

Purpose/Objectives: The Imaging and Radiation Oncology Core (IROC) Houston QA Center has been auditing proton therapy centers since 2007. The data from 16 proton centers has been compiled to present an overview of the proton approval and credentialing process.

Materials/Methods: A proton therapy center must complete five steps to become approved for the use of proton therapy in clinical trials: completion of a proton facility questionnaire, annual output verification with thermoluminescent dosimeters (TLD), electronic transfer of treatment plans, irradiation of baseline anthropomorphic proton phantoms, and completion of an on-site dosimetry review. Each step is monitored by IROC Houston.

The proton facility questionnaire is provided on the IROC Houston website and covers topics from proton beam production and delivery to treatment planning. We ask that institutions update the questionnaire when significant changes to the beam delivery system are made, for example when a scattered beam proton facility commissions scanning beam capabilities.

The annual output verification is performed using Lithium Fluoride TLD-100 capsules. The acceptance criterion for this measurement is $\pm 5\%$.

The electronic data transfer is verified when institutions submit DICOM treatment plans for the baseline phantoms they irradiate for proton approval. The baseline proton anthropomorphic phantoms include a prostate, head, spine and lung phantom. The prostate and spine are required for uniform scanning and scattered beam facilities and the prostate, head, and lung are required for modulated scanning systems. Phantom irradiations are also required for clinical trial credentialing for specific protocols, such as the RTOG 1112 protocol, which requires irradiation of IROC Houston's proton liver phantom.

The proton approval site visit consists of QA and treatment planning review along with dosimetric and IGRT measurements. Feedback is provided to each institution for measurements that fall outside of criteria and areas of improvement in treatment planning and QA practice.

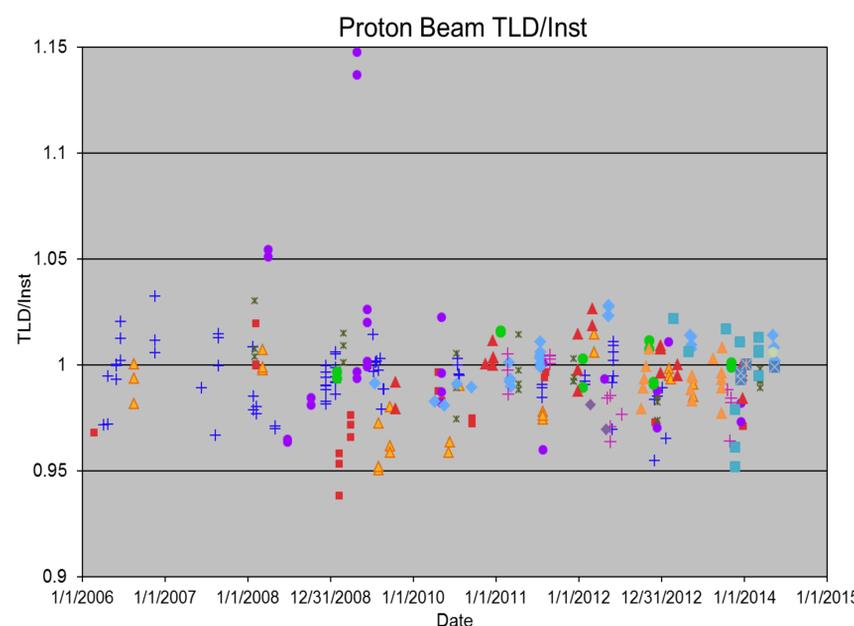


Figure 1. TLD results for proton beams monitored by IROC H.

Results: IROC Houston has collected proton facility questionnaires from 14 institutions. Annual TLD output checks have been performed for 16 institutions. 14 institutions have demonstrated the ability to electronically transfer treatment plans. 62 anthropomorphic proton phantoms have been irradiated by institutions and analyzed by IROC Houston. 18 site visits have been performed at 14 proton institutions to review proton therapy delivery with scattered, uniform scanning, and modulated scanning techniques. 13 institutions have been approved to participate in clinical trials using proton therapy.

TLD results are shown in Figure 1. In the first few years of proton TLD annual audits, errors up to 16% were observed. In one instance, we were able to detect errors caused by the institution's cyclotron. In the last three years, all TLD results were within 6%, showing much better agreement among institutions.

	Prostate	Spine	Lung	Head	Liver	TOTAL
Number of Irradiations	27	16	11	7	1	62
Passed	18	13	8	7	1	47
Pass Rate	67%	81%	73%	100%	100%	76%

Figure 2. Phantom irradiation results and pass rates.

Results (cont'd): One treatment planning system is still developing DICOM electronic data transfer. Errors in the in-house export were caught through a phantom irradiation for another institution. Phantom irradiations have identified errors in treatment planning systems, such as an incorrect conversion curve for CT Number (CTN) to Relative Linear Stopping Power (RLSP). Phantom irradiations have also revealed errors in patient alignment processes and dose calculations. The number of each type of phantom irradiated and the pass rates are listed in Figure 2.

Recommendations from site visits are presented in Figure 3. Site visit measurements have identified differences among institutions' CT Number to RLSP conversion curves. The procedural review during site visits has identified weaknesses in treatment planning, IGRT, and QA that have been improved based on recommendations by the site visit team.

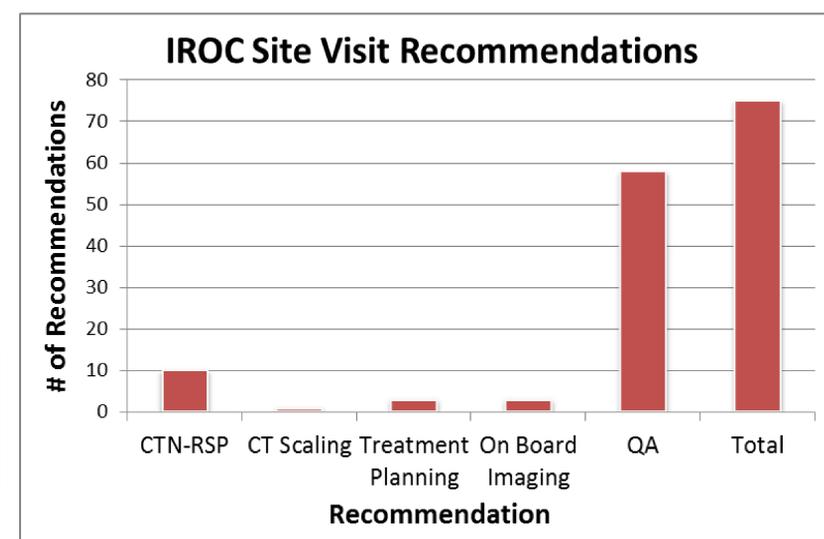


Figure 3. Recommendations received by institutions from site visits.

Conclusions: By working with institutions that showed discrepancies in different steps of the approval process, IROC Houston has set a quality threshold for proton dosimetry and quality assurance. Resolution of these problems has established consistency across proton therapy centers, which is critical for the success of clinical trials involving proton therapy.

Support:

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