COMPREHENSIVE TEST SUITE FOR RADIOTHERAPY MACHINES FULLY AUTOMATES ACCEPTANCE, COMMISSIONING, AND DAILY QUALITY ASSURANCE FOR INCREASED PROFITABILITY

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Quality assurance is critical in the setup and operation of linear accelerators (LINACs) and requires significant time and expense

Before they can be put into use, new LINAC radiotherapy machines and their integrated treatment planning systems (TPSs) must go through a labor-intensive acceptance and commissioning process performed by medical physicists. Acceptance testing ensures that the machine meets the product specifications, while the commissioning step tests system functions, documents different capabilities, and verifies the algorithms that reproduce measured dose calculations. Undetected errors from incorrect TPS commissioning can result in inaccurate radiation doses, reduced treatment plan effectiveness, and even harm to patients. The process typically takes 5–8 weeks, during which the machine cannot be used to treat patients.

Additionally, the required daily quality assurance (QA) tests for LINACs may take up to 2 hours and necessitate taking the machine offline, resulting in lost revenue. Annual tests must also be performed that require the purchase of a water tank for $70K–$100K, a service contract for $5K–$10K, and roughly $6K in a physicist's time.

As radiation treatment delivery becomes more complex, there is a pressing need for robust tools to improve efficiency and comprehensiveness, while simultaneously maintaining high accuracy and sensitivity.

Suite of tools streamlines and automates testing and QA for radiotherapy machines for substantial increases in revenue

This comprehensive suite of hardware and software tools enables full automation of LINAC acceptance and commissioning, daily QA testing, and required annual testing. The suite comprises an electronic portal imaging device (EPID), QA phantoms (with energy plugs), and software for analysis and comparison. Using an application program interface (API), the automated commissioning test suite incorporates recommended tests from published guidelines in radiation oncology to facilitate QA testing of the TPS system.

During commissioning, the system performs treatment machine configuration checks, image dataset and digital phantom integrity checks, radiation plan dosimetry checks, and plan-specific QA checks. This system automatically validates the EPID image prediction model to enable treatment planning as a

service (TPaaS).

By fully automating the acceptance and commissioning steps, a process that typically takes 5–8 weeks can be done in only 2–4 days. This translates into savings of $70K–$90K per machine in initial setup costs. For example, a typical LINAC machine grosses approximately $60K per day; reducing setup time by roughly 6 weeks results in a revenue gain of $1.8M per machine.

Additional features:

- Automatically validates TPS dose and image prediction models
- Automates and expedites QA plan creation with AutoQA Builder and AutoQA Analysis
- Provides a simplified method for verifying LINAC 6 flattening-filter free (6FFF) beam dosimetry, eliminating the need for a 3D water tank system
- Automates imager QA using a physical phantom and numerical procedure, saving over 2 hours of testing time
- Performs 20-minute automated daily standardized QA testing using EPID
- Includes cloud-based import and export software that enables backups as well as exports to additional machines
- Provides dual-frequency oscillating platforms to simulate cardiac and respiratory motions in phantoms
- Includes image analysis process and algorithms based on phantom images, deriving high-contrast spatial resolution, low-contrast resolution, slice thickness, etc.

Solution Advantages

- **Improves patient treatment:** By eliminating third-party services for QA and testing, this suite increases the number of QA tests that can be performed, improving overall reliability and potentially enhancing patient treatment.
- **Increases revenue:** The accelerated acceptance and commissioning process (2–4 days rather than 5–8 weeks) significantly increases revenue, adding approximately $1.8M per machine.
- **Reduces costs:** The system reduces costs for required annual testing, saving over $100K per year. Also, the integrated EPID eliminates the need for additional QA phantoms, saving tens of thousands of dollars.
- **Decreases QA time:** The system saves over 2 hours each day by incorporating a phantom, a numerical procedure, and software for performing daily QA tests. It reduces the duration of the positioning test, X-ray tube test, and image quality test, and it generates the analysis and QA report in 20 minutes.
- **Simplifies QA:** The API-assisted QA plan creation can be done without following tedious procedures, and automated analysis can be performed inside of the clinical oncological information system.
- **Enables remote service:** With added cloud capability, remote daily QA can be performed without a radiation oncology physicist on site.
- **Simplifies TPS input:** The TPS requires minimal input and interpretation from the user, relying on performance benchmarking through cloud-based services to enable clinicians to identify potential system errors.
- **Enables TPaaS:** This technology allows researchers to quickly recreate their clinical environment within a new research system for TPaaS. The suite supports importing and exporting internal LINAC definitions and backups and restoring machine and beam data.

- **Secure:** The suite includes built-in security features to ensure users have rights to use the specific machines.

Potential Applications

- Radiation treatment delivery
- Radiation treatment planning systems
- QA for radiation oncology