugal in 2018 had 100% participation of the radiotherapy centres performing IMRT treatments;

• Overall, the audit results showed that the status of TPS calculations and delivery for H&N IMRT in Portugal are within the specified tolerances. At the same time, factors that contributed to increased uncertainties in the IMRT dose delivery were identified, and relevant recommendations for quality improvement were given.
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