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Standardisation of the treatment planning workflow through custom graphical user interfaces and a centralized database

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Standardization of treatment planning techniques can reduce the risk of error and increase the dosimetric quality of treatment planning. In 2019, our center initiated the implementation of a new treatment planning system and saw an opportunity to standardize our treatment planning processes through a graphical user interface (GUI) and a centralized database.

In order to optimize the treatment planning process, a Python-based GUI was developed to guide the technologists, the radiation oncologists and the planners through the various planning and verification steps. These tools are triggered in the planning system (RayStation). The centralized database is used to store standard contours info, streamline the transfer of information and collect patient-specific treatment dose statistics.

Starting at the scan, a GUI guides the technologists through all the steps required for the selected clinical site. Via in-house scripts, localization points, table model contours, organ-at-risk contours, and fusion are quickly generated. Using another GUI, treatment targets and dosimetric clinical goals are then defined by the radiation oncologists and saved into the centralized database. This eliminates any possible confusion regarding targets definition, fractionation, dose level, and clinical goals. All this information is fed into a site-specific automated planning algorithm that aims to provide a clinically acceptable plan straight away.

For the last years, our department has been leaning toward a very high level of automation in regards to treatment planning. This new framework will help up push forward plan quality and reduce errors through even more checks and automation.

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Neutron activation in the radiotherapy bunker: strategies for managing radiation safety.

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Purpose: Radiotherapy linacs producing high energy photon beams create unwanted activated by-products through photodisintegration and neutron capture. Activated material may pose a risk to staff and patients. **Methods:** Measurements (Varian TrueBeam) were performed with 6 and 10 MV (both regular & FFF), and 15 MV photon beams. Data was collected at isocentre and elsewhere using calibrated survey meters. Because of pulse pile-up, all data collection began 30 s post beam-off. **Results:** Activation below 10 MV is negligibly low. A half-life of about 3.5 min, measured over the first 30 min was observed for the 15 MV beam. The initial activation rate of the 15 MV beam is a function of linac dose rate, and beam-on time. When the half-life, initial dose rate, and time of irradiation are known, the dose near the linac following beam-off can be estimated. For example, a person entering a linac after a treatment delivery of 500 MU, at 600 MU/min, with a 15 MV beam is subject to an initial exposure rate near isocentre of approximately 5.0 microSv/hr with a half-life of 3.5 min. Staying 2 min in this area would yield a dose of about 0.1 microSv. **Conclusions:** Linac activation, dose-rate and half-life can be measured and parameterized to predict ambient dose rate conditions inside the linac bunker. These parameters allow an estimation of the dose to personnel and patients as a function of beam energy, linac dose rate, MU delivered, location and duration of stay in the bunker.

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A comprehensive process for end-to-end orientation and coordinate system testing for external beam radiation therapy

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Purpose: Develop a QA tool and process to comprehensively verify the accuracy of patient orientations and coordinate systems at all stages of the radiation therapy process, including: CT simulation, TPS import and planning, R&V import, CBCT import and acquisition, automatic couch shift calculation and execution, plan delivery and portal image acquisition. **Methods:** Two components of this work are the design of a physical phantom, and the design of a modular end-to-end process which validates orientation and coordinate systems at checkpoints throughout the radiation therapy chain.

The phantom design is anthropomorphic and based on a lowercase h-shape that uniquely identifies flips and rotations about any axis. Phantom dimensions enable MLC porting, unique DRRs and non-truncated portal and CBCT images. Setup and plan isocentre laser marks and embedded BBs allow verifiable setups for CT, TPS, CBCT, treatment delivery and portals, and verifying couch automatic shifts.

The modular vendor-agnostic process mimics the complete clinical radiation therapy process, with shared execution between therapists and physicists. Various orientation verification checkpoints are introduced to identify failure-modes and enable subsets of the process to be executed upon isolated system upgrades. **Results:** The phantom and associated complete end-to-end process were validated, including successful identification of combinations of failure-modes. Subsets of the process were used to verify orientation after isolated CBCT system upgrades, and as part of a complete linac commissioning. **Conclusions:** We developed a comprehensive radiation therapy orientation validation phantom and processes to be used for commissioning and periodic QA, as recommended by medical physics guidance documents.

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13 Years of Clinical Trial Radiation Therapy Quality Assurance in Canada

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Since 2006, there have been 19 randomized clinical trials conducted by the Canadian Cancer Trials Group (CCTG) that focused on a radiation therapy (RT) technique-related research question. Successful conduct of these trials required customized radiation therapy quality assurance (RTQA) which was reviewed and approved by the CCTG Radiation Oncology Quality Assurance Committee (ROQAC). Here we present the various approaches adopted by investigators for conducting clinical trial RTQA through credentialing and central case review.

Site credentialing was required for all trials to ensure appropriate infrastructure, treatment planning software, RT equipment and local quality assurance processes were in place. Five recent trials involving radiosurgery or brachytherapy required credentialing of individual local investigators who became responsible for on-site review of each other's cases.

Conducting central case review for CCTG RT trials has been a challenge since, until 2019, the infrastructure (RAISIN) has only supported digital submission of screenshots and case report forms. Reviewers verified data completeness and evaluated protocol compliance. CCTG investigators conducting trials involving IMRT/VMAT in head and neck or those involving contoured nodal targets for breast RT have used and are still using the Quality Assurance Review Centre, Rhode Island to perform reviews of DICOM-RT plans, at considerable cost per case.

An RTQA companion study will evaluate the effectiveness of current CCTG RTQA strategies using RAISIN against those based on DICOM-RT plan submission.

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Comparison of Gross Tumor Volume (GTV) on free breathing CT, 4DCT and CBCT images of stereotactic body radiotherapy (SBRT) of non-small-cell lung cancer (NSCLC)

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Purpose: The purpose of this study is to compare the volumetric differences of gross tumor volumes (GTV) defined on free breathing CT, 4DCT and CBCT images of non-small-cell lung (NSCLC) cancer. **Materials and Methods:** Twenty NSCLC patients underwent lung SBRT with free breathing CT scan and 4DCT scans of the thorax were investigated retrospectively. The prescription was 48 Gy in 4 fractions, or 50 Gy in 5 fractions. The daily setup CBCTs were performed before treatment and in between the beam delivery, and registered to the planning CT during radiotherapy. The GTV were contoured on free breathing CT (GTVFB) and all the CBCT (GTVCBCT); The averaged CBCT GTV were used for individual patient's comparison. Phase 0% Inhale (GTV0%), 50% Inhale (GTV50%) and 100%