UKRO

O-001 Radiotherapy planning results for patients in the hypofractionated Biologically Optimised IMRT for Prostate Radiotherapy Trial (BIOPROP20)

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Aims/objectives: We present the phase II BIOPROP20 study (NCT02125175) prostate radiotherapy planning results; 60 Gy (intra-prostatic tumour boost to 68 Gy) in 20 fractions dose-painting schedule for intermediate to high-risk patients.

Content: Patients received multi-parametric MRI and 18F-choline PET/CT prior to androgen deprivation (ADT), and planning MRI and CT following 2 months' ADT. Registration used fiducial markers. Intra-prostatic boost volumes were outlined by combining visually-identified lesions on MRI and PET. Rotational IMRT planning was performed using Pinnacle software (Philips). Patients with unexpected regional lymph node PET uptake also received pelvic radiotherapy with boost.

Relevance/impact: In the CHHiP trial, hypofractionated prostate radiotherapy with 60 Gy in 20 fractions was non-inferior to conventional radiotherapy: 74 Gy, 37 fractions. Prostate dose-painting may improve biochemical relapse-free survival similar to whole organ dose-escalation, whilst avoiding increased associated toxicity.

Outcomes: Forty-eight (of 59) patients have been planned thus far, 5 with concurrent pelvic radiotherapy. Both groups had median prostate dose excluding boost of 61.0 Gy (range 60.4-61.7 Gy). Median dose to intra-prostatic boost volume was 68.2 Gy (66.2-68.9) and 67.2 Gy (66.8-68.5) respectively. In the pelvic radiotherapy group, lymph node dose of 45 Gy with boost to 50 Gy was achievable. Normal tissue (bladder, urethra, rectum and bowel) dose volume constraints were achieved in all patients, and boost doses were reduced if this was not possible.

Discussion: Radiotherapy planning for hypofractionated prostate dose painting is practicable for patients recruited into the BIOPROP20 study thus far.

O-002 The introduction of a research funded interventional clinic within the NHS to enable participation in prostate clinical trials

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Background/purpose: Within prostate cancer clinical trials there has been an increasing move towards hypo-fractionated and Stereotactic Ablative Radiotherapy (SABR) regimes. This has led to an increased requirement for Image guided Radiotherapy (IGRT). It was therefore necessary at our centre to implement a service to facilitate the implanting of fiducial markers and other interventional procedures to enable our participation in such clinical trials.

Method: Funding for this service was secured from a research grant. A multi-disciplinary working group of consultant clinical oncologists, radiographers, hospital management, nurses, clinical trials team and clinical research fellows was formed. Meeting at regular intervals throughout the set-up process this group ensured the service was introduced in a safe and controlled manner, writing protocols and work instructions, and designing and implementation a competency-based training programme for staff undertaking and assisting procedures.

Results: All training and processes are now in place with the service receiving its first patients. The inaugural clinic was held in December 2015. This service is now a prerequisite for three clinical trials at our centre with the service also being utilised to facilitate the collection of prostate tissue for research purposes.

Conclusion: This service has been a major undertaking requiring input from a large multi-disciplinary group. Demand for this service will continue to grow with the opening of further clinical trials

O-003 Individual case review of adherence to the conformal radiotherapy planning protocol in the UK NeoSCOPE trial

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Introduction: Failure to adhere to trial protocols for planning within radiotherapy trials may have an adverse effect on, and potentially invalidate, trial outcomes. The CRUK-funded NeoSCOPE trial (UKCRN 13764) involved prospective individual case-reviews to identify and correct such variations.

Method: All participating centres had passed a pre-accrual planning benchmark case. Real-time review (feedback to centres within 3 working days) was performed on the first 10 patients recruited and the first case submitted from each participating centre. All subsequent cases were subject to 'timely-retrospective review', with review within 2 weeks of the start of RT. Radiotherapy plans for all cases were submitted in DICOM format to the RTQA centre and reviewed by the QA physicists allocated to the trial. Each case was reviewed against pre-determined acceptable and unacceptable variations. Unacceptable variation required re-submission.

Results: 83 cases were reviewed, 39(47%) of which were real-time and 44(53%) timely-retrospective. 4(5%) cases required re-submission and these were each the first plan submitted by a participating centre. Undercoverage of PTV, particularly at the superior/inferior extents, was the most common planning variation and the RTQA centre advised on techniques for improving coverage (e.g., opposed sup-inf wedges). 28(72%) of the real-time reviews were returned within 3 working days and 42(95%) of the timely-retrospective reviews were returned within 2 weeks. There were no delays to RT start time.

Conclusions: Prospective review of planning in NeoSCOPE has enabled identification and correction of unacceptable variations from the protocol without introducing treatment delays. The planning reviews were complemented by prospective review of outlining.

O-004 Quality assurance of image registration in radiotherapy clinical trials

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Aims/objectives: To investigate quality assurance (QA) requirements for image registration in radiotherapy (RT) clinical trials and the associated technical issues.

Content: The National Radiotherapy Trials Quality Assurance (RTTQA) group is developing procedures for QA of image registration for RT clinical trials (e.g. PACE, INTERLACE and HIPPO). The areas to include and issues to address are presented here.

Relevance/impact: Multimodality imaging (e.g. MR, PET) is increasingly being used in RT treatments and clinical trials to more accurately identify target volumes. In addition, the use of stereotactic body radiotherapy (SBRT) intensifies the need for precisely targeted RT delivery and hence accurate registration of images used for localisation and treatment.

Outcomes: Development of the image registration QA programme will need to consider: the variety of registration techniques in clinical use (e.g. fiducial markers, soft tissue matching); how to analyse and report the registration given its subjective nature; the lack of standardisation in the exports from different systems; registration of 4D image sets; and identifying suitable software to enable assessment of the registration.

Discussion: Liaison with software manufacturers is needed to help overcome the difficulties associated with exporting and reviewing registered RT image sets. A task group has been set up within the National RTTQA group to establish these links and resolve these issues in order to draft an image registration QA programme for use in RT trials.

O-005 Identifying national research priorities for the radiography profession: An online Delphi consensus study

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Aims/objectives: To develop consensus on research priorities for the radiography profession across all aspects of diagnostic imaging and radiotherapy for the next 5 years.

Content: The results of a College of Radiographers funded Delphi consensus study will be presented, including both quantitative and qualitative data. The expert panel consisted of 118 diagnostic and therapy radiographers and 10 from other disciplines, student radiographers and user representatives. The presentation will show the ranked radiography research priorities from the panel that were obtained through a series of online survey rounds.

Relevance/impact: Defining research priorities provides strategic direction for radiography researchers wishing to apply for research funds, as well as communicating to funders the key/emerging research priorities for the profession.

Outcomes: Round 1 produced 325 research areas (categorised into 19 themes/sub-themes) from an independently validated list of experts across a range of key specialties (n=128). In round 2 the panel ranked importance (on a 5-point Likert scale) of the round 1 topics. In round 2 consensus was defined as a mean importance rating of the topic of ≥3.5 and as ≥75% agreement (% of panel members scoring 4 (important) or 5 (very important).

Discussion: Using an online Delphi consensus technique involving key stakeholders (including a range of specialist radiographers, service users and students) enabled the prioritisation of radiography research topics. The priorities identified reflect important issues related to users of radiography services and the staff caring for them. The study will inform a research priorities framework covering the specialisms in radiography and which focuses on improving patient care, services or radiographers' education.

O-006 Consistency of bladder volumes in cervical cancer patients undergoing radiotherapy

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Aims/objectives: Whether pre-treatment and on-treatment bladder volumes of cervical cancer patients are within local protocol recommendation of 200-300cm3.

Content: Quantitative data showing pre-treatment and on-treatment bladder volumes of patients (n=8) treated with radiotherapy for cervical cancer, using cone-beam computed tomography (CBCT) image-guidance.

Relevance/impact: If on-treatment bladder volume is not congruent with planning CT scan there can be no certainty that the plan is being delivered as intended; hence accurate and reproducible treatment cannot be guaranteed, leading to poorer patient outcomes.

Outcomes: At planning CT scan, bladder volumes ranged from 71.69-700.85cm3 (mean of 256.56cm3). Two patients (25%) had bladder volumes at planning scan within local protocol tolerance of 200-300cm3. On-treatment volumes ranged significantly, from 24.92-1097.66cm3 (mean of 276.70cm3). Mean on-treatment bladder volumes per patient were 46.73-494.80cm3. Only 10 (13%) of 84 treatment scans contoured fell within tolerance.

Discussion: A challenge in pelvic radiotherapy is accounting for internal organ motion, an issue complicated by bladder filling at time of treatment. Specific drinking protocols for gynaecological patients aim to achieve consistency and ensure bladder size is similar to that at planning scan. Despite being instructed to carry out specific drinking protocols, bladder volumes can vary both between and within patients, at planning CT scan and during treatment. If patients are not receiving daily scans to assess bladder status, then accurate and reproducible treatment cannot be guaranteed and the plan may not be delivered as intended. In order to account for the volume variations that are apparent, daily bladder assessment is recommended, either by ultrasound bladder scanner or CBCT.

O-007 Using a complex clinical algorithm to predict treatment intent from the radiotherapy dataset (RTDS)

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Background: It was recommended that intention to treatment (radical or palliative) be omitted from the national radiotherapy dataset, RTDS until such a time that there was clinical guidance or protocol in the use of radical and palliative intent. The authors have produced an algorithm of other clinical data items available in RTDS to be able to report intent on historical data 2009 – 2013.

Methodology: The algorithm analysed individual episode records by primary cancer diagnosis, anatomical site/ region, prescribed dose and fractionation, technique and number of attendances to predict the treatment intent based on clinical rules. This prediction is known as the 'Calculated Intent'. The algorithm was tested for exactitude by comparing the data entries for treatment intent collected in the RTDS from April 2013 known as 'Submitted Intent' with the data entries of 'Calculated Intent'.

Results: The results showed an overall >90% match rate, and will be stratified by primary diagnosis and NHS Trust to offer an explanation in variation.

Conclusions: This algorithm should be used to report intent on cohort based population analyses using RTDS. It could be developed further with additional complex rules to account for newer protocols. Additional linkage to other data sources i.e. TNM Staging in Cancer Registry data would allow a more accurate prediction of calculated treatment intent.

O-008 Integration of automatic Raystation scripts within the clinical pathway to provide and manage the in-vivo diode measurement data

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Introduction: Many aspects of the radiotherapy planning process are manual. Department specific auxiliary planning processes wont fall under any general solutions provided by efforts to 'automate planning'. One example process is the production of data related to the in-vivo diode dose check measurements performed in many clinics. We present a potentially general automatic solution using the Raystation scripting environment within the Raystation Treatment Planning System (TPS) for the provision and management of the in-vivo measurement data.

Methods: A Raystation script and MS-Excel template have been developed to automate the calculation, measurement and management of in-vivo diode doses. A Python representation of the geometry sufficient to ray-trace, and thus locate the diode position, has been integrated with a Raystation script to aid the positional calculations. The information relevant to the dosimetric calculation is provided and is then parsed by a simple MS-Excel template such that it is accessible directly in the clinical pathway. Further to dosimetric considerations the script provides a second Dicom RTPlan object which when imported into the Mosaiq Record and Verify system aids placement of the diode by way of positional guides in the form of 1.0cm2 light fields.

Results: Efficiencies are made by the automatic provision of the initial data, the removal of the need to transcribe and manually interpret data, the removal of paper copy and the use of light field positional guides. The results of comparisons between predicted measurement doses using this system and the former manual method show good general agreement.

O-009 Informing and improving the radiotherapy treatment planning process by the integration of automated quality and risk metrics using the Raystation Scripting Interface

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Introduction: Full optimisation of radiotherapy treatment plans is an information intense operation; there has never been more information in Radiotherapy. The TPS currently optimises a selection of metrics but the decisions and manual interventions of the operator have a large influence on the final plan. Information from the analysis of the individual case and the available population of similar cases, with consideration to the experience gained from verification measurements can be used to inform and automate parts of the manual processes.

Method: Raystation scripting has been used to calculate various metrics to describe and characterize each RT plan for a cohort of one hundred clinical VMAT prostate cases. In each instance the data has been examined for trends and correlations that could inform and improve the planning processes. Consideration has been given to methods of employing Raystation Scripting within the planning processes to provide in-line feedback and aid the operator in navigating the Problem and Solution spaces.

Results: Analysis of the results of the prostate cohort has enabled the identification of outlier plans, for example some plans are found to be overly complex. The work suggests that is it possible to perform in-line automatic analysis of the case and use results to inform influential decisions in the planning processes. Further work is underway to identify more specific metrics indicative of high and low quality, risk and deliverability and to similarly automate their use in the clinical pathway to provide a more comprehensively optimum plan.

O-010 Creation of a reporting dashboard to collect radiotherapy quality measures centrally

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NATCANSAT (National Clinical Analysis And Specialised Applications Team)

In 2012/13 the NHS Commissioning Board (now NHS England) approved the creation of a Quality Dashboard pilot for specialised services. The pilot generated a Specialised Services Quality Dashboard for Radiotherapy, and produced a set of measures which were to be collected on a quarterly basis. The information provided is required to understand the quality and outcomes of services and reasons for excellent performance.

Data was submitted originally by individual NHS Trusts during a trial period. At that time there was no quality assurance and varying values were allowed to be submitted with little 'sense check'. Interrogation of this data showed that there was some misinterpretation of the measures which created disparity between providers. Some of the measures were difficult to process and validate internally.

The authors were asked by providers to generate centrally the measures reported from the national radiotherapy dataset, RTDS. Additional data sources were collated from other datasets, and a few measures were not publically available.

The creation of a dashboard which processed and reported data centrally bringing together all the quality measures has several advantages:

- Time saving
- Avoids duplication
- Prevents poor quality of data and misinterpretation
- Benchmarking
- Consistent/improved measures

The central dashboard is efficient to use allowing existing data sources to be processed centrally. It allowed service providers to influence the definitions of the measure ensuring that they accurately represented the service. It was successfully implemented with 96% of providers using it. This methodology could be applied to the other specialised measures.

O-011 Should delivered dose for palliative patients be planned using a 2D or 3D calculation model?

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Aims/objective: To assess whether a 2D dose calculation algorithm reliably produces sufficiently accurate results for the planning of palliative radiotherapy treatments when compared to a 3D calculation algorithm.

Content: A dose analysis was performed on 11 patients who had received 2 field palliative radiotherapy using virtual simulation and 2D dose calculation. Treatment was recalculated using a 3D calculation algorithm in a treatment planning system. The patients received treatment to either their chest or their pelvis. Variations in dose to the prescription point were calculated by fixing the number of delivered monitor units (MU) for each beam to those calculated in the original 2D calculation and assessing the variation in the contribution of dose to the prescription point from each beam.

Relevance/impact: 3D models of patients generated from CT scans are routinely used for virtual simulation of palliative treatment but not always to calculate dose. This study tested whether the 3D calculation model should be used routinely in clinical practice.

Outcomes: Of the 11 patients, 5 were excluded from the report as they proceeded to a more complicated plan. For the 6 patients included, the percentage variation of the dose contribution to the prescription point varied between 2% and 14%.

Discussion: Although the 2D calculation can be accurate in some circumstances, for some patients the accuracy of the calculations falls outside the acceptable limits of ICRU 24. It is therefore justifiable to implement the 3D calculation method for calculating the dose for all simple treatments planned using virtual simulation.

O-012 A single centre experience of high dose palliative radiotherapy (36 Gy in 12 daily fractions) in locally advanced head and neck cancers

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Objective: To evaluate the tolerability and clinical outcome of high dose palliative radiotherapy 36 Gy in 12 daily fractions in patients with locally advanced head and neck cancer.

Method: Between July 2011 and June 2013, twenty seven patients with histologically proven locally advanced were treated with 36 Gy in 12 daily fractions of radiotherapy. The data on patients' demographics, disease characteristics, treatment toxicities and clinical outcome were collected retrospectively.

Results: The total number of patients was 27 (17 males and 10 females) with a median age of 70 years (range: 49-90). Oropharynx was the leading primary site of disease ((n = 11; 40%) followed by hypopharynx (n = 8; 30%), oral cavity (n = 3; 11%), larynx (n = 2; 7%), paranasal sinuses (n = 2; 7%) and unknown primary (n = 1; 4%). Majority of the patients (n = 15; 56%) were of WHO performance status 2 at presentation, followed by 8 (30%) patients with performance status of 0 or 1. Three (11%) of patients had performance status of 3 and 1 (4%) had performance status of 4.
A vast majority of the patients (n = 24; 89%) presented with stage IV disease, including 4 patients who were having distant metastatic disease at presentation. Two (7%) patients had stage III and 1 (4%) had stage II disease.
Twenty five (93%) patients managed to complete the planned course of radiotherapy. One patient (with performance status 4) died during radiotherapy due to cancer related event and one could not complete the treatment due to co-morbidities and poor performance status. Two patients died soon after completion of radiotherapy (2 and 3-months respectively).
Measureable response was available in 23 patients. Five (22%) had complete response and remain disease-free, 24-36 months after initial diagnosis. Thirteen (57%) patients had partial response, 3 (13%) had a stable disease. In 2 patients (9%) disease progressed. The incidence of grade III mucositis and grade III dermatitis was 18% and 4% respectively. There was no grade IV toxicity.
To date, 19 patients (70%) have died with a median overall survival of 13 months (range: 2 -40).

Conclusion: Our limited study confirms the efficacy of this hypofractionated dose fractionation schedule. Multicentre phase III trial is essential to validate these results in large patient population.

O-013 Informing a secondary dose calculation with a region of interest representing the water equivalent depth of the calculation point created automatically using Raystation Scripting

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Introduction: It is common practice to perform a secondary dose calculation of the radiotherapy treatment plan. The introduction of complex planning techniques has required that secondary dose calculations develop to support complex techniques. While some perform full inhomogeneity and scatter corrected dose calculation on the RT-CT dataset many perform calculations assuming the external Structure Set contour is composed of water. This work developed and tested a script that creates a 'water equivalent' external contour representing the effective depth of the calculation point at each VMAT control point.

Method: A script was developed in the Raystation scripting environment which adds a Region of Interest (ROI) to the Structure Set and reshapes it such that at each control point, the radius of the ROI represents the effective depth of the calculation point. This ROI can then be exported within the Dicom Structure Set and used to represent an accurate water equivalent depth in the secondary dose calculation. We have used this technique to perform secondary dose checks on VMAT prostate plans using the Diamond secondary check software from PTW.

Results: Twenty-two clinical VMAT prostate plans were calculated on the real external ROI and on the effective depth ROI. Diamond assumes the external ROI to be water filled. In both cases the secondary calculation result was compared to the TPS. The mean difference was reduced from -3.7% to 0.9%. In this case the use of this script increases the accuracy of the secondary dose calculation potentially improving sensitivity of the check.

O-014 The dosimetric impact of changing anatomical contours in radical radiotherapy treatment to the head and neck

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Purpose: A course of radiotherapy to the head and neck is traditionally planned using one initial planning CT, obtained more than a week prior to commencing treatment. Over the course of the treatment patient's contours can change significantly, leading to questions regarding potential dose implications. This paper reports a single-institutional experience when analysing the actual delivered doses to core organs at risk (OARs) over the course of treatment.

Methods: All routine treatment cone-beam computed tomography (CBCT) images for 10 patients with locally advanced oropharyngeal or nasopharygeal cancer were retrospectively analysed in the department's planning system. Actual delivered doses were then calculated and compared to the initial planned doses. Observed variations were analysed in respect to weight loss, separation changes and duration in to the course of treatment.

Results: Variations between planned and delivered doses were noted in all observed OARs. The delivered doses to the contra-lateral parotid gland exceeded the tolerance dose of 24Gy in 3 patients. The spinal cord planning risk volume delivered dose also exceeded the 48Gy tolerance dose in 3 patients. Spinal cord doses remained under 45Gy for all patients. There was no statistical significance between the observed dose differences and weight loss, separation changes, or duration; although it was noted that all dose breeches had occurred by the end of week 3.

Conclusion: The data reveals that adaptive radiotherapy may benefit some patients. A mid-treatment analysis is recommended in order to develop a targeted approach to this treatment strategy.

O-015 The absorbed dose rate to water from Valencia applicators; validation by direct measurement of the commissioning guidance issued by Elekta

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Aims/objectives: To increase confidence in the commissioning process of Valencia type brachytherapy applicators for utilisation in skin treatments by using ion chamber measurements to perform an absolute dose measurement under a clinical based setup.

Content: To outline a methodology and the measurements acquired in order to measure the absorbed dose to water at a given depth from Valencia type applicators.

Relevance/impact: An advantage of brachytherapy is the steep fall off of absorbed dose with distance from the source. Due to this and other dosimetric issues, the validation of brachytherapy treatment plans by measuring the Absorbed Dose at a given point is frequently omitted from any commissioning process. Therefore at commissioning the recommended guidance is to infer the absorbed dose rate to water rather than directly measuring the absorbed dose rate to water at a given depth.

To increase confidence in the output of the applicators a procedure was developed to measure the absorbed dose rate at 3mm deep in water using standard ion chambers.

Outcomes: For the 2cm and 3cm diameter Valencia Applicators being commissioned the absorbed dose rate to water at 3mm deep in water was measured to within 3.6% and 6% respectively of the absorbed dose rate to water given by Elekta.

Discussion: This measurement is independent of the procedure given by the manufacturers of the applicators. Therefore by measuring the absorbed dose rate to water for a clinical setup the outlined methodology adds confidence of the Elekta commissioning guidance.

O-016 Review of acute toxicity in anal cancer patients following progression from 3D conformal radiotherapy to volumetric modulated arc therapy

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Aims: The aim of this study was to review changes in acute toxicity in anal cancer patients treated with volumetric modulated arc therapy (VMAT) in comparison to those treated with 3D conformal radiotherapy (3DCRT).

Method: The 3DCRT technique followed the ACTII trial protocol [1], consisting of an AP/PA pair of fields (30.6Gy in 17 fractions) followed by a conformal plan to the primary PTV (19.8Gy in 11 fractions). The current method involves

a dual-arc VMAT plan (53.2Gy in 28 fractions) following the National Guidance [2]. A randomly selected cohort of VMAT patients were re-planned following the CFRT protocol, to ensure no detriment in terms of target coverage using VMAT compared to CFRT. Review clinic notes were interrogated to determine the maximum recorded toxicity for a sample of patients treated using each technique.

Results: Initial results of the planning comparison show that VMAT plans result in similar PTV coverage with improved conformality compared to 3DCRT. Notably, significant reductions in dose to the genitals (D5%-VMAT=38.9Gy; D5%-3DCRT=51.0Gy) correlates with reduced incidences of Grade 3 skin toxicity (VMAT 20%; 3DCRT 90%). There were no significant differences in other toxicities.

Discussion: The transition to VMAT from 3DCRT technique has allowed an increase prescription to target volumes while reducing acute toxicity in patients.

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O-017 Interdepartmental verification of the dosimetric accuracy of VMAT treatment delivery

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Aim: To verify that VMAT treatments at six departments meet the minimum Gamma analysis pass rate of 95% (3% dose difference, 3mm distance to agreement).

Method: An anonymised dataset representing a prostate treatment including elective irradiation of the pelvic nodes was used by all participating centres to create a treatment plan based on a locally developed protocol. The resultant treatment plan was measured on a linear accelerator at each centre using the SunNuclear ArcCheck phantom. Gamma and Dose Volume Histogram (DVH) analyses were carried out. The DVH analysis consisted of comparing planned against measured mean doses for all target volumes (PTVs) and the planned against measured volume of the rectum for V70Gy and V30Gy indices.

Results: All participating centres achieved the required Gamma pass rate. The mean pass rate was 99.5% while the minimum and maximum pass rate were 98.6% and 100% respectively. The average deviation of the measured PTV mean doses against planned doses across all centres were 0%, +0.3% and +0.1% for PTV1, PTV2 and PTV3 respectively. On average over all centres, the volume of rectum receiving at least 70Gy was 0.4 percentage points lower than planned while the volume of rectum receiving at least 30Gy was 0.1% higher than planned.

Conclusion: All participating centres achieved the required Gamma analysis pass rate though some variations were observed across the sites. The DVH analysis showed close agreement between planned and delivered dose to targets and organs at all sites.

O-018 VMAT with image guided verification for rectal cancer patients; a service evaluation to current CBCT protocol

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We aim to develop current rectal CBCT protocol at use in our large radiotherapy centre.

VMAT for rectal cancer patients is used when dose constraints to the small bowel cannot be met using 3D conformal planning. In these cases CBCT data was acquired for the purposes of on-treatment verification to ensure geometric accuracy. This data has been analysed to ensure the current matching process allows for adequate target volume coverage.

CBCT data has been analysed and the protocol justified, there can be a move towards treating all rectal cancer patients using VMAT at our centre.

It was found that performing an online match using stable bony anatomy alone allowed for adequate GTV coverage in 81.4% of cases. In 100% of cases, a bone match allowed for adequate coverage of the CTV and PTV. A significant

association was found between the presence of gas and poor GTV coverage. The study also found patients treated in a supine position had smaller geometric set-up errors in all directions compared to patients treated prone. This did not lead to statistically fewer CBCT scans.

The benefits of treating using VMAT in terms of improved dose distributions, whilst reducing organ at risk (OAR) exposure, make this an advantageous technique for treating rectal cancer. There has been a reluctance to do so due to concerns about steep dose-gradients and an inability to verify geometric accuracy appropriately. This work has given confidence in the use of VMAT for rectal cancer through the analysis of CBCT scans.

O-019 Effective comparative indices for complex brain radiotherapy involving overlapping target and normal tissue structures (in glioblastoma multiforme patients): VMAT vs 3D conformal

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Purpose: This study is concerned with the effectiveness of physical and radiobiological brain radiotherapy plan quality metrics considering target/normal structure proximity/overlap. The evaluation is based on comparisons between three-dimensional conformal radiotherapy (3D-CRT) and volumetric modulated arc therapy (VMAT) using physical and radiobiological parameters. Dosimetric criteria are widely used as surrogates of biological response for plan assessments but can dosimetric superiority of a plan be directly translated as superiority at a radiobiological level?

Method: Retrospective data from 56 3D-CRT and 33 VMAT glioblastoma multiforme (GBM) plans were used. All patients received 60 Gy in 30 fractions and concomitant chemotherapy. Mean, minimum and maximum doses were used for dosimetric evaluation of the planning target volumes (PTV) and principal organs-at-risk (OAR) (brainstem, optic nerves and optic chiasm). Target coverage with the 95% isodose, conformity and homogeneity were also evaluated. Data were analysed after sample stratification based on target-OAR proximity. Relative TCP, normal tissue complication probability (NTCP) and equivalent uniform dose (EUD) values were calculated in BioSuite using published Linear-Quadratic and Lyman-Kutcher-Burman model parameters.

Results and conclusion: VMAT was substantially superior in terms of target mean dose, coverage and homogeneity in cases of tumour/OAR overlap while, for less challenging cases, differences were insignificant. VMAT displayed consistent optimal conformity of the 95% isodose to the PTV regardless of geometrical challenges. The radiobiologically based observations were generally in good agreement with observations based on dosimetric quantities which may imply that the latter are adequate surrogates of biological effectiveness, although direct translation in therapeutic gain is questionable.

O-020 Development of an imaging guided radiotherapy strategy for radical cervix radiotherapy

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Purpose/objective: This study aims to assess if the current departmental IGRT strategy can guarantee that both uterine and pelvic nodes are covered adequately with the existing planning target volume(PTV) margins.

Methods/materials: All radical cervix patients were treated with departmental bladder/bowel preparation protocols. The imaging protocol was daily bony match with kilovoltage(kV) planar imaging pairs. Cone beam computed tomography(CBCT) was done for the first three treatments and then repeat weekly(total of 6). Additional CBCTs were performed provided that there were concerns on PTV coverage. A retrospective review of CBCTs was carried out. The primary uterine PTV coverage was assessed and scored as good/poor after bony matching solely. Bladder/rectum status on CBCTs was assessed. Chi square test was used to determine if there was any significant association between primary PTV coverage after bony match and changes in bladder/rectum.

Results: 14 patients(137CBCTs) were included. 6/14patients required additional CBCT beyond the imaging protocol. The mean number of CBCTs per patient is 10(range 6-18). The coverage of the primary PTV was rated as poor in 35% (48/137) of images after using bony matching solely. Significant associations were found between the primary PTV coverage and changes in bladder/rectum($p<0.05$).

	Number of CBCTs showing changes in bladder filling	Number of CBCTs showing no change in bladder filling
Number of CBCTs showing Good uterine PTV coverage	57	32
Number of CBCTs showing Poor uterine PTV coverage	39	9
Chi Square p-value	0.036	
	Number of CBCTs showing changes in rectum filling	Number of CBCTs showing no change in rectum filling
Number of CBCTs showing Good uterine PTV coverage	38	50
Number of CBCTs showing Poor uterine PTV coverage	30	19
Chi Square p-value	0.043	

Conclusion: It's suggested that using bony anatomy matching solely could not guarantee adequate primary uterine PTV coverage. Bladder and rectum filling have been shown to influence uterine movement in this study. CBCTs can be utilised to provide volumetric information on bladder/rectum status. The findings will inform the development of an adaptive protocol for this patient group.

O-021 A comparison of measured and calculated Field Edge Area (FEA) width for Flattening Filter Free (FFF) beams in low density media

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Aims/objectives: To evaluate and validate the performance of the MC algorithm in MONACO in low density materials against measurements with EBT3 radiochromic films in FFF beams. The region of interest is the FEA: 20-80% of dose maximum.

Content: The film was placed in a phantom at depths of 3 (water), 10 (lung) and 20 (water) cm and three field sizes were used: 2x2, 5x5 and 10x10cm2. These setups were reproduced within Monaco. Profiles were measured from the film and compared to those calculated with the TPS. The FEA was calculated and the results were compared.

Relevance/impact: The comparison was part of the treatment planning system validation.

Outcomes: The profile differences between the two methods were primarily within 1mm for all field sizes and at all depths. The largest difference between Monaco and measurement at 10 cm deep was 0.7, 1.2 and 1.0mm in the crossline direction for 10x10, 5x5, and 2x2cm2 respectively. The respective differences in the inline direction were 2.2, 1.2 and 1.0mm. The FEA calculated with Monaco is overall broader than that measured, with differences being largest in lung.

Discussion: The excellent agreement indicates that the TPS satisfactorily predicts profiles even in low density material. Some limitations of Monaco's algorithm may affect the beam profile when the medium changes density. The differences could be due to partial volume effect as the spatial resolution of Monaco is lower than that of film. Jaw misalignments may be responsible for differences in FEA between the different jaws.

O-022 Determination of clinically appropriate flattening filter free (FFF) energy for treating lung SABR

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Purpose: To determine a clinically appropriate flattening filter free (FFF) energy choice for lung stereotactic ablative body radiotherapy (SABR).

Materials/methods: A lung SABR planning study was conducted (following UK Consortium Guidelines [1] using Eclipse V.11, AcurosXB) for 11 patients using both 6FFF and 10FFF energies, with two half arcs and the MU Objective function [2]. Plans were compared with the original 6MV 'flattened beam' clinical plans. A number of parameters

including organ at risk (OAR) doses, target doses, treatment time, conformity index and gradient measure were examined for significance.

Results: Clinically acceptable plans could be produced for all beam energies. 6FFF provided statistically significant OAR sparing, compared to the standard 6MV plans, for spinal cord and Lungs-GTV. 10FFF provided a small yet significant increase in dose to the contralateral lung but otherwise OAR doses were comparable to the clinical baseline. 6FFF plans showed greater OAR sparing, improved gradient measure and V50%/V(PTV) over 10FFF plans but not for skin sparing or treatment time. PTV conformity was similar in both FFF plans. 10FFF treatment times were 0.8 minutes shorter than 6FFF and 3.8 minutes shorter than 6MV plans (excluding gated beam holds).

Conclusions: 6FFF plans showed statistically significant OAR sparing compared to 6MV and 10FFF plans but all were within clinical tolerance and acceptable [1]. 10FFF plan deliveries gave reduced delivery time which could yield great benefits for elderly SABR lung patients with existing comorbidities.

References:

SABR UK Consortium, v.4.1, 2014
Lung Cancer, Volume87, Suppliment1, Pages S47-S48

O-023 Development of an imaging guided radiotherapy strategy for prostate and nodes radiotherapy

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Mount Vernon Cancer Centre

Purpose/Objective: This study aims to develop an image-guided radiotherapy(IGRT) strategy in prostate and nodes radiotherapy(PPN RT) to ensure both prostate and nodes are covered adequately with our current departmental planning target volume(PTV) margins.

Methods/Materials: A retrospective review of verification images of PPN patients was carried out. The imaging protocol was daily kilovoltage(kV) planar imaging pairs with weekly conebeam computed tomography(CBCT) in combination with departmental bladder and bowel preparation protocols. The image matching was performed on the kV planar images using bony anatomy and fiducials respectively. The differences between two matching methods in terms of vertical(VERT), longitudinal(LNG) and lateral(LAT) shifts required were calculated. The CBCTs were used to assess the prostate and nodal PTV coverage after applying bony and fiducials match results.

Results: 18 PPN patients(120kV pairs&CBCTs) were included. The mean differences between two matching methods are 2.5mm(95%CI:2.1-2.9mm) in VERT, 2.3mm(95%CI:1.9-2.6mm) in LNG, and 1.3mm(95%CI:1.0-1.6mm) in LAT. 89%(107/120) of the image sets were with <5mm difference between bony and marker matches. 31% (37/120) resulted in sub-optimal prostate PTV coverage by applying bony matches solely. Using fiducials-based matching, the nodal volumes were outside PTV only when the difference between bony and fiducials matches was more than 5mm(4/120).

Conclusion: The two steps matching process using kV planar imaging (first bony match and then fiducial match) should work for 90% of our patient population without compromising prostate and nodal PTV coverage, provided that the difference between bony and marker matches is no more than 5mm. CBCTs can be utilised as an intervention to provide volumetric information to explain why the difference exists.

O-024 Experience of “Going Dutch” for VMAT commissioning of an Elekta VersaHD

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A Versa HD Elekta linac with flattening-filter-free (FFF) beam facility was commissioned at Nottingham. Tests specific for Volumetric Modulated Arc Therapy (VMAT) included assessment of the ability of the linac to vary the dose rate, gantry rotation and Multi-Leaf-Collimator (MLC) motion. One of the aims of VMAT commissioning was to test the ability of the new linac to accurately deliver stereotactic ablative radiotherapy (SABR) and stereotactic radio-surgery (SRS) VMAT plans.

Our tests were structured according to the VMAT commissioning report 24 by Netherlands Commission on Radiation Dosimetry: “Code of Practice for the Quality Assurance and Control for Volumetric Modulated Arc Therapy”. It comprised tests of MLC and dose rate with static gantry, as well as more complex tests, where all dynamic

parameters (dose rate, MLC motion and gantry rotation speed) are included, one by one. Test results with static gantry are used as the baseline for the tests with dynamic gantry, e.g. output linearity, beam profile, MLC position accuracy. We used the Elekta iComCAT tool to create required complex bespoke plans.

All clinically relevant tested parameters were within the tolerance levels suggested in the NCS report. The overall accuracy of MLC position was within 1mm for both static and dynamic gantry. The MLC test was more accurate with Gafchromic film instead of the EPID (electronic portable imaging device). We also tested the accuracy of the delivery of interrupted VMAT treatments.

Overall, the performance of the linac was acceptable for VMAT deliveries, including high dose treatments with over 1000MU.

O-025 Commissioning intracranial SRS: Imaging, treatment planning, quality assurance, end-to-end verification and audit.

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Royal Surrey County Hospital

Aims/objectives: To commission a system to treat intracranial brain metastasis.

Content: The different stages of commissioning will be described, including: Exactrac imaging system V6.1 and iPlan treatment planning system V4.5 (Brainlab, Germany); planning study; plan-specific quality assurance (QA); end-to-end verification and a collaboration Audit with National Physics Laboratory.

Relevance/impact: Increasing numbers of patients are treated with stereotactic radiosurgery (SRS). The technique requires high precision and accurate small field dosimetry. This work describes methods for the safe implementation of stereotactic radiosurgery.

Outcomes: The system was successfully commissioned within 6 months; current minimum clinical field size of 1cm using Varian HD-MLC with the potential to use conical collimators with diameters of 4-15mm . The treatment technique chosen from the study was 4 dynamic conformal arcs (DCA), with a 10MV flattening-filter-free (FFF) beam. Initial plan-specific QA results show greater than 95% within 2%/1mm for EBT3 film, with pinpoint chamber doses within +/-1%. The audit results were within +/-2%.

Discussion: Hardware and software required for a new intracranial SRS service was commissioned. Using FFF reduces treatment time and out-of-field dose. DCA reduces the volume of normal brain receiving high dose compared to fixed-field treatments, but increases the low-dose volume. Our implemented methods show an exceptionally high degree of correlation between planned and measured dose distributions.

O-026 Intracranial stereotactic radiosurgery: Class solution and assessment of plan quality using VMAT

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Aim: Develop and evaluate a class solution using volumetric modulated arc therapy (VMAT) for intracranial stereotactic radiosurgery (SRS) with a view to development of a local SRS service.

Method: 12 cases were planned using Monaco treatment planning system for an Elekta Versa FFF linac. Single and multiple lesions were included. Organ at risk constraints were set using published data. Plans were scaled so 95% of the PTV and 98% of the GTV received >/=100% of the prescription dose.

Results: A class solution using 3 arcs was established: 1 full arc at couch 0°, and 2 non-coplanar partial arcs.
Plan quality was assessed using a range of published conformity indices, including the Paddick conformity index (PCI) and gradient index. PCI was noted to increase whilst gradient index reduced with increasing PTV volume. Organ at risk constraints could be met for all cases except one
Typical beam on time was 7-8 minutes for a single lesion treated with a single fraction of 20Gy.

Conclusion: Planning studies indicate VMAT using 5mm MLC can be used to produce highly conformal plans for single and multiple intracranial lesions. Treatment times are short which is beneficial for patients and for efficient work flow. Conformity and organ at risk doses may be improved further for smaller lesions with micro-MLC; however our results indicate that high quality SRS plans can already be produced with our existing radiotherapy platforms.

O-027 The impact of a consultant radiographer to stereotactic radiotherapy service

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Purpose/objective: This study aims to investigate the impact of a consultant radiographer on stereotactic radiotherapy service at our institution.

Materials/methods: With the increasing demand for Stereotactic Radiosurgery and Radiotherapy(SRS/SRT), our institution has appointed a consultant radiographer to lead the service since 2014. The post holder was expected to enhance our SRS/SRT service delivery and hence improve patient outcomes by increasing capacity and patient throughput. This helps the service to meet national and cancer targets. A retrospective review of SRS/SRT patients who were treated in 2013 (without the consultant radiographer) and 2015 (with the consultant radiographer) at our institution was carried out to determine the interval between decision to treat and treatment start dates(INT). Mann-Whitney U test was performed to test for any significant difference in INT between the years.

Results: 155 consecutive patients from January2013 to September2015 were included.

There was a 35% increase in the number of patients treated in 2015 compared to 2013. A significant difference ($p<0.05$) was found in INT between 2013 and 2015. The mean INT in 2015 is shortened to nearly half of that in 2013 despite the increase in workload.

Year	2013 (Jan-Sept)	2015 (Jan-Sept)
Number of patients treated	66	89
Mean INT (days)	39.4	22.0
95% Confidence Intervals for Mean INT (days)	32.2-46.7	18.9-25.

Conclusion: This analysis suggests that intervals between decision to treat and treatment start dates of our SRS/SRT patients have been shortened since the consultant radiographer was appointed. The post holder has streamlined the patient pathways that still deliver high quality services but in more resourceful and innovative ways including radiographer led target volume delineations and consent.

O-028 Audit on overall treatment time for cervical chemo-radiotherapy with weekly HDR brachytherapy

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Objectives: To assess the feasibility of delivering radical chemo-radiotherapy utilising contemporary brachytherapy in relation to recommended overall treatment time (<56 days).

Content: We have looked at overall treatment time on patients treated between 2013 and 2015. Patients received external beam radiotherapy (EBRT) +/- chemotherapy. Brachytherapy is delivered with a single implant followed by a single fraction; this is usually given weekly, but a twice a week fractionation is occasionally used. Insertion is carried out under general anaesthesia. All fractions are planned on CT scan, MRI is done on the day before the 1st brachytherapy, without applicators in situ. No interstitial needles were used.

Results: We identified 24 patients treated between 19/02/2013 and 09/11/2015. Average treatment time was 45.2 days (38-52). 4 patients received 4 fractions due to difficulties meeting the recommended dose constraints.

Conclusion: It is possible to complete an outpatient treatment within a 56 day timeframe, even with weekly fractions. Starting brachytherapy before completing EBRT allows overall treatment time to be kept within recommended guidelines.

O-029 The impact of CT scanner settings on image quality and Hounsfield units for radiotherapy CT planning

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Aim: To characterise the performance of a Toshiba Aquillion LB CT scanner in terms of the variation of Hounsfield Units (HU) with scan settings. Information obtained was to support optimisation of CT image quality and dose for head and neck planning whilst understanding any effect on radiotherapy dose calculations. There are few publications on radiotherapy CT optimisation and its impact.

Content: A Catphan 600 phantom was used to assess the variation of: HU, visibility of low contrast details, image noise and high contrast spatial resolution for different scan parameters: namely reconstruction field of view, acquisition and reconstructed slice thickness, effective mAs and reconstruction algorithm. HU variation was compared against tolerances of +/- 50HU for air, +/- 30HU for water and +/ 150HU for bone. Literature suggests these correspond to radiotherapy dose changes within +/-2%.

Outcomes/Relevance: The choice of reconstruction algorithm had the biggest impact on HU variation. For most of the algorithms tested, HU variations remained within tolerances when compared to the mean HU for different materials. HU variation was minimal when all other parameters were separately varied. Important parameters for detail visibility were reconstruction algorithm and effective mAs for low contrast details, and reconstruction field of view for small, high contrast details.

Discussion: Results demonstrate the impact of scan parameter changes on HU values and image quality. Improvements in H&N CT images may be possible without significantly affecting treatment planning calculations.

O-030 An image acquisition and analysis strategy for comparison of ventilation CT and HP gas MRI

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Introduction: "Ventilation CT" assumes that lung expansion and density change of corresponding parenchymal voxels equate to lung ventilation. However, its physiological accuracy has yet to be fully validated against established ventilation modalities. Here, we present an imaging protocol for acquiring pulmonary CT that can be used to calculate ventilation surrogates for direct comparison with hyperpolarised (HP) gas 3He-MRI.

Methods: Our protocol was tested on six lung cancer patients who underwent expiration and inspiration breath-hold CT. On the same day, 3He and 1H-MRI were acquired in the same breath and at the same inflation state as the inspiratory CT. Registration accuracy was validated using a reference 4D-CT data set for 6 patients with 100 expert anatomical landmarks defined on both images. Ventilation CT images were calculated from voxel-wise intensity differences in Hounsfield unit (HU) values. To ensure that 3He-MRI was in the same spatial domain and inflation state as the CT ventilation surrogate, the former was registered to the inspiratory CT data via same-breath anatomical 1H-MRI. The transformation from 1H-MRI to CT was then applied directly to 3He-MRI allowing direct comparison of 3He-MRI and CT ventilation.

Results: Visual examination indicated accurate registration of inspiratory and expiratory breath-hold CTs and the reference data set had a mean registration error of 1.1±0.2mm (mean±SD). Successful registration enabled direct comparison of ventilation CT with MRI.

Conclusion: It is feasible to acquire CT and 1H/3He-MRI with similar breath-holds and posture such that registered data can be used to directly compare CT ventilation and 3He-MRI ventilation maps.

O-031 A clinical investigation of optimal CBCT image matching for non-SABR radical lung cancer patients

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Purpose/objective: Spine-based image registration has traditionally been used for patient setup for non-SABR radical lung cancer radiotherapy. Enhanced visualisation of soft tissue structures through volumetric imaging has led to research of various landmarks that may offer target localisation of increased accuracy compared to spine-based registration. The objectives of this project were to answer the following: Can using carina or tumour as registration landmarks for IGRT offer superior target coverage compared to spine registration? Does the position of tumour affect which registration landmark offers superior target coverage? What are the implications of carina or tumour registration on spinal cord safety?

Material/methods: Ten patients with central tumours and ten patients with peripheral tumours were selected. A clinical expert assessed a sample of CBCTs from each patient and selected which thoracic landmark (spine, carina, or tumour) produced the the optimal match. CBCTs from each patient (238 CBCTs in total) were matched using the spine and the optimal match and translational displacements were recorded. The difference between the spine-match displacements and optimal-match displacements were calculated. The shortest distance between the spinal cord and tolerance isodose was measured for each patient.

Results: Carina-and tumour-matching produced target localisation of increased accuracy compared to spine-matching. The average bone-to-optimal 3D vector displacement was 0.4 cm. The 2D vector (vertical and lateral) displacements were more relevant for spinal cord safety because longitudinal displacements did not affect the spinal cord-to-tolerance isodose distance in this sample. The 90th percentile of the 2D vector bone-to-optimal displacements were 0.6 cm and 0.5cm for the central and peripheral groups, respectively.

Conclusion: For central and peripheral tumours, carina- and tumour-matching produced the most optimal target coverage, respectively. The spinal cord-to-tolerance isodose distance is important, as any deviation from spine-matching could result in spinal cord tolerance being exceeded. Using a threshold spinal cord-to-tolerance isodose distance, based on the 90th percentile 2D vector bone-to-optimal displacement, is a measurable method of indicating if carina or tumour match introduces a risk of exceeding spinal cord tolerance dose.

O-032 Neo-adjuvant chemoradiation for resectable OG cancer: a single centre experience

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Background: The addition of neoadjuvant chemoradiation (NACRT) to the treatment of resectable oesophageal cancer increases R0 resections and improves survival. Postoperative morbidity however remains a concern with this approach.

Methods: Between October 2012 and July 2015, 34 patients with resectable oesophago-gastric cancer underwent treatment NACRT in our institution. Treatment consisted of 3 cycles of Cisplatin 60 mg/m2, day 1, and capecitabine 1250 mg/m2, days 1-21, and 3-D conformal radiotherapy with 45Gy in 25 fractions starting on day1 of cycle 2. Survival analyses were performed with the Kaplan-Meier method.

Results: There were 27(79%) male and 7(21%) female patients with a median age of 66 years (42-78). 32 (94%) were adenocarcinomas. 27(79%) patients were UICC stage III. 31 patients underwent surgery at a median of 67 days after the last fraction of RT. Pathological complete response (pCR) was 15% (n=5). Circumferential resection margin was negative in 22 (73%), within 1mm in 6 (20%).
Median hospital stay was 12 days (1-55). Post-operative complications included anastomotic leak in 2(6%), wound complications (1, 3%), sepsis (5,16%) and cardiac events (6,20%). 6 (19%) patients died in the postoperative period (range:15-78 days) with 30-day mortality at 9.8% (n=3).
With a median follow-up of 21.1 months 95%CI (15.8 - 26.4), 20 (59%) patients remained alive. Median overall survival was not reached [mean: 22 months 95%(17.8-26.3)].

Conclusion: This report indicates the feasibility and effectiveness of pre-operative chemoradiotherapy for resectable oesophageal /GOJ cancer. Postoperative morbidity and mortality remains a relevant concern.

O-033 Outcomes from adjuvant radiotherapy to regional lymph nodes after therapeutic lymphadenectomy for malignant melanoma: 7 year experience from a single UK centre

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Background: Adjuvant nodal radiotherapy after lymphadenectomy reduces the risk of loco-regional recurrence in high risk malignant melanoma but has no effect on overall survival1. We have audited the outcomes of our patients receiving adjuvant nodal radiotherapy for malignant melanoma.

Methods: This retrospective audit included all malignant melanoma patients with regional lymph node metastasis treated with lymphadenectomy plus adjuvant radiotherapy. Data was collected through case notes review, radiology and histopathology reports and analysed for treatment outcomes and side effects.

Results: 96 patients received adjuvant nodal radiotherapy between January 2008 and December 2014. Median age was 65 years (20 to 91) and median follow-up was 22 months (m) (IQR2 9-30). 83 patients were treated with 60Gy, 11 patients with 50-60Gy, and 2 received <50Gy. At the time of analysis 53 (55.2%) patients were still alive, 7 (7.2%) had recurrence with in the radiotherapy field and 51 (53.1%) developed distant metastasis. Median PFS was 22.4 m (CI 16.6-28.1). 31 patients with metastatic disease received systemic treatment. Median overall survival was 35.3 m (CI 25.1-45.4). Overall the treatment appeared to be well tolerated with 23 (24%) patients developing lymphedema, 1 (1%) being grade≥ 2 and one had (1%) grade≤1 peripheral neuropathy.

Conclusion: Local recurrence was low in these unselected high risk patients receiving adjuvant radiotherapy after lymphadenectomy. Patients with lymph node recurrence remain at high risk for developing distant metastasis indicating the need for adjuvant systemic therapy possibly in addition to radiotherapy.

1 Henderson MA, et al. Lancet Oncology 2015; 9:1049-60
2 interquartile ranges

O-034 The impact of linac output variation on clinical outcomes

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Aims: When delivering radiotherapy treatments, linac output is considered constant, with a +/-2% tolerance during daily checks. This work aims to quantify the impact on clinical outcomes due to variation in daily linac output.

Method: Daily output data from 133 linacs in 23 UK radiotherapy centres was collected from January to June 2015, creating a national picture of dose variation. The potential impact on clinical outcomes has been assessed from the steepness of dose response curves for a variety of cancers and variation in outputs for individual linacs and within centres.

Results: There was a difference of 3.6% between the maximum and minimum mean linac outputs, with a range of 2% between the 5th and 95th percentiles. Within a single centre a maximum difference of 2.8% was found between linacs. Only a single linac had a mean output which exceeded +/-2%, with 13 linacs (9.8%) outside +/-1%.
Head and Neck cancers have steep dose response with 1% dose change giving 2% TCP change and 5% in side effects. Based only on the measured output variations it is predicted that TCP would vary by 7.2% across all studied linacs, and 5.6% in an individual centre, with side effects varying by 18% and 14% respectively.

Conclusions: Variations in clinical outcomes due to linac output are not insignificant which has potential implications for QA tolerances as well as QA in clinical trials. This work is part of the larger QUASAR project aiming to quantify the impact of QA and audit on clinical outcomes.

O-035 Commissioning experience for PTW QuickCheck daily constancy test devices for matched linear accelerators

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The QuickCheckWebline (PTW, Freiberg) is a constancy device with 13 vented ionisation chambers for measuring daily output, flatness, symmetry and beam quality (BQ) with automatic temperature and pressure correction. This purpose of this work was to commission and characterise three such devices for daily QC of four matched Varian linear accelerators with photon and electron beams. No prior publication exists.

The devices were cross-calibrated against ionisation chambers traceable to the NPL (Teddington, UK) primary standard for dose and to an ionisation chamber array (MatriXX Evolution (IBA, Freiberg) for flatness and symmetry. The BQ measurement, which is measured using four chambers with copper filters and a polynomial relation, was calibrated against local beam quality measurements. The device was characterised by assessing the linearity of dose (50-200cGy), reproducibility and consistency.

All three devices exhibited a linear dose response over the investigated range (R2=1.00), with day-to-day dose reproducibility within 0.5% compared to absolute dose measurements. This suggests an initial pre-irradiation period for the devices. The BQ measurement was very stable (<0.5%) but linac specific, with up to 2% variation between

matched linacs (within 0.5% for TPR2010 for photons). This may suggest significant energy dependence of the system. The QuickCheck measured flatness and symmetry were within 1.5% of the MatriXX.

It has been shown that QUICKCHECKs are suitable and convenient for linac consistency checks. The performance indicates that the devices can improve the efficiency of monthly QC testing.

O-036 Performance evaluation of an MV constancy device (PTW Linacheck) for use on an orthovoltage unit

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MV constancy devices have been used for orthovoltage units [1]; however, at beam qualities below 1mmCu, detector response showed sufficiently large beam quality dependence to require beam quality assessment before output could be determined. Similarly, the update of IPEM report 81 [2] is likely to recommend that copper foils be used to harden soft beams to avoid device saturation due to low energy fluorescence, if used over large energy ranges. However, we propose to use the LINACHECK (PTW) constancy device without additional filtration (energy range 70-250kV) following commissioning and clinical performance evaluation.

The LINACHECK was cross-calibrated against a Farmer chamber at 250kV on a Gulmay 3300 unit. The detector's energy response was characterised and an appropriate MU selected for routine measurement. Linearity, repeatability and reproducibility were assessed by repeat measurements. Routine HVL measurements show little beam quality variation (2σ=3.5%), therefore neither beam quality adjustment factor nor added filtration is necessary.

LINACHECK response was linear from 15MU to saturation; sensitivity ranged from 0.146-0.050arb.unit.MU-1 across 70-250kV. Measurement repeatability varied with energy from 0.1-0.5% of the mean (2σ), with mean reproducibility at 0.3% (range 0.2-0.4%). Six months' clinical data will be presented at the conference.

Assessment of device performance indicates that the LINACHECK is an acceptable solution for constancy measurements for a clinical kV unit without any additional build-up or filtration.

[1] Nikolic M and Van Dyk J 1993 Med. Phys.
[2] Correspondence with co-editor of draft updated IPEM Report 81

O-037 Critical evaluation of the management options of radiotherapy related diarrhoea for pelvic cancer patients

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Around 17 000 people treated each year in the UK. Pelvic RT, delivered daily over treatment periods of 5–7 weeks, can cause radiation induced diarrhoea (RID) in about 50% of treated patients. Due to the close proximity of the gastrointestinal tract to the pelvic organs, radiation results in defect in bile salt malabsorption. RID usually develops during or after the second week of RT and can last until 2 weeks (acute RID) and/or 18months to 15 years (chronic RID) after RT is completed. Diarrhoea can interfere with patients' daily activities markedly affect their psychological well-being and overall quality of life (QoL). The aim of this poster is to critically evaluate the current management options of RID for pelvic cancer patients.

The role of RT in the treatment of pelvic cancer is progressively increasing due to both effectiveness and the rapid advent in the technology. Despite technological advances, ionising radiation toxicity remains a major obstacle to radical pelvic cancer treatment. A new therapeutic strategies are needed to tackle acute RID. A high quality RCTs are imperative to investigate novel pharmacological and nutritional interventions. A more prominent role for Specialist Therapeutic Radiographers within a multidisciplinary gastroenterologist-led clinics. Finally, it is important to raise awareness of the extent and impact of long-term RID. These will not only inform new strategies for managing acute RID, but also improve QoL including function and emotional wellbeing for pelvic cancer survivors.

O-038 Establishing the prevalence of patient-reported late-effects of pelvic radiotherapy symptoms utilising a simple patient reported outcome measure (sPROM)

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Aims/objectives: To establish the prevalence of self-reported symptoms of late-effects in the pelvic radiotherapy treated population, to identify service needs and model correlative factors.

Content: The risks of late radiotherapy side-effects occur months to years post treatment. Mechanisms associated with these effects are complex and not fully understood, making risk-stratification post-treatment challenging. Assessment of the efficacy of the sPROM questionnaire in identifying and managing late-effects was assessed and statistical regression methods used to review associative factors.

Relevance/impact: The survey was a cost effective method of establishing the burden of patient-reported late treatment effects in the population, supporting service planning and patient focused care.

Outcomes: An excellent response rate (77.7%) was achieved, with a high level of data completion.
The prevalence of patients self-reporting symptoms of late treatment for any sPROM question was 76.0% and a clinically significant sPROM question was 38.1%.

Discussion: The study captured data on 25 specific functional sPROMs with 7 of these sPROMs designated as requiring clinical follow up and management.
It was not possible to identify overall any correlation or model of sPROM late effect triggers with age, elapsed-time from treatment, prescribed dose or gender. 6 questions revealed statistically significant associated variables with maximum pelvic dose being the most statistically significant.

O-039 Introduction of improved bladder filling and use of an ultrasonic bladder volume scanner to improve reproducibility of bladder volume in patients undergoing pelvic radiotherapy

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East Gloucestershire NHS Foundation Trust

Background: Maintaining consistent bladder volumes is important to decrease bowel toxicity and PTV movement and to enable implementation of intensity-modulated radiotherapy (IMRT).This can be challenging despite the use of bladder filling protocols. This study looks at the reliability of an improved bladder protocol and benefit of implementing bladder ultrasound (BUS) for obtaining bladder consistency for pelvic radiotherapy.

Methods: Following retrospective review to look at the variation in bladder filling with our original protocol, we performed an observational study in women with cervical and uterine cancer undergoing IMRT with a new bladder protocol. BUS was performed immediately prior to planning CT and each cone beam imaging (CBCT) in line with departmental verification protocol. Bladder volume was measured on planning CT and all CBCTs and BUS.

Results: Retrospective review of 4 patients and 53 CBCTs with the original bladder protocol showed large variation of between 20 and 125% in bladder volume at treatment compared with planning CT.
Following implementation of the new bladder protocol, results from 15 patients undergoing 135 scans showed more consistent bladder filling during the course of treatment. Furthermore, the volumes from BUS were comparable with planning CT/CBCT showing on average, a difference of +/- 50ml.

Conclusion: By implementing more defined and robust bladder filling protocol it has been possible to implement IMRT while maintaining small CTV-PTV margins.

BUS provides a quick, easy and reliable method for measuring bladder volume avoiding unnecessary repeat CBCTs, optimizing treatment times and patient experience.

O-040 Patient acceptability of clarity ultrasound image guided radiotherapy to the prostate

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Aims/objectives: The Clarity system is one of the most recent advances in image guided radiotherapy. The 3D ultrasound system has significantly improved the accuracy of target localisation for daily radiotherapy treatment. The technique addresses both the potential for movement following the original planning CT scan, as well as motion occurrence during treatment itself. In addition, the technique is non invasive and requires no further radiation to the patient.
The aim of this project is to assess whether the Clarity ultrasound system is acceptable to patients undergoing prostate radiotherapy.

Content: Between January and July 2015, patients undergoing prostate radiotherapy using the Clarity system were asked to complete a simple feedback questionnaire during treatment. The questionnaire asked patients to rate aspects of their treatment on a Likert scale. They could also provide further feedback in free text boxes.
25 patients completed the questionnaire and only 4% reported that the ultrasound procedure was either intrusive or uncomfortable. The majority of patients (88%) would agree to having a further prostate ultrasound in the future.

Relevance/impact: Alongside improvements and advances in radiotherapy technology, it is important to remember that a patient's experience during treatment is crucial to providing good quality care.

Outcomes/discussion: Image guided radiotherapy using the Clarity system is both acceptable and comfortable for patients. In comparison to other image guided techniques, it is neither invasive nor requires a further dose of radiation to the patient.

O-041 Image guided radiotherapy for prostate cancer using transperineal ultrasound

Serena Hilman; Ruth Smith; Helen Coomber; Petra Jacobs; Susan Masson
Bristol Cancer Institute

Aims/objectives: To describe our experience implementing Clarity Ultrasound™ (Elekta) as daily image guided radiotherapy (IGRT) for prostate only radiotherapy. We are utilising this to monitor interfractional motion.

Content: The prostate gland moves between fractions (interfractional motion) and during the radiotherapy fraction (intrafractional motion). This, and the impact of changes in bladder and rectal filling during treatment can lead to geographical miss and increased toxicity to organs at risk. Transperineal ultrasound (USS) allows soft tissue matching and is less invasive than inserting fiducial markers. It allows the visualisation of the prostate, penile bulb, symphysis pubis and assessment of bladder fill. There is no additional radiation exposure unlike with daily cone beam computerised tomography (CT) scans or kV imaging for fiducial markers. CT and USS images are acquired during planning and physics staff mark a reference positioning volume (RPV) within the clinical target volume. Radiographers use the RPV to perform a soft tissue match on set. Clinicans currently do not use the USS images for planning.

Relevance/outcomes: Radiographer training, audit and patient satisfaction surveys have confirmed this to be a clinically acceptable system. There is a 95% agreement with offline and on-line matching by radiographers to within < 3mm. Shifts exceeding 10mm have been seen, if they occur systematically for 5 fractions the patient has a repeat CT scan to assess prostate motion.

Discussion: This IGRT tool is now used daily and we hope to use it for intrafractional monitoring in the future.

O-042 Image-guided radiotherapy strategies for prostate cancer in the United Kingdom

Hemal Ariyaratne[1]; Hayley Chesham[2]; Roberto Alonzi[1]
[1]Mount Vernon Cancer Centre; [2]GenesisCare

Aim: To survey the technology and practice of image-guided radiotherapy for prostate cancer in the United Kingdom

Materials/methods: A pre-tested semi-structured online questionnaire was sent to NHS and private radiotherapy providers in the United Kingdom between March and April 2014. The survey was carried out using the Opinio online platform.

Results: There was a high survey response rate of 83%. Bladder preparation was similar across radiotherapy centres, but there was wide variation in bowel preparation protocols. There is widespread use of intensity-modulated radiotherapy and advanced verification imaging modalities. The majority of centres used 74 Gy in 37 fractions treatment regimen, with few doing dose escalation. Cone beam CT is the main verification imaging modality in radical prostate radiotherapy, used in 66% of UK centres. Fiducial markers in combination with imaging were used in 30% of centres. Over half the centres used daily imaging of some sort, with a day 1-3 followed by weekly frequency being the next common schedule. 26% of centres used daily cone beam CT.

Conclusions: There is widespread use of volumetric verification imaging with cone beam CT for prostate radiotherapy in the UK. Further research is required to determine the optimal verification schedules for prostate image-guided radiotherapy.

O-043 Dose fractionation of radical radiotherapy for prostate cancer in the UK

Chris Ball
The Clatterbridge Cancer Centre NHS Foundation Trust

Aim: To understand the variation by analysing the national radiotherapy dataset, RTDS.

Background: Recent results from the CHHiP Trial D. Dearnaley et al 1 which compared this standard to hypofractionated radiotherapy recommended the study regime of 55 Gy in 20 fractions over 4 weeks will change practice.
RTDS allows analysis of current radical dose fractionation and the reduction in attendances.

Methodology: For patient receiving radiotherapy between April 2009 and March 2015 episodes of radiotherapy were selected from teletherapy RTDS records by primary diagnosis of prostate cancer (ICD10 C61), by treatment site of pelvis, with curative intent to report the prescribed and given dose fractionation.

Outcomes: The results show the dose fractionation by provider and by overall activity.

Discussion: The results show that from 2014 to 2016, prostate cancer patients received radical radiotherapy intent with a dose fractionation regime of 20 or more fractions. With hypofractionation becoming the standard regimen the number of attendances will decrease in the UK.

O-044 Provision of site specialist therapeutic radiographers in the treatment and care of men with prostate cancer in the United Kingdom

Spencer Goodman; Sarah James; Charlotte Beardmore
The Society and College of Radiographers

Aims/objectives: The overall aim of the project was to describe the current situation in relation to the UK prostate specialist therapeutic radiographer (RT) workforce and to understand the specific nature and value of these roles. The support and development needs of practitioners were identified in order to create an online community forum and framework for collaborative practice with associated resources, opportunities for networking and future role developments.

Content: Exploration of a mixed methodology project comprising quantitative data collection from key stakeholders targeted at every cancer centre in the UK through an online survey, and qualitative data via workshops with identified individuals working in the field.

Ongoing work to support a growing workforce.

Relevance/impact: More men will receive radiotherapy treatment for prostate cancer than any other treatment modality. Integrated care across the whole patient pathway is crucial for ongoing development of service delivery and this project explores this across multiple stakeholders.

Outcomes: This project has demonstrated that prostate specialist RT roles are reliably in place in 18 cancer centres, mostly in England, and their numbers are increasing with comparative data available for other specialist roles

Discussion: Specific recommendations are proposed for stakeholders including prostate specialist RT's, radiotherapy service managers, professional and charitable bodies.

Sustainability for an online community developed for these roles.

O-045 The use of a comprehensive low fibre diet sheet to reduce the number of radiotherapy CT planning scan attempts for patients receiving radical radiotherapy to the prostate

Renita Pawaroo; Helen Corbishley; Ian Sayers
New Cross Hospital, Wolverhampton

Background: Patients receiving radical radiotherapy to the prostate are required to have a bowel volume of 4cm or less for their CT planning scan to reduce variation during treatment. This is difficult to achieve and some patients require numerous attempts before their bowel volume is correct.

Due to limited facilities, the use of daily microenemas is not possible therefore patients are advised to follow a low fibre diet and take daily laxatives. A comprehensive low fibre diet information sheet was created and trialled on a group of patients to investigate if its use could reduce the number of attempts.

Method: 24 patients followed a low fibre diet sheet 1 week prior to their CT planning scan, alongside taking a laxative (Group A)
Patients educated about following a low fibre diet and importance of bowel preparation
Number of CT scan attempts and bowel volume recorded for Group A and compared to a control group (Group B)
Patients completed a service evaluation questionnaire

Results: 74% of Group A successfully scanned within 2 attempts compared with 52% in Group B, t test performed not significant (p=0.312)
100% of patients found the low fibre diet sheet easy to follow and only 10% found it affected their daily life
79% of Group A found the clear explanation of the diet useful, 58% preferred an additional clinic appointment for this
Conclusions: Although not statistically significant there is a trend towards a benefit of the dietary advice that is consistent with our subjective assessment of their usefulness.

O-046 Concurrent boost technique in prostate IMRT under-treats significant proportion of PTV at periphery

Ananth Sivanandan; Georgina Walker; Santhanam Sundar
Nottingham University Hospitals NHS Trust

Introduction/relevance: The CHHiP trial supports the hypothesis the α-β ratio is low for prostate cancer and larger fractions of radiation have better cell kill. It follows the concurrent boost technique, which has become a standard of care in the UK, has a radiobiological flaw as the use of fraction sizes smaller than 2 Gy/fraction under-doses a significant proportion of PTV1 and PTV2.

Aims: To determine the extent of the PTV in patients in our centre treated with radical radiotherapy to the prostate receiving less than 2 Gy/fraction.

Methods: We audited the PTV volumes of patients treated with radical radiotherapy to the prostate over a 10-month period from April 2014 to February 2015. Patients selected were comparable to those in the CHHiP study. PTV1 received 60Gy, PTV2 71Gy and PTV3 74 Gy with PTV1- PTV2 receiving 1.62 Gy/fraction and PTV2 - PTV3 receiving 1.92 Gy/fraction.

Outcomes: 74 consecutive cases were eligible for analysis. We found median volumes of PTV1, PTV2 and PTV3 were 178cc (range 119 - 259), 126cc (range 68 - 229) and PTV3 76cc (range 36 - 144) respectively. Median percentage volume receiving 1.62Gy/fraction was 32% (5 – 54%) and 1.92Gy/fraction was 39% (33 – 61%).

Discussion: The results from our centre indicate a significant proportion of the PTV receives less than 2 Gy/fraction, which is at odds with the low α-β ratio of prostate cancer. We suggest adoption of a constant PTV rather than a shrinking PTV may alleviate the problem of concurrent boost.

O-047 Initial experience with the prone breast technique

Emma Orchard; Sarah Lambert
Peterborough City Hospital

Introduction: The prone breast technique is widely used in a number of departments worldwide but has not gained popularity within the UK. Locally, patients with large, pendulous breasts have previously been scanned with a bra to improve breast tissue coverage. This was found to be unreliable throughout treatment with images showing a large variation in breast tissue position. A service improvement was undertaken to introduce the prone breast technique after considerable research into its use elsewhere and a multidisciplinary working group established to finalise the method we wanted to use locally. To date, 3 patients have been successfully treated in the prone position.

Method: Patients were selected as suitable if the standard supine tangent field failed to cover breast tissue adequately or included >2cm central lung distance (CLD).
At CT patients were positioned on the Bionix Prone Breast System. Additional tattoos and alignment marks given to ensure reproducibility.

Daily CBCT for treatment and treatment times recorded.

Results: For all 3 patients the lung V12Gy was reduced considerably, for one patient 17.2% to 0.1%. The patient separation was reduced allowing 6mv plans to be delivered, PTV coverage comparable but reduced 105% in the prone position.
Treatment times recorded and comparable to standard supine technique and feedback from the radiographers suggests that with experience it is straightforward to deliver and tolerated well by the patients.
Conclusions: Our experience to date has shown the prone breast technique to be a successful solution for treating patients with large and pendulous breasts where conventional supine radiotherapy would lead to increased dose to critical structures.

O-048 Using 3D stereophotogrammetry to evaluate the stability, and positional accuracy of a breast immobilisation device

Keeley Rosbottom; Heidi Probst; Simon Choppin; Heath Reed; Andrew Stanton
Sheffield Hallam University

Developments in breast cancer radiotherapy require greater accuracy in patient positioning.

Aim: Testing the capabilities of a novel support bra to accurately reposition breast tissue and provide modesty.

Content: The usefulness of 3D stereophotogrammetry as a method for establishing immobilisation capabilities is addressed. Surface scanning images of twenty healthy volunteers wearing the prototype support bra are used to ascertain the repeatability of breast positioning over repeated bra fittings. How repeatedly breasts can be positioned within the bra is used to inform design modifications.

Impact: 3D stereophotogrammetry provides an opportunity for device testing and refinement ahead of patient testing; facilitating a smoother more effective design process. Greater reproducibility of breast tissue is paramount with modern breast irradiation techniques; a support bra may also dramatically change the patient experience by preserving dignity.

Outcomes: This exploratory study informed design developments before a clinical feasibility study. 3D stereophotogrammetry allowed quality measurements to be obtained which are difficult to obtain using traditional techniques. Positional movements of breast tissue (measured in mm) with repeated wearing of the bra, changes in breast shape and experiences of comfort while wearing the bra were assessed.

Discussion: 3D stereophotogrammetry is a new technique that could be adopted for evaluation of other immobilisation devices prior to clinical implementation. It reduces patient exposure during product development phases and may ensure a shorter clinical pilot testing phase, enabling refinement based on quantitative non-invasive data. The opportunity to evaluate public perceptions and preferences gives early insight to patient compliance.

O-049 A review of the immobilisation in patients receiving radical radiotherapy for lung cancer

Katie Bye Harris; Lauren Todd; Deborah Brown; Ruth McLauchlan; Danielle Power; Conrad Lewanski
Imperial College Healthcare NHS Trust

Radiotherapy is improving at a rapid rate and the need for accurate treatment delivery is vital. Radical radiotherapy aims to deliver a high dose to the tumour whilst minimising dose delivered to normal tissues. During four dimensional computed tomography (4DCT) planning, lung and tumour movement are accounted for, improving dose conformity and potentially reducing planning margins. Immobilisation plays an integral part in ensuring treatment position reproducibility. This review examines both accuracy and efficacy of using the CIVCO wing board to immobilise these patients.

A retrospective sample of 20 patients with a primary lung diagnosis was identified by clinicians at referral to receive a 4DCT planning scan. Patients were immobilised as per departmental protocol. Cone beam computed tomography (CBCT) and megavoltage portal images with the cine function was used for verification. Experienced observers reviewed the images and data was collected daily on treatment set up and performance status. The systematic and random errors in treatment set up for each group were calculated and results confirmed that the immobilisation is sufficient for our current margins.

All patients presented at different clinical stages with varying co-morbidities contributing to variance in the data. The results demonstrate that bony anatomy is not a good surrogate for confirming a gross target volume within the lung. The development of tumour lobe specific immobilisation with increased image guided radiotherapy may reduce the treatment set up error further. A plan to re-audit with improved immobilisation is underway.

O-050 Assessing set-up accuracy and reproducibility in breast cancer patients – one department's experience over 8 years

Ruth McLauchlan[1]; Katie Bye Harris[2]; Camarie Welgemoed[2]; Susan Cleator[3]; Pippa Riddle[3]

[1]Department of Radiation Physics and Radiobiology, Imperial College Healthcare NHS Trust; [2]Department of Radiotherapy, Imperial College Healthcare NHS Trust, [3]Department of Radiation Oncology, Imperial College Healthcare NHS Trust

In 2007, a set-up accuracy and reproducibility study was first performed in our centre for patients receiving radiotherapy for breast cancer in preparation for entry into the IMPORT trial. This identified some issues regarding immobilisation and staff training that were addressed and shown to be effective in a repeat audit the following year. As we have moved from a 2D planning technique to more sophisticated 3D optimisation and the use of breath-hold for suitable patients, we have repeated our set-up studies to ensure we obtain the maximum benefit of improved dosimetry.

Each study comprised a prospective review of on-treatment verification images. In the latest study this included separate groups of whole breast free-breathing patients, whole breast breath-hold patients, and chest-wall free-breathing patients to enable any set-up differences to be identified. All patients had MV portal images of the medial tangential field taken daily with the cine functionality used for the free-breathing patients to allow intra-fraction variation to be assessed. The portal images were compared with planning CT generated Digitally Reconstructed Radiographs and measurements of the following parameters were reviewed by a single, experienced observer: Central Lung Distance, Central Flash Distance, and Inferior Central Axis Margin. The systematic and random errors in treatment set-up for each group were calculated and demonstrated both an improvement over the previous study and agreement with published data.

Over the past 8 years we have ensured that improvements in planning technique have translated to patient treatment via thorough evaluation of our clinical set-up.

O-051 The influence of tumour location in the breast on boost modality selection

Elaine Reilly[1]; Colin Baker[2]; Maria Flynn[3]; Helen Mayles[4]; Andrew Reilly[1]

[1]Western Health and Social Care Trust; [2]Royal Berkshire NHS Foundation Trust; [3]University of Liverpool; [4]The Clatterbridge Cancer Centre NHS Foundation Trust

Background/purpose: To establish whether photon or electron beams provide better dose coverage to tumour bed sites in different regions of the breast.

Methods: 10 patient data sets were selected from a trial cohort, 2 patients each with tumour beds in one of 5 regions within the breast – Superior Lateral Quadrant (SQL), Superior Medial Quadrant (SMQ), Inferior Lateral Quadrant (ILQ), Inferior Medial Quadrant (IMQ) and the Central Quadrant. The dose to the whole breast treatment of 50Gy in 25 fractions was combined with a boost plan to the tumour bed of either photons or electrons with a dose of 16Gy in 8 fractions. Dose to the Planning Target Volume (PTV), lung, heart and breast tissues outside the tumour bed were assessed by using dose volume histograms (DVH).

Results: Tumours in the SLQ received better dose coverage by the photon boost plans. All other areas in the breast received comparable coverage with either photons or electrons. However electron coverage is dependent on surface contour regularity and tumour geometric shape. Lung and breast outside the tumour bed had consistently lower doses with photon boost plans. The heart doses were not consistently lower with either a particular modality of tumour position within the breast.

Conclusion: Electrons were a less favourable treatment modality for SLQ tumours, but either photons or electrons were suitable for treating tumours in other regions of the breast. Attention must be paid to the use of bolus for electron beams planned on irregular surface contours.

O-052 PROSPECT: Phase 2 rescanning of seromas in patients to evaluate CTV reduction in breast cancer

Gillian Smith; Peter W Robson
The Clatterbridge Cancer Centre NHS Foundation Trust

Aim: Single centre feasibility study to assess the reduction in sequential boost volume treated by rescanning patients during their final week of whole breast radiotherapy (WBRT).

Content: Patients requiring a sequential boost treatment who had a tumour bed seroma greater than 1cm on initial radiotherapy planning (RTP) CT scan were considered for entry into the study.
Thirty patients were sequentially recruited at the planning stage if they met this inclusion criteria. Patients were consented for entry into the trial and a second planning scan (RTP2) was conducted in their final week of WBRT. RTP2 scan was used to determine the volume treated for their sequential boost.

Impact: The CTV on both scans were outlined by the chief investigator and the CTV changes were annotated.

Outcome: 83% of patients had a substantial reduction in CTV (>25%) in RTP2 compared to RTP1. The mean CTV reduction overall was 41.9% with a median reduction 42.5%. Mean time between scans was 27 days; median time 29 days. Mean time from start of WBRT treatment to RTP2 was 14 days.

Discussion: This study shows that rescanning breast patients during the final week of WBRT leads to a significant decrease in treated boost volume in the majority of patients.

O-053 Febrile neutropenia rate in patients on adjuvant fec-d receiving primary G-CSF prophylaxis with docetaxel

Hannah Williams; Thiagarajan Sreenivasan
United Lincolnshire NHS Hospital Trust

Background: The efficacy of adjuvant chemotherapy with FEC-D (5-fluorouracil–epirubicin–cyclophosphamide followed by docetaxel) is superior to that with FEC-100 in node positive breast cancer. However, as the use of FEC-D increased, health care providers noted higher-than-expected toxicity rates and frequent early treatment discontinuations due to this. Local study showed an unacceptably high (35.5%) rate of febrile neutropenia (FN) requiring hospital admission following first dose of Docetaxel. Primary GCSF prophylaxis was therefore introduced for the Doctaxel arm of the regime in our institution from October 2012. In this study we have looked at the impact of this change in practice in reducing the rate of hospital admissions with FN.

Methods: Patients prescribed adjuvant FEC-D for node positive breast cancer within our centre form October 2012 to April 2015, where all retrospectively reviewed. They all received prophylactic G-CSF as standard. Information was collected from discharge summaries, chemotherapy charts, blood and microbiology online results.

Results: One Hundred and thirty four patients were included in the study, receiving this regimen. FN or neutropenia requiring admission occurred in 14/134 (10.4%). A reduction from 35.5% rate without G-CSF. Median days in hospital 4. Range 1-7. No death was related to treatment.

Conclusion: Introduction of GCSF primary prophylaxis for the Docetaxel arm of FEC-D regime has clearly shown significant reduction in rates of hospital admissions with neutropenia after Docetaxel. It is therefore a standard practice in our centre to use primary GCSF prophylaxis with both arms of the sequential FEC-D regime for patients with breast cancer.

O-054 Radiotherapy skin reactions: Assessment and management

Samantha Bostock
Gloucestershire Hospitals NHS Foundation Trust

Aims: To standardise the assessment and management of radiotherapy skin reactions across care settings over a wide geographical area.

Content: Having evaluated the use of a novel dressing in managing radiotherapy-induced skin reactions (RISR) it was identified that staff required education to recognise and treat RISR. Radiotherapy skin care varied widely across care settings. A range of patient and healthcare professional (HCP) documentation including an assessment and intervention pack were designed which adhere to Society and College of Radiographers guidance. RISR can be

challenging to dress due to the anatomical areas affected. A guide for fixing dressings on RISR in difficult to dress areas of the body was also created as a result of a multidisciplinary focus group.

Impact/outcomes: Using the Radiotherapy Oncology Group (RTOG) assessment criteria a guide for assessment and management of RISR was created and distributed throughout the author's health economy resulting in standardised care for patients receiving radiotherapy. It has also been adopted across other Trusts nationally. Presenting at conferences and study days ensured HCPs were aware of the new tool.

Discussion: By implementing a standardised approach to the management of RISR, staff knowledge is enhanced and the quality of patient care has improved. Patients are better informed and therefore more involved in their care outcomes by the provision of clear, relevant information. By educating HCPs involved at all stages of the patient pathway the effects of RISR can be reduced meaning patients do not have to face discomfort/pain or delayed healing relating to sub-optimal skin care regimes.

O-055 No ifs, no butts: Compliance with NICE guidance smoking cessation by providers of cancer therapies in the UK

Daniel Hutton[1]; Ivan Gee[2]
[1]The Clatterbridge Cancer Centre NHS Foundation Trust; [2]Liverpool John Moores University

Introduction: The introduction of the Health Act in England, coupled with the white paper Healthy lives, healthy peopleprompted many NHS trusts to adopt smoke free policies. Despite evidence that stopping or abstaining from smoking reduces acute sequelae and enhances the efficacy of treatment, there have been problems with engagement, compliance and enforcement.

Method/materials: A semi-structured questionnaire containing quantitative and qualitative elements was developed to audit compliance with NICE (PH48) guidance.

Results: 10 trusts reported that their hospital site was smoke free in practice. 47 trusts reported to be smoke free although only in theory. A third of respondents encouraged, those patients who did not stop smoking, to abstain for a period of time prior to treatment. One trust allowed the use of e-cigarettes inside the hospital. Very Brief Advice training was used by 44% of respondents. Over half reported having no smoking cessation training.

The reduced effectiveness of treatment in patients, who continue to smoke, if communicated, was communicated in the main verbally. The verbal message was supported by written information in less than a third of respondents. Given that patients understanding may be compromised by anxiety coupled with a lot of information it is considered good practice to provide the message in multiple formats.

Conclusion/discussion: Practice relating to smoking cessation varied significantly from policy and guidance.

This work identifies beacons of best practice in terms of smoking cessation support to better support patients and their families to abstain or stop smoking.

O-056 Opening up that "can of worms" to discuss sexual orientation and sexuality with lesbian, gay and bisexual cancer patients

Sean Ralph[1]; Steve Brown[2]
[1]The Clatterbridge Cancer Centre NHS Foundation Trust; [2]The University of Liverpool

Background: Previous research has identified that a significant number of lesbian, gay and bisexual (LGB) patients are having poor experiences of healthcare services as a result of their sexual orientation. A major source of frustration for LGB cancer patients are the constant assumptions of heterosexuality which are made by health professionals. 57% of LGB people surveyed at gay pride events in 2012 and 2014 think it is important for health professionals to know about the sexual orientation of patients; however, 57% of health and social care professionals surveyed by YouGov in 2014 don't consider a patient's sexual orientation to be relevant to their healthcare needs.

Aims: To enhance the cancer journey for LGB patients by:
Exploring the views and experiences of health professionals on discussing sexual orientation and sexuality with LGB patients.
Exploring ideas on how service improvement and advances in clinical practice can best be facilitated.

Methods: This study is inviting health professionals working with cancer patients to take part in an initial semi-structured interview. Following on from this some participants will then be invited to take part in a focus group to discuss the findings from the interviews and explore in more details how clinical practice might best be improved in order to enhance the cancer journey for LGB people.

Results/conclusions: This study is being undertaken as part of an NIHR CLAHRC NWC clinical academic research internship and will be completed by the end of February. Recruitment is still therefore currently ongoing.

O-057 Drinking protocols: Understanding why prostate patients may not comply

Leah Untisz; Amy Taylor
Sheffield Hallam University

Aims/objectives: To enhance accuracy and reproducibility of prostate radiotherapy, patients are required to adhere to a local drinking protocol throughout their treatment. Noncompliance however is often anecdotally reported and can impact not only the treatment accuracy and daily set-up variations, but also the working practices of radiotherapy department. The study aimed to identify possible barriers to protocol compliance, the results of which intended to aid changes in local practice to help improve patient compliance.

Content: The presentation will discuss the findings of a qualitative focus group (n=7) conducted at the authors department

Relevance/impact: Patients receiving radical radiotherapy often adhere to a local drinking protocol, ensuring a reproducible bladder size is maintained, this helps to reduce the amount of bladder and small bowel within the field. Improving compliance to such protocols can improve treatment accuracy; in turn this can reduce bladder related side effects.

Outcomes: The focus group identified a number of common themes perceived as barriers to compliance including lack of understanding, limited knowledge of hydration and a lack of involvement of family members and carers.

Discussion: The issue of compliance may not only be as simple as a lack of understanding towards the drinking protocol but as a consequence of other factors. A change in the way information is delivered should be considered along with the content included, such as addressing the necessity of hydration. The focus group aided the department to develop a visual aid and address other current practices.

O-058 Trainspotting

Lorraine Whyte
Beatson Cancer Charity

Cancer patients with addiction issues are a high risk group that require broader health care input, including health improvement & targeted interventions. We as therapy radiographers are not well equipped to deal with this patient group and require specialist education and guidance. However, there are no addiction specialists equipped to deal solely with cancer patients. It is the case that these patients' needs are not being met and there is an educational deficit.

A learning needs analysis was carried out amongst staff at the Beatson to assess whether there was a need for specialist education with regards to caring for patients with both cancer and addiction issues. The answer was a resounding yes.

Many unexpected issues were raised, especially from the teenage cancer trust and the use of Legal Highs amongst their patient group. The Trainspotting generation were also raised as an issue as people who are opioid dependent have an excess risk of a range of cancers compared with the general population.

Patients with cancer and addictions are an important group to look at when investing resources into patient support and staff education. Addiction specialists need a new evidence base and guidance when it comes to dealing with cancer patients in order to educate us effectively. In order to address this unmet need a conference has been arranged for Autumn 2015. This is a considerable task as sympathy is often very low for drug addicts, who may are deemed by some as unworthy of care or attention.

O-059 Enhancing the clinical learning environment for undergraduate therapeutic radiography students

Lynne Gordon; Paula Powell; Susan Murray
University of Hertfordshire

Aim/objective: By understanding the clinical demands on therapeutic radiographers, we can work together with the partners who provide clinical practice placements to ensure that appropriate opportunities are provided to enable student radiographers to develop their clinical skills.

Content: The purpose of this submission is to report on the findings of 3 consecutive annual surveys of therapeutic radiographers and students at our contracted practice placements in order gain an understanding of the placement experience. Survey data collected during the first semester of academic years 2013-14, 2014-15 and 2015-16 will be analysed in order to determine the perspective of participants on the strengths and weaknesses of the clinical placement experience and the learning opportunities they offer. This is a work in progress with final data collection due to complete in February 2016.

Relevance/impact: With the recent Government spending review expected to create change in the way health students (and therefore student radiographers) are recruited, it is likely that new initiatives will be developed that aim to increase recruitment and retention of students. Existing evidence has pointed to clinical placement experience being an important influence on recruitment and retention. This survey may provide a useful contribution to this body of evidence as well as informing our local educational provision.

O-060 An audit to evaluate the use of tablet computers in undergraduate radiotherapy student practice education

Sue Murray; Lynne Gordon; Paula Powell; Anthony Herbland
University of Hertfordshire

We aim to investigate how tablet computers can be used to enhance the learning of radiotherapy students while in clinical practice. The following secondary aims will be addressed:
1: Evaluate the use of the tablets by means of a diary-based audit of Link Lecturers and survey of students;
2: Data generated by educational technologists will aid understanding of the technical support required for the use of tablets in the clinical setting.

Staff have been asked to diarise their use of the tablets and the barriers/challenges to use. Findings related to clinical practice learning and teaching, administration, communication, technological support and programme delivery will be presented. Use of technology to support learning has been a recent theme in radiography research but has focussed on academic learning (Bleiker, Knapp & Frampton 2011; John-Matthews, Gibbs & Messer, 2013; Lorimer & Hilliard, 2009), therefore this research adds to the existing small body of knowledge. Although use of technology to enhance learning is commonplace in academic settings, no published research related to tablet use (or similar) in radiotherapy clinical education settings was found.

O-061 How does anatomy teaching influence a medical student's ability to interpret cross-sectional imaging?

Jill Christy[1]; Gill Barnett[2]; Li Tee Tan[2]; Richard Benson[2]; Sarah Jefferies[2]; David Noble[2]; Tilak Das[3]
[1]School of Clinical Medicine, University of Cambridge; [2]Department of Oncology, Cambridge University Hospitals NHS Foundation Trust; [3]Department of Radiology, Cambridge University Hospitals NHS Foundation Trust

Aims/objectives: To investigate the relationship between undergraduate anatomy teaching and anatomical knowledge, and confidence and ability to interpret cross-sectional imaging

Content: Results of an online questionnaire completed by 103 clinical medical students at our institution are presented. Students were asked to rank the contribution of different teaching methods to their knowledge and confidence in interpreting CT scans. They were then asked to identify 12 anatomical structures on CT images in an online quiz.

Relevance/impact: Understanding of cross-sectional anatomy is relevant to all trainees interpreting scans to assist in patient management and is a critical skill for radiotherapy planning.

Outcomes: 94% of students selected cadaveric dissection as contributing 'A Lot' to anatomical knowledge. Ward-based teaching was thought to contribute least. Dedicated radiology teaching sessions were ranked most useful in developing CT interpretation skills. The mean score for the CT anatomy quiz was 57% (range 17%-92%). There was

no significant correlation between increased years of study and higher scores (p=0.82) or increased confidence (p=0.65). There was no correlation between different teaching methods and quiz scores. However, there was a correlation between increased confidence and higher quiz score (Pearson's correlation coefficient 0.37, p=<0.001).

Discussion: The lack of correlation between ability to correctly identify CT anatomy and year of study suggests a need for improved methods of teaching cross-sectional imaging. Conclusions drawn from this study are limited due to the relatively small numbers. There is potential to expand this survey to include medical students in other universities and doctors of all levels.

O-062 The use of self-directed, group project work for teaching technical aspects of radiotherapy equipment to undergraduate therapeutic radiography students

Kerrie-Anne Calder; Mike Kirby
University of Liverpool

Aims/objectives: To demonstrate enhancement of student learning and engagement through successful use of group project work for technical aspects of radiotherapy equipment.

Content: Group project work forms a key element of teaching methods for our radiotherapy equipment module; in resonance with our philosophy of combining academic depth with relevant clinical practice. The cohort is divided into groups to research a relevant key subject area. In the academic setting, groups analyse the problem using PBL and mind mapping methods; strategizing and directing information collation, especially during clinical placement. When completed, the final group work is presented to class and edited by the lecturer prior to revision for the unseen written exam.

Relevance/impact: Learning and teaching with group project work is vital to developing deep learning experiences, tying together clinical scenarios with academic depth; a must for therapeutic radiographers in clinical practice.

Outcomes: Originally groups were chosen randomly throughout the cohort, now students at each clinical site research a particular topic – this has improved the evaluations having no negative comments regarding the group dynamics/ work. The technical focus has also changed to align with the oncology module studied concurrently, again resulting in positive comments. Marks achieved show a steady rise in maximum and mean marks for the group work.

Discussion: Developments have resulted in positive changes in results and evaluations; reduction of adverse comments through a continued philosophy of change and refinement to teaching strategies and maintenance of clinical focus on what is technically and content-wise a difficult and voluminous module.

O-063 PBL Accreditation for educators

Brian Hewitt
North Wales Cancer Treatment Centre

This poster was produced as part of the assessment component for my accreditation and entry onto the SCoR Practice Educator register. I chose to deal with the introduction of the student to & training in the use of the virtual simulation system. I had previously been undertaking student education in the workplace for over 10 years but had received no formal training in educational techniques. As my own most recent brush with formal education had been a number of years previously most of the principles and techniques were new to me and the notion of reflection was a mystery.

The learning outcomes described in the SCoR publication on practice educators are quite specific and these formed the basis for my work.

6.2.1 The Practice Educator should provide evidence that s/he is able to:

1. Describe the role and identify the attributes of an effective Practice Educator;
2. Apply learning theories that are appropriate for adult and professional learners;
3. Plan, implement and facilitate learning in the practice setting;
4. Apply sound principles and judgement in the assessment of performance in the practice setting;
5. Evaluate the learning experience;
6. Reflect on experience and formulate action plans to improve future practice.

When the time came to present my work I felt somewhat more confident. Since my participation on the course I have modified my approach to teaching. I now spend a lot more time with my students before we begin working within the clinical setting assessing their favoured learning style and try to alter my teaching accordingly.

O-064 The use of a virtual environment for continuous professional development in the training of deep inspiration breath hold (dibh) technique

Urvina Shah; Angela Williams; Michael Brown; Hema Shah
East and North Herts Trust

Radiotherapy techniques are accelerating rapidly and ongoing training is essential to maintain and develop knowledge. This presentation aims to demonstrate how a virtual reality tool can provide an effective, fun and alternative learning environment in order to gain the knowledge and skills of a new technique.

The training package consists of a workshop to include a virtual reality training tool, DiBH technique for breast radiotherapy with a comparison to the conventional method, discussion based on visual scenarios and multiple choice questions. It includes an introduction to DiBH, the equipment used, identification of chest anatomy, set up errors to problem solve and also decision making skills. CPD questions were also provided.
31 therapy radiographers attended the session between August and September 2015.

An evaluation questionnaire was completed to determine if this tool was effective in aiding learning and understanding technique. The results showed that 100% of trainees found the session useful, helpful and aided their learning through visualisation, revision and thought provoking and engaging scenarios.

Analysis of the data suggests the virtual reality teaching tool can enhance learning, influence decision making, improve knowledge and understanding. To this effect further training sessions will be held and evaluated within the multidisciplinary setting.

O-065 The implementation of advanced pelvic radiotherapy training for multidisciplinary professionals using a virtual reality environment

Angela Williams; Urvina Shah; Gregory Fury; Louise Codd; Michael Brown; Yat Man Tsang
East and North Herts Trust

Radiotherapy accelerates rapidly and ongoing training is essential to develop and maintain knowledge. This study aims to demonstate how a training package for advanced pelvic radiotherapy can be implemented in a mutidisciplinary setting using a virtual reality environment.

The training package consists of a virtual reality training tool (visual demonstration) and site specific workbooks (self filled questions). It includes identification of pelvic anatomy, review of different radiotherapy treatment planning and delivery techniques (conformal, static field intensity modulated radiotherapy and volumetric modulated radiotherapy), image guided treatment scenarios and radiotherapy related side effects.

Pre and post training questionnaires were complete by trainees by scoring their knowledge from 1 (not confident at all) to 10 (exceptionally confident). These were designed to assess the effectiveness of the training package in terms of the trainees' knowledge and decision-making skills in advanced prostate and cervix radiotherapy. An evaluation of the training sessions was also completed.

Between September and December 2015, 20 staff (14 therapy radiographers, 4 physicists and 5 clinical oncologists) attended the training sessions. All trainees found the session useful and appropriate for their level of experience. All would recommend the training package to their peers.

Using Wilcoxon signed rank test, significant improvements in scoring were found in all questions ($p<0.05$).

Analysis of the data suggests the virtual reality teaching tool can enhance learning, influence decision making, improve knowledge and understanding of cervix and prostate radiotherapy for radiographers, physicists and clinicians. To this effect, further multidisciplinary training sessions will be held and evaluated.

O-066 Perceptions of feedback in undergraduate diagnostic radiography and radiotherapy students

Bridget Porritt
The University of Liverpool

Aim: To investigate how a student defines feedback and how it impacts upon them as learners both in the academic and clinical practice environments.

Method: Qualitative approach using focus groups to capture the thoughts and experiences of undergraduate students. Dialogue is recorded and then analysed using i n order to establish key themes.

Results: Definitions of feedback vary greatly. As indeed does the student experience regarding the effectiveness and impact on student learning.

Conclusion: As educators we have to ensure our feedback practices are robust, enabling development of key skills and attributes in all our students. As future mentors and teachers, our students need to have an understanding of feedback processes, ensuring future students have a positive training experience.

O-067 Assessment of reproducibility of patient positioning using mask immobilisation on the Leksell Gamma Knife® Icon™

Miranda Edens; Ruth Smith
Bristol Haematology and Oncology Centre

Aims: To assess the reproducibility of patient positioning using mask immobilisation on the Leksell Gamma Knife® Icon™.

Content: A reference Cone Beam CT (CBCT) and a CBCT prior to treatment determine changes in patient positioning in terms of translation and rotation. This is corrected for by recalculating the bed position for each shot. GammaPlan® v11.0.1 computes the changes in dose distribution.
Eight mask patients had their translation and rotation errors between reference CBCT and initial treatment CBCT recorded. The mean and standard deviation of the set-up error were used to assess random and systematic variation of patient positioning. The impact of this correction regarding dose to tumour and OAR was evaluated on GammaPlan®.

Relevance: This study quantifies the reproducibility of this new technique and assesses the clinical impact of correcting for this set-up error on the delivered dose distribution.

Outcomes: Seven single fraction patients; mean (±standard deviation): translation x=0.3 (±0.8) mm, y=-0.1 (±0.5) mm, z=1.0 (±2.0) mm; rotation x=-1.1 (±1.8) °, y=0.3 (±1.5) °, z=-0.1 (±0.6) °.
One 25 fraction patient; mean (±standard deviation): translation x=-0.1 (±0.2) mm, y=-0.3 (±0.1) mm, z=0.5 (±1.5) mm; rotation x=0.2 (±0.8) °, y=-0.3 (±0.3) °, z=1.3 (±1.0) °.
Displayed doses to tumour and OAR typically changed by 0-0.2Gy (0-0.5% of tumour prescription dose) so treatment proceeded for all patients.

Discussion: Early results indicate the mask provides sufficiently reproducible patient immobilisation with no significant systematic set-up error. The mask is an appropriate fixation for stereotactic treatments. Further data will be presented at the meeting.

O-068 A comparison of the dosimetric merits of Leksell Gamma Knife® versus Radionics® X-knife

Louise Charlton; Christopher Herbert; Ruth Smith
Bristol Haematology and Oncology Centre

Objective: The relative dosimetric merits of the Leksell Gamma Knife and the Radionics X-Knife systems are compared.

Content: Differences in Gradient Index (GI), Paddick Conformity Index (PCI) and the volume of tissue receiving a minimum of 12 Gy (V12) are shown and their effects evaluated. Preliminary work studied ten patients with brain metastases treated using each system. The median dose for X-Knife patients is 16.5 Gy to the 50% isodose, and median tumour volume is 5.16 cm^3. The median dose for Gamma Knife patients is 20 Gy to the 50% isodose, and the median tumour volume is 4.03 cm^3.

Relevance/impact: Previous studies indicate that the risk of experiencing brain injury becomes significant when V12 exceeds 20 cm^3.

Outcomes: Initial results show that GI is comparable for both systems, with a mean value of 2.89 for X-Knife and 2.82 for Gamma Knife. V12 is also comparable for both systems. The median dose delivered to Gamma Knife patients is greater, which significantly benefits patients treated on Gamma Knife. The mean value of PCI for X-Knife is 0.61 compared to a mean value of 0.84 for Gamma Knife. Further results will be presented at the meeting.

Discussion: Gamma Knife treatment produces significantly increased conformity, demonstrated by having a higher PCI. The PCI for X-Knife patients shows no significant improvement with increase in tumour volume, however a significant improvement in PCI is observed with increase in tumour volume for Gamma Knife patients.

O-069 Radiotherapy plus concurrent and adjuvant temozolomide for glioblastoma multiforme: A 4-year case series

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Aims/method: Retrospective review to determine treatment outcomes for glioblastoma multiforme (GBM) patients treated in a UK centre from October 2009 to September 2013, with follow-up cut-off at October 2015. Kaplan-Meier survival curves were used. We also compared our outcomes against the benchmark Stupp study, as well as selected contemporaneous series.

Results: 70 patients underwent treatment with radical intent using radiotherapy plus concurrent and adjuvant temozolomide, as per Stupp regimen. 94% had ECOG performance status of 0/1. Nine (13%) patients were 70 years or older. Ten (14%) had biopsy only. Median time from decision-to-treat to starting treatment was 12 days. 94% received 60Gy/30#. 68 (97%) patients were alive post-chemoradiation. Of these, 22% received none, whilst 28% received 6 cycles or more of adjuvant temozolomide. 5 patients (7.1%) encountered grade 3/4 toxicity - all were haematological and died within 30 days of completing chemoradiation. Venous thromboembolism rate was 17%. Median and 2-year overall survival was 13.6 months, and 19.7% respectively. Median time to progression was 9.8 months. Of the 55 patients with documented relapse, 36 (66%) received further therapy, including surgery in 8/36.

Discussion/conclusion: MGMT molecular status was not routinely performed yet during this study period. Our treatment outcomes were comparable to the Stupp study. Patient selection criteria is important when comparing results with other series.

O-070 Time based ionometry for patient specific QA in multiple field IMRT

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Aims: Usual approaches to assurance in delivery in commissioned dose calculation and delivery systems are point-like or planar dosimeters of varying complexity and cost. The ionometric fluence (not dose) based approach presented uses a 1 litre air filled ionisation chamber and a fast electrometer to log current as delivery progresses to the phantom. It has potential to affirm consistency under non-fault indication in quasi-real-time like (retrospective) log file analysis, although measurement based and with useful tolerances.

Content: Although traceable dosimetry is a keystone of radiation therapy, geometric distribution of dose is paramount. IMRT and its precision are difficult to map onto a metric. Dosimeters are used with appropriate metrics, uncertainties and tolerances. In performing patient specific QA, often a subset of commissioning experiments is repeated, with the aim of traceable dosimetry. These experiments and their precise systems may include complexities of a similar nature to the original TPS system. The operation of ion chambers and electrometers are reasonably understood and in this work have been demonstrated to follow well reported function, such as ion recombination dependence on ion density.

Relevance/impact: This work sacrifices traceability in an attempt to bring measurement to bear on risk in IMRT by modeling the relationship between ion current and input geometry of radiation.

Outcomes: Whilst it does not yet permit traceable dosimetry, the data show linearity with MU as a function of beam aperture within a useful tolerance of a few percent. The simplicity of this approach exhibits resilience and reliability.