cal setting, whether Hp(3), Hp(0.07) or Hp(10), has received little attention in the literature; however, the effect has been identified as the dominant source of uncertainty in current eye dosimetry methods. Accordingly, this study aims firstly to measure scattered x-ray energy spectra to staff in Interventional Radiology procedures under varied conditions and system settings. Consequently, the dosimetry accuracy of a series of currently available eye dosimeters, including TLDs (100s, 100Hs), OSLD and Electronic Personal dosimeters (EPDs), and a variety of real-time trunk dosimeters will be presented, with energy dependent correction factors established for each dosimeter type, leading to more precise dose measurement.

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A review of Slope Intercept GFR patient data to validate and optimize the introduction of Single Sample GFR technique

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The Glomerular filtration rate (GFR) is a quantitative measure of kidney function determined from the plasma clearance of a radiopharmaceutical such as 51Cr EDTA or 99mTc DTPA. The British Nuclear Medicine Society 2018 guidelines recommend a single sample GFR (SS-GFR) analysis method replacing the slope intercept method (SI-GFR) of the previous 2004 guidelines. This research explores the feasibility and implications of making the transition from SI to SS GFR, by retrospectively determining the SS GFR on a patient population whose GFR was previously evaluated using SI-GFR. One shortcoming of the SS-GFR method is that a prior approximation of the GFR is necessary for choosing a sampling time for an accurate result. The objectives of this study are to, firstly, assess the agreement and associated errors of the SS-GFR when compared to SI GFR and, further, to optimise the single sample approach. The study examines the reliability of using previous GFR measurement or a biochemically determined eGFR documented in the patient healthcare record as a guide to optimum blood sampling time. The use of other GFR predictors is also investigated for patients undergoing DTPA imaging, functional indicators gained from renogram curves such as body surface area (BSA) and sensitivity corrected summed functional phase slopes. Regression analysis will be carried out on renogram parameters to identify the statistically significant predicators ($p<0.05$) which will be entered into a multivariate model. Statistical agreement between the SI-GFR and SS-GFR is tested using Bland-Altman plots and the associated errors quantified.

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Verification of manufacturer supplied source paths for Elekta ring applicators at Cork University Hospital

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Ring applicators are routinely used in gynaecological brachytherapy to direct a radioactive source through a number of predetermined dwell positions close to the tumour. Literature has shown that the dwell positions of radioactive sources in ring applicators can deviate from their expected positions by several millimetres. Since high dose rate 192Ir sources are used, even small deviations can have a large impact on the distribution of dose received by the patient. AAPM Report 59 deems positional accuracy of within 2 mm to be clinically acceptable. This study investigates the level of agreement between the measured source path and manufacturer supplied source path for Elekta ring applicators of diameters 26 mm, 30 mm and 34 mm. Dwell positions were measured using both the "gold standard" approach of GAFchromic film and a MatriXX ionisation chamber array. We developed processing algorithms using ImageJ. Use of an ionisation chamber array with free, open source software for this application is novel. Our results found insufficient evidence to verify that the actual source path matches the manufacturer supplied source path for any of the applicators. Most source paths were found to be clinically acceptable, however, deviations of the source from the expected path of up to 3.8 mm (MatriXX) and 4.0 mm (film) were recorded. Inter-applicator deviances of up to 1.7 mm (MatriXX) and 2.1 mm (film) were observed. Measurements using the MatriXX were found to be comparable to the standard film-based approaches for source path measurement, offering improvement in speed, ease of use and cost.

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A study on the comparison of the dose distribution of low kV X-ray radiation in generically modulated bone and CT scanned bone

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The INTRABEAM system is a device that uses low kV X-ray radiation in the treatment of cancers. During Kypho-IORT the INTRABEAM delivers a single high dose of radiation to a metastasis in a spinal vertebra, sterilising the metastasis, before the vertebra is stabilised with PMMA. However, much remains uncertain about the dose distribution of low kV X-ray radiation in heterogeneous tissue, such as bone. Current generation planning CTs do not have sufficient resolution to resolve the trabecular architecture. Voxel averaging therefore affects the calculation of bone density values which are typically underestimated. This subsequently affects dose calculations. In this study the GEometry ANd Tracking 4 (GEANT4) code was used to develop a generic model of a spinal vertebra that includes trabecular architecture. The dose distribution of low kV X-ray radiation within this architecture was modelled using a Virtual Source Model (VSM) of the INTRABEAM and compared to the dose distribution of the same radiation in simulated CT scanned bone. The results show that the dose distribution of low kV X-ray radiation in trabecular bone is more complex than previously suggested. A spherical dose distribution is modulated by the trabecular architecture such that the energy deposition in the trabecular walls can reach five times higher than expected, while the energy deposition in the trabecular openings is reduced by upwards of 50%. With further development, this code may be incorporated into future treatment planning software resulting in improvements in the dose distribution calculations for low kV treatments such as Kypho-IORT.

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Dosimetry assessment of patient-specific 3D printable material for HDR surface brachytherapy

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Purpose: 3D printable material water equivalence was investigated within the range of Iridium-192 source energies. The aim is to validate it for superficial brachytherapy treatments.

Methods and materials: 3D Cheetaflex material (bolus) was examined both in a water tank and with CIRS anthropomorphic phantom, performing an end-to-end test. In water tank, a GafChromic EBT3-V3 film was oriented perpendicular to the source axis obtaining percentage depth dose (PDD) from 7 mm to 30 mm of distance from the source, with and without a bolus 5 mm thick. Two films were oriented parallel to the source at 5 mm and 15 mm of distance and results were compared with TG-43 implemented on Oncentra® Brachy treatment planning system (TPS). A set of CT images of CIRS phantom was acquired and a bolus with 7 trajectories (1 cm interdistance and 5mm from skin) was created. A new CT set of images with bolus and phantom was imported on TPS where a target was defined and a dose plan was created. Plan was delivered with two films positioned between two different slabs of phantom, at reciprocal distance of 2 cm, orientated perpendicularly to the source axis.

Results: PDDs show a maximum difference of 4.7% (average 2.2%). At 5 mm and at 15 mm, the gamma pass rate is 100% with tolerance 3%/2 mm DTA. Results of films placed intra-slabs show a high pass rate (>96%) with tolerances of 2% dose and 1mm DTA.

Conclusion: 3D material investigated is water equivalent at Ir-192 energies and is suitable for superficial brachytherapy.

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Young Investigator Grant – 2018 Grantee 15:45 – 16:05

The development of high quality training program for real tine trans rectal ultrasound low dose rate (LDR) prostate brachytherapy

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Although ultrasound forms a critical component of transrectal ultrasound image guided brachytherapy for prostate cancer, ultrasound training is not required as part of radiation oncology training programs, nor does any objective competency measure exist to independently assess clinical performance [1]. Physical simulation training and objective clinical competency testing can provide a structured approach to training [2], but only if suitably challenging training devices are available which replicate the complex anatomy of the male pelvis and prostate. This study describes the iterative process in the development of a range of training devices which simulate both the anthropomorphic and sonographic characteristics of the different presentations of patient specific prostate cancer. The design of the clinical features involved selection of patient cases and then rapid prototyping the different anatomical features and inverse casting these features in tissue mimicking materials (TMM). Novel TMMs were developed that had the sonographic appearance of the prostate and overlying tissues, as well as having the relevant mechanical compliance to give the training devices required haptic feedback. These devices will be used in the development of a training programme and will complement the learner's development of the specific skills required for the procedure. The use of training strategies such as gamification allows trainees to track their own performance over time as well as relative to their peers; thereby, providing a structured and competitive approach to learning. The 3D prototyped clinical features in these devices provided a more clinically-relevant representation of the procedure, thus providing a more efficacious training opportunity.

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Joint Session 16:05 – 17:00

Radiation dosimetry across a variety of CBCT devices in radiology

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Cone beam technology offers fast diagnosis at the point of care and is becoming more prominent in Radiology departments. Currently in our hospital we have an extremity CT, an O-arm and a number of C-arms offering 3D capabilities. Each of these modalities use wide cone beam CT technology to image the area of interest in one single rotation. Traditional CTDI metrics for radiation dosimetry in CT depend on a narrow beam geometry. Hence, the relevance of the CTDI as a dose indicator for wide beam scanning, which can be up to 400 mm for CBCT scans, has come under question due to underestimation of dose lying outside the 100 mm chamber length and CTDI phantoms being of insufficient length to achieve scatter equilibrium. In an attempt to better quantify the dose from wide-beam scanning, alternative methodologies have been developed which attempt to counter the limitations of the CTDI methodology. For the systems in our hospital, different manufacturers have stated a dose metric as either CTDI or DAP without noting the methodology used to calculate their measurements. In this study we utilised the CBCT methodology outlined in the IAEA Report 5. This method was chosen it is uses a standard CTDI dose phantom and pencil chamber, both of which are typically available to a diagnostic imaging physicist. Here we discuss our CBCT dose results together with the issues we faced in attempting to develop a common CBCT measurement protocol for our hospital. The measured results are compared to manufacturer's stated values, where available.

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EPA funded radon research in Ireland and its impact on the National Radon Control Strategy

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Radon is a radioactive gas formed in the ground by the radioactive decay of uranium which is present in all rocks and soils. It is