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Patient-Specific QA in SRT: Clinical Practice in Absence of Guidelines – Status and New Approach from the DGMP Working Group for Physics and Technology in Stereotactic Radiotherapy

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Purpose

Patient-specific quality assurance (PSQA) is a critical component of stereotactic radiotherapy (SRT), yet dedicated guidelines for its implementation are currently lacking. Existing recommendations for IMRT and IMAT cannot be directly transferred to SRT because commonly used QA devices, measurement methods, and evaluation metrics are often insufficient for small-field and high-precision treatment conditions. The objective of this work was to identify limitations of current PSQA practice in SRT, assess the suitability of available quality assurance approaches, and develop practical guidance for selecting and evaluating QA strategies. Furthermore, we aimed to establish a structured framework for comprehensive PSQA program assessment.

Materials and Methods

A comprehensive review of the available literature, including existing QA guidelines and recommendations, was performed. To identify challenges in current clinical practice, surveys were conducted among both clinical users and commercial vendors. Available QA devices, software solutions, measurement techniques, and evaluation metrics were systematically analyzed with respect to their applicability to stereotactic treatments. Independently, we defined the requirements of an appropriate PSQA program for SRT and compared these requirements with currently available technologies in a vendor-neutral manner. The resulting framework was subsequently reviewed and refined by an expert group specializing in stereotactic radiotherapy physics and technology.

Results

The analysis demonstrated substantial limitations in current PSQA approaches for stereotactic radiotherapy. No single device or measurement method was found capable of addressing all relevant quality assurance requirements. Differences in treatment techniques, clinical workflows, and technical implementations created significant variability between institutions. By systematically linking PSQA requirements with available devices and verification methods, we developed a vendor-independent toolkit designed to identify strengths and deficiencies of site-specific QA programs. The framework enables users to recognize potential blind spots in their verification process and supports the selection of complementary QA methods to achieve more comprehensive assessment of stereotactic treatment quality.

Conclusion

A universal PSQA solution for stereotactic radiotherapy does not currently exist. Effective quality assurance therefore requires a combination of methods together with carefully selected evaluation metrics tailored to local clinical needs. The diversity of stereotactic treatment implementations prevents the formulation of a simple static guideline applicable to all centers. To address this challenge, we developed a practical decision-support toolkit that helps institutions evaluate and optimize their PSQA programs. This framework provides a structured approach for identifying gaps in quality assurance coverage and for selecting appropriate verification strategies, thereby supporting safe and reliable stereotactic radiotherapy delivery.

QA method		Treatment planning: Beam modelling	Treatment planning: Dose algorithm	Machine-related: Data transfer & plan deliverability	Machine-related: Beam generation & collimation system	Machine-related: Table positioning	Patient pos. / monitoring: Patient setup	Patient pos. / monitoring: Patient anatomy variations	Equipment characteristics: Measure-ment area	Equipment characteristics: Absolute dose	Equipment characteristics: 3D dose	Equipment characteristics: Dose gradient/ resolution	Time effort / complexity M: Machine S: Staff
2D array on table at isocenter		++	n/a	yes	++	0	0	n/a	large field	++	no	+	M: high S: high
2D HiRes array on table at isocenter		+++	n/a	yes	++	+	0	n/a	small field	++	no	+++	M: high S: high
2D array on table at iso – rotating w/ gantry		++	n/a	yes	++	0	0	n/a	large field	++	yes	+	M: high S: high
2D HiRes array on table at iso – Rotating w/ gantry		+++	n/a	yes	++	+	0	n/a	small field	++	yes	+++	M: high S: high
2D array in headmount		++	n/a	yes	++	n/a	n/a	n/a	large field	++	yes	+	M: high S: high
EPID (pre-treatment)		+	n/a	yes	+	n/a	n/a	n/a	full field	+	yes	+++	M: medium S: medium
EPID in vivo patient transm.		n/a	n/a	no	n/a	0	+	+	large field	+	yes	++	M: n/a S: medium
Film QA on table		+++	n/a	yes	++	++	0	n/a	small field	++	no	+++	M: high S: very high
Gel QA on table		+++	n/a	yes	++	++	0	n/a	small field	++	yes	+++	M: high S: very high
Head-mounted transition chamber		0	n/a	yes	0	n/a	n/a	n/a	full field	0	no	n/a	M: n/a S: low
Single Point measurement		+	n/a	yes	0	n/a	n/a	n/a	n/a	+++	no	n/a	M: high S: medium
Plan re-calculation based on CT/CBCT	CT	++	+++	no	n/a	n/a	n/a	n/a	full field	n/a	yes	+++	M: n/a S: low
	CBCT	n/a	n/a	no	n/a	n/a	0	+++	large field	n/a	yes	+++	M: n/a S: low
Log-file analysis		n/a	++	yes, if applied pre-treatment	++	n/a	n/a	n/a	full field	n/a	yes	n/a	M: n/a S: low
In-room imaging		n/a	n/a	no	n/a	+++ (if applied for all table positions)	+++	depending on modality	n/a	n/a	no	n/a	M: n/a S: medium
Surface-related devices (e.g. Motion Management)		n/a	n/a	no	n/a	+	++	+	n/a	n/a	no	n/a	M: n/a S: low

+++ highly suited ++ quantitative + qualitative 0 not isolable n/a not applicable 4D extendable for gating / tracking

Fig. 1 : Suitability of QA methods for monitoring defined QA characteristics.

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