Survey Results of Current Standards for Verifying Patient Positioning and Dose Delivery in IMRT

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Purpose:

To describe and report results from a survey of current standards for verifying patient positioning and dose delivery in IMRT.

Methods:

The Imaging and Radiation Oncology Core (IROC) monitors sites that participate in NCI-sponsored trials through annual output checks and anthropomorphic phantom irradiations. To track changes of site's personnel, machines, and treatment modalities, IROC maintains a Facility Questionnaire. This questionnaire is sent annually (or more often as needed) to every institution to allow for updates to the institution's status.

The survey was included as part of IROC-Houston's Facility Questionnaire. The survey was available to 2,681 sites. Results were limited to those institutions that updated the questionnaire in 2017, resulting in 1,455 respondents. The purpose of this survey was to understand the use of treatment positioning verification and delivered dose verification in IMRT. The survey was broken into two main sections. First, two questions about the methods and frequency of patient imaging for setup verification. Second, eight questions about the methods, tools, and interpretation of patient specific IMRT dose delivery quality assurance (QA).

Questions	Available Answers
Which of the following treatment modalities does you institution use? (Check all that apply)	Routine IMRT (Sliding Window, Step and Shoot, Tomotherapy etc.) VMAT/Rapid Arc
What are your standard tool(s) for verifying that the treatment unit delivers the planned dose for individual patients? (Choose all that apply.)	Point(s) Measurement Film 2D Diode array 2D Ion Chamber array EPID 2.D (pseudo 3D) array/multi-plane array 3D dosimeter Other
When you make QA measurements, which of the following do you most commonly do?	Deliver beams at the same fixed gantry angle Deliver at the planned gantry angle
Do you mount your detector on the gantry?	Yes No
Are your plans usually assessed for pass or fail based on:	Each field-by-field measurement Composite measurement (all fields)
How do you assess agreement (select all that apply), and what are your most commonly used comparison criteria?	Point Dose Planar 3D/Volumetric analysis
Do you do routine in-vivo dosimetry for IMRT patients?	Yes No
If your QA does not meet your passing criteria, what actions do you take? (choose all that apply, rank in order of attempt (1 denotes first strategy))	Re-measure with the same setup (at the same point/plane) Move to a new calculation point/plane and re-measure Try fixed gantry angle delivery Re-plan Scale the MU's (partially or fully) Change the passing criteria for the case Analyze in relative dose mode instead of absolute dose mode Document result and deliver the plan Something else: _____

Table 1: Example of Survey Questions from Patient-Specific IMRT QA: Verification of Delivered Dose

Results:

The majority of responding sites were from the United States and Canada (91.9%).

Figure 1 depicts the distribution of answers related to patient positioning. Verification of patient positioning was performed mostly by MV imaging (91.3%) and/or kV imaging (86.7%) followed by CT/CBCT (74.8%) and only a small percentage of sites utilized other techniques (10.4%).

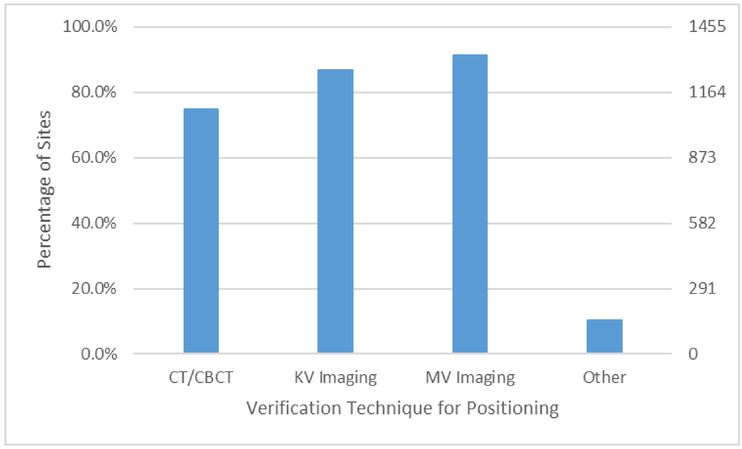

Fig. 1: Response to Survey Questions: "How do you verify field positioning relative to Patient's Anatomy?"

Figure 2 shows that the most common tools for dose verification are a 2D diode array (52.8%), point(s) measurement (39.0%), EPID (27.4%), and 2D ion chamber array (23.9%). Many sites had and used multiple devices; the number of standard tools utilized by sites was most often one (40.1%), but was commonly two (33.5%) and even three (18.5%). Responders reported using up to 7 different tools for this purpose.

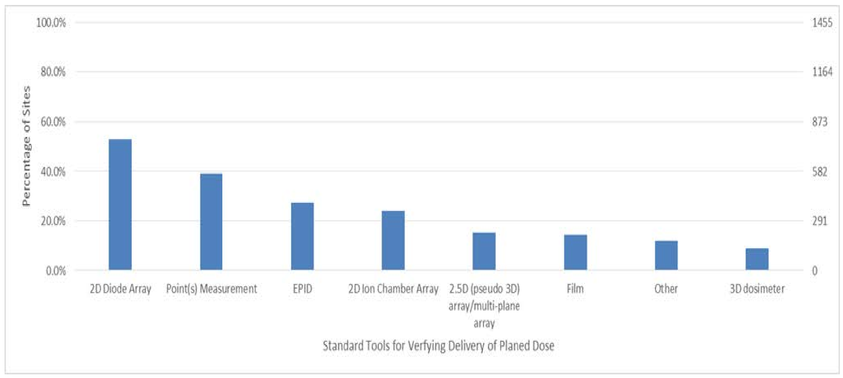

Fig. 2: Response to Survey Questions: "What are your Standard Tool(s) for Verifying that the Treatment Unit Delivers the Planned Dose for Individual Patients?"

Results (cont.):

If IMRT QA did not pass, we provided nine possible next steps to choose from in our survey. Sites were given the opportunity to rank them on a scale of one to nine with one denoting the first strategy taken. These strategies are ordered in Table 9 according to the average rank order of the strategy (for places employing that strategy).The highest average rank selection was to re-measure with the same setup, which had an average position ranking of 1.1 with 81.4% of sites placing this at rank one; 90.4% of facilities employ this strategy. The second highest average rank selection was to move to a new calculation point and re-measure (54.9%) and had an average ranking of 2.1 with rank two (41.3%) holding the majority of the selections. Strategies became less clearly established in the community after this: the third highest average rank selection was "other", i.e., not one of the 9 options provided.

Strategies	Average Rank	Percentage of Sites (Number):	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	Rank 7	Rank 8	Rank 9
Re-measure with the Same Setup	1.1	90.4% (1316)	81.4%	7.0%	1.8%	0.2%	0.1%	-	-	-	-
Move to a New Calculation Point and Re-measure	2.1	54.9% (799)	4.1%	41.3%	7.6%	1.2%	0.3%	0.2%	-	-	-
Other	2.6	26.9% (391)	4.7%	9.1%	7.1%	4.3%	1.1%	0.5%	-	-	0.1%
Analyze in Relative Dose Instead of Absolute Dose	2.8	25.9% (376)	2.5%	8.1%	8.4%	4.9%	1.3%	0.4%	0.1%	0.1%	-
Try Fixed Gantry Angle Delivery	2.9	11.6% (169)	0.5%	3.3%	5.1%	1.7%	0.6%	0.1%	0.1%	-	-
Change the Passing Criteria for the Case	3.1	30.2% (440)	2.7%	7.5%	9.7%	6.3%	2.7%	0.7%	0.3%	0.2%	-
Re-plan	3.3	84.0% (1222)	2.3%	17.3%	34.0%	20.2%	8.3%	1.5%	0.5%	-	-
Scale the MU's	3.5	11.4% (166)	0.3%	2.3%	3.6%	2.8%	1.2%	0.7%	0.2%	0.2%	-
Document Result and Deliver Plan	4.3	17.4% (253)	0.3%	1.2%	3.1%	5.2%	3.9%	2.3%	0.7%	0.5%	0.1%

Table 2: Response to Survey Questions: If your QA does not meet your passing criteria, what actions do you take? (Choose all that apply, rank in order of attempt (1 denotes first strategy)). Percentages are based on 1455 participants.

Conclusion:

The survey provides a snapshot of the current state of patient positioning and dose verification for IMRT radiotherapy. This provides guidance, at least in terms of consensus practice, for clinics across the county.

Support:

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