o001 **Feedback from students on the formative assessment process as well as their mentors' responsibilities: Presenting a novel evaluation tool**

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Background The Society and College of Radiographers showed attrition rates of 36.5% for therapeutic students between 2010 and 20111. Reasons for attrition vary but evidence suggests that unsatisfactory placement learning and support contribute to poor placement experience which can result in student withdrawal. Mentors are fundamental in providing learning opportunities and student support, however, opportunity to receive feedback on their performance from students is limited. To address this gap, a novel evaluation tool has been developed for use with students from the University of Hertfordshire (UH) so they can provide feedback on the formative assessment process and their mentors.

Purpose The formative assessment feedback evaluation tool was created as part of a prospective evaluative pilot study to determine mentor compliance with the assessment process and facilitation of positive student learning experiences. Second year students were invited to use the tool which resulted in 15 forms being collected over a 6 week placement. Data analysis informed amendments to the tool after which time use of this tool was made mandatory for all students. A repeat analysis of the amended tool has been conducted. Since then, use of the tool has been implemented by other departments affiliated with UH.

Summary Information from this novel evaluation tool has the potential to identify mentor training needs and examples of good practice. This can then be shared initially with all the other departments affiliated with UH and hopefully nationally. It also highlights any trends in the formative assessment process which may need to be addressed.

1. Colyer H. (2013) Improving retention of the radiotherapy workforce - the role of practice placements in student attrition from pre-registration programmes in England: executive summary and recommendations. Society and College of Radiographers.

o002 **The educational role of automated planning metrics feedback for radiotherapy student practical planning support: qualitative findings**

Mark Warren; Pete Bridge; Marie Pagett

University of Liverpool

Background: Student feedback is important in higher education; ensuring learning has taken place in both formative and summative assessments. In radiotherapy treatment planning education it is suggested that automated feedback derived from planning metrics software may develop performance and clinical-decision-making skills. This study reports student feedback related to use of automated feedback in their radiotherapy planning education.

Method: All 26 students on an undergraduate Year 2 radiotherapy planning module were invited to complete an anonymous questionnaire relating to the value of the automated feedback and plan evaluation tool. Thematic analysis of open responses was performed independently by two researchers via coding, collation of keywords and identification of conceptual themes. Results 16 students completed the questionnaire and 10 themes were identified from analysis of the 49 free text comments. Themes related to the planning process, goal setting, plan evaluation, assignment support, learning, speed and ease of use.

Conclusion: The data suggests that automated feedback is valuable to radiotherapy students with little radiotherapy treatment planning experience. Although these students find the automated feedback to be easy to interpret and act upon, other students clearly preferred to rely on tutor support. The findings suggest that automated feedback has a useful supportive role as part of a range of mechanisms within an educational environment.

o003 **The role of the research and development radiographer in implementing new technology and techniques within the radiotherapy department**

Karen Crowther

Belfast City Hospital

Introduction: Radiotherapy is one of the most potent and cost-effective curative treatments for cancer and the potential benefits from improvements in tumour control and reduction in toxicity are considerable.[1] Technical developments in radiotherapy can make a major contribution to this strategy. It is imperative that technical developments are introduced in a safe and robust manner. [2-5]The introduction must be carefully planned with thorough risk assessment, review of staffing levels and skills required, and documentation must be updated prior to implementation.[6]

Methodology: A multi-disciplinary group was formed who acts as an expert advisor and provides guidance and direction to the Radiotherapy Multi-professional Team and Senior Medical Staff Committee in identifying, prioritizing and implementing new and advanced radiotherapy technology and techniques. This group promotes a collaborative multi-disciplinary approach and the Research and Development Radiographer takes a lead role coordinating the group, ensuring projects are kept to the defined timelines while ensuring the implementation pathway is followed (Figure 1).

Results: All proposals for implementation of new technology are now formally presented to this group which ensures the proposal contributes to the Radiotherapy Department Research and Development Strategic plan. New techniques successfully implemented using this pathway are: Lung Stereotactic Ablative Radiotherapy (SABR); Prostate SABR; Deep inspirational breath hold; Prostate fiducial marker implantation clinic; and ExacTrac Imaging.
Conclusion: This group and the lead role the Research and Development Radiographer plays has enabled our centre to make great progress in recent years ensuring we provide a patient-centred, modern, safe and equitable, and research-driven radiotherapy service.

1) National Cancer Research Institute (NCRI). CTRad: national leadership in radiotherapy research. Achievements and Vision, 2014 2) The Royal College of Radiologists, Society and College of Radiographers, Institute of Physics and Engineering in Medicine. On target: ensuring geometric accuracy in radiotherapy. London: The Royal College of Radiologists, 2008. 3) Cancer Research UK and NHS England. Vision for Radiotherapy 2014–2024. 2014. 4) Independent Cancer Taskforce. Achieving world class cancer outcomes: A strategy for England 2015-2020. 5) Department of Health, Social Services and Public Safety. Service Framework for Cancer Prevention. 6) Donaldson, S.R. Towards safer radiotherapy. British Institute of Radiology, Institute of Physics and Engineering in Medicine, National Patient Safety Agency, Society and College of Radiographers, The Royal College of Radiologists, London; 2007.

o004 **CASPIR Trial: Interim analysis of prostatic calculi as an alternative to fiducial markers for IGRT**

Angela O'Neil

Queens University of Belfast

Purpose: To compare fiducial markers (FMs) with Prostatic Calculi (PC) as an aid to prostate IGRT. Preliminary results are reported.
Method: We designed a clinical trial investigating the feasibility of using PC as natural FMs. Patients planned for prostate radical EBRT +/- brachytherapy are eligible. Prior to CT planning, 3 gold fiducial markers are inserted trans-perineally under TRUS guidance. PC within the PTV are contoured. EBRT is aligned to FMs using daily CBCT. CBCTs are analysed in Eclipse (version 13.6). Random and systematic set-up errors are determined based on FMs, PC (where present), prostate gland (PG) and bony landmarks (BL). CTV-PTV margins are derived for each data set.
Results: To date 25 participants have been recruited. 12 participants have PC contoured, 6 of whom have completed radiotherapy. PTV margins required based on each reference structure are summarised in Table 1.
Conclusion: The maximum difference between the CTV-PTV(PC) margin and CTV-PTV(FM) margin is 1.3mm in the X or L/R dimension. This is less than the maximum difference between CTV-PTV(FM) and CTV-PTV (BL) for the same dimension (1.7mm). Preliminary results demonstrate some evidence to support the use of PC as an alternative to FMs for prostate IGRT. Recruitment continues with a target of 30 patients with PC

o005 **Harmonisation of molecular radiotherapy dosimetry between multiple centres for the SEL-I-METRY trial**

Rebecca Gregory [1]; Iain Murray [1]; Jonathan Gear [1]; Sarah Chittenden [1]; Andrew Fenwick [2]; Jill Wevrett [3]; James Scuffham [4]; Martha Stuffins [5]; Sofia Michopoulou [5]; Brian Murby [6]; Jill Tipping [6]; Steve Jeans [6]; Glenn Flux [1]; Jonathan Wadsley [7]

[1]Royal Marsden NHS Foundation Trust and The Institute of Cancer Research; [2]National Physical Laboratory; [3]The Royal Surrey County Hospital and National Physical Laboratory; [4]The Royal Surrey County Hospital and The University of Surrey; [5]University Hospital Southampton NHS Foundation Trust; [6]The Christie NHS Foundation Trust; [7]Sheffield Teaching Hospitals NHS Trust

The SEL-I-METRY trial is the first of its kind to implement molecular radiotherapy (MRT) dosimetry based on quantitative SPECT/CT imaging in a multicentre setting, to build the evidence base for radiation absorbed dose thresholds for successful radioiodine therapy of advanced thyroid cancer enhanced using Selumetinib. This MAP kinase inhibitor may be able to increase the uptake of radioiodine in patients previously refractory to radioiodine, providing a new treatment option [1]. In this trial an iodine-123 scan will be performed before and after 4 weeks of Selumetinib treatment. Patients that demonstrate enhanced radioiodine uptake (>30%) will receive radioiodine therapy alongside dosimetry measurements. Three to 4 iodine-123 SPECT/CT scans will be acquired to determine the dose that will be delivered at therapy. The patient will receive the standard 5.5 GBq iodine-131 therapy and undergo a further 3-4 SPECT/CT scans, to validate the predicted therapeutic dose. Whole body counting and dosimetry will be used to indicate the likelihood of toxicity. Sites participating in this trial will follow standardised procedures. Therefore doses measured at each centre will be comparable, to establish the dose thresholds for an optimised treatment regime. The SPECT/CT systems at each site have been set-up and calibrated for quantitative iodine-123 and iodine-131 SPECT/CT imaging using standardised protocols. The calibration factors and system capabilities varied between sites supporting the requirement for individual calibration of all systems. In this way the first network of centres able to perform MRT dosimetry measurements in a standardised way is being established in the UK.

*1. Ho, A.L., et al. (2013) Selumetinib-enhanced radioiodine uptake in advanced thyroid cancer. N. Engl. J. Med. **368**(7), 623-32.*

o006 **Can we influence the response rate to a research questionnaire?**

Nicola Rivington

Queen Alexandra Hospital, Portsmouth

Background The oncology team were asking patients to complete a questionnaire for research. With their agreement they were given it to complete at home and then asked to post to the chief investigator in a pre paid envelope. Accrual would be awarded to the department for completed questionnaires received by the Chief Investigator. This study examined the relationship, between the amount of time the researcher spent explaining both the study and the questionnaire to the patient and the response rate.

Method Three different members of staff approached the first breast cohort. Two clinicians in the outpatients clinic asked patients if they wished to help with a questionnaire survey. Extra time spent by the clinician was no more than two minutes. The third staff member gave them a detailed explanation of the study in a separate clinic room. Time spent was approximately 15 minutes plus time spent waiting for clinic rooms. The same method of detailed and brief explanation was used for the second prostate cohort. For this group, all communication was from the same staff member which would negate personality factors.

Results There was no significant difference in the number of questionnaires that were completed and returned between the two methods of approach.

Conclusion Proving there is no significant correlation between return rate and time spent by the researcher with the patient has large resource implications. For any Future similar studies the department will use the most time efficient approach knowing that it will not be detrimental to study uptake.

o007 **Radiotherapy patient experiences and perceptions of enrolling in clinical trials: a qualitative interview study to inform patient-centric best practice for enrolment**

Kim Meeking [1]; Lyndsey Kilgore [1]; Susannah Chapman [1]; Elaine Cooper [1]; Nicola Jarrett [2]

[1]*University Hospital Southampton;* [2]*University of Southampton*

Background: Less than 1% of cancer patients are recruited to radiotherapy clinical trials [1]. In a measure to improve this, national recruitment targets have been set for the first time [2]. There is a need to identify and address existing barriers to recruitment in order to increase participation [3]. Previous research has explored barriers to trial recruitment but research relating specifically to radiotherapy trials is scarce. This relevant and timely study seeks to understand the factors influencing recruitment to radiotherapy trials from the patients' perspective.

Method: This is a qualitative study using semi-structured interviews with approximately 20 patients who have received radiotherapy. Perspectives will be sought from a variety of radiotherapy patients; patients previously approached regarding a radiotherapy clinical trial, and patients naive to the experience of clinical trial participation. The interviews will be recorded, transcribed, and thematic analysis will be used to explore the data, and draw out relevant themes.

Results / Conclusion: To follow (results are expected in March 2017)

1. National Institute for Health Research Clinical Research Network. (2016) High Level Objectives Year End Performance Report - 2015/16. [Online] Available at http://www.nihr.ac.uk/about-us/how-we-are-managed/managing-centres/crn/our-performance.htm [Accessed 15th August 2016] 2. Bateman, A., Walters, J., Nicholls, A. (2016) CRN: Wessex Cancer Research Team Newsletter [Newsletter] Autumn 2016 ed. NHS National Institute for Health Research. 3. Cancer Research UK, (2014) Vision for Radiotherapy 2014-2024. [Online] Available at https://www.cancerresearchuk.org/sites/default/files/policy_feb2014_radiotherapy_vision2014-2024_final.pdf [Accessed 15th August 2016]

o009 **All of a twitter: the radiotherapy conversation in the digital age**

Kim Meeking

University Hospital Southampton

Background: Twitter is an online social networking platform with 15 million users in the UK [1]. Patients, healthcare professionals and healthcare organisations are increasingly turning to sites like Twitter to share information, to build networks, and to find support [2]. Previous research has shown that cancer patients tweet about all aspects of their pathway [3], but the needs expressed by patients or the purpose of the exchanged information has not yet been studied. The aim of this research is to determine the extent and purpose of radiotherapy-related messages posted on Twitter. Furthermore, to explore how social media research can contribute to improving the care and support of radiotherapy patients.

Method: This is a cross-sectional observational study using content analysis. 2000-3000 tweets relating to radiotherapy will be collected over one composite month. The dataset will be analysed with quantitative and qualitative methods to explore what is being said, by whom, and why.

Results/Conclusion to follow (results expected early April 2017)

1. Statista: The Statistics Portal (2016) Twitter: Number of monthly active users 2010-2016. Statista Inc. Available from: http://www.statista.com/statistics/282087/number-of- monthly-active-twitter-users/ [Accessed 15 June 2016] 2. Ventola C (2014) Social media and health care professionals: Benefits, risks and best practices. Pharmacy and Therapeutics, 39(7): 491-499 3. Tsuya A, Sugawara Y, Tanaka A and Narimatsu H (2014) Do cancer patients tweet? Examining the Twitter use of cancer patients in Japan. Journal of Medical Internet Research 16(5): e137

o010 **Developing a national guidance document for consultant radiographers**

Neill Roberts; Stella Campbell

SCOR Consultant Radiographer Sub Group

Introduction: Since the implementation of the Consultant Allied Health Professional Role in 2000, the development of the Consultant Radiographer post has taken a varied and inconsistent route. There is limited literature available regarding role development and appropriate job structure therefore the SOR Consultant Radiographer group felt it was now time for a more consistent approach with supporting documentation and guidance. According to the Department for Health (DoH), non-medical Consultant posts consist of four core domains of practice

1. Expert clinical practice.
2. Professional leadership and consultancy.
3. Education, training and development.
4. Practice and service development, research and evaluation.

Aims/Objectives:

* To provide a national guidance document for those new and established in Consultant Radiographer posts for imaging and radiotherapy, for use by clinical staff, service leads and academic staff alike.
* To contribute towards greater transparency in: the function, training, terms and conditions and governance of these posts.
* To promote interdisciplinary working and the Consultant Radiographer role more widely. **Discussion/Outcome**: A working party was formed from Consultant Radiographers representing a variety of disciplines and geographical locations. This group has written an 'all encompassing' document to meet the aims above, it explores all four core domains, explains the rationale for robust job descriptions and job plans, clarifies how to facilitate role development, with recommendations or requirements for trainees and touches on terms and conditions. Radiographers of all disciplines, commissioners, managers, multidisciplinary teams that interact with CRs, aspiring CRs and other healthcare professionals are the intended audience for this publication.

o011 **The impact of a departmentally developed PROMS baseline questionnaire for prostate cancer patients due to under go radical radiotherapy**

Gayan Chetiyawardana

Mount Vernon Hospital – The Hillingdon Hospitals NHS Foudantion Trust

Aim: Baseline function is important to differentiate between treatment related toxicity and disease symptoms [1]. An audit and discussion with the Society of Radiographer's (SOR) Prostate, Radiotherapy Information, and Support and Review Special Interest Groups (SIG) found that there was no national consensus of a flawless single validated toxicity tool, for assessing Genito-urinary, gastrointestinal, sexual function and androgen deprivation therapy toxicity [2]. Many departments, including our own, utilised modified toxicity tools or combinations of different questionnaires [2]. The opportunity was identified for a potential national consensus to develop a single fit for purpose toxicity tool and this was developed using feedback from multiple stakeholders including patients, urological specialist oncologists, the British Association of Urological Nurses (BAUN) and the British Society for Sexual Medicine (BSSM).

Method: A PROMS toxicity questionnaire was developed using modification and amalgamation from the commonly used validated toxicity questionnaires identified in the audit of the SOR SIGs. It's was decided to test the questionnaire in the baseline only setting first to test efficacy. The questionnaires were filled out during a pre-prostate radiotherapy group consultation in both guided and non-guided settings. Amount of support required in filling out the questionnaire, time taken and patient satisfaction were all assessed as primary end points through questionnaires carried out mid way through their radiotherapy treatment.

Results: Data still being collected at present.

Conclusions: Will be dependent on analysis of final data.

1. Pearse M, Choo R, Danjoux C, Gardner S, Morton G, Szumacher E, Loblaw A, Cheung P (2008) Prospective Assessment of Gastrointestinal and Genitourinary Toxicity of Salvage Radiotherapy for Patients With Prostate-Specific Antigen Relapse or Local Recurrence After Radical Prostatectomy. International Journal of Radiation Oncology Biology Physics. Vol 72 (3) p792-798 2.

o012 **An institutional audit to assess online image guidance for lower limb sarcomas**

Chaide Taylor [1]; Mark Warren [2]; Jacqui Parker [3]; Julie Stratford [3]

[1]*The University of Liverpool;* [2]*University of Liverpool;* [3]*The Christie NHS Foundation Trust*

Background: With the initiation of the IMRIS trial in the UK, increased confidence in set up margins is vital for radiotherapy for sarcoma of the lower limb. However, there are conflicting reports of the adequacy of small magnitude set up margins1 to adequately compensate for the overall set-up uncertainty. As a

Result, daily on-line imaging is usually recommended. This study aimed to investigate a less intense institutional strategy of on-line imaging, which allows for the offline correction of systematic error after the first three fractions and on a weekly basis thereafter, provided that discrepancies were below a 3mm action level.

Methods: A retrospective analysis of 30 patients was performed. Patient set up and correctional data derived from cone beam CT analysis was retrieved. The population systematic and random error was derived and planning margins calculated. The timing, frequency and magnitude of correctional episodes were evaluated.
Results: The required Planning Target Volume margin for the study population was 0.55cm, 0.41cm and 0.50cm in the lateral, caudocranial and anteroposterial directions. 20% of patients had no offline correctional episode over the duration of treatment, and 47% had one. The maximum number of offline correctional episodes per course of radiotherapy was 4, which occurred for 2 patients. 34% of episodes occurred within the first 5 fractions.
Conclusion: The required PTV margin for this population compares well with other published daily, online correctional strategies. A less intense online imaging strategy can therefore be used in conjunction with online image guidance to achieve small planning margins.
1. Dickie C, Parent A, Chung P, Catton C, Craig T, Griffin A, et al (2010). Measuring Interfractional and Intrafractional motion with cone beam computed tomography and an optical localization system for lower extremity soft tissue sarcoma patients treated with preoperative intensity-modulated radiation therapy. Int J Radiat Oncol, Biol Phys; 78 (5): 1437-1444

o013 **Hearing voices**

Lorraine Whyte, *Beatson West of Scotland Cancer Centre*

Introduction: The cancer story is changing...There is a new story for advanced cancer. Many people with incurable advanced cancer can live good quality lives with the right support...if a patient needs palliative Radiotherapy, we can be fairly certain that Radiotherapy is not all the patient needs (1). We as health care professionals need to be better educated and must acquire the necessary skills to provide us with the tools to support the "whole" patient. This qualitative research was carried out in order to improve our knowledge base and help us understand the experiences of our palliative in-patients here at the Beatson West of Scotland Cancer Centre.
Methods and Materials: Here at the Beatson we have a patient Wellbeing Centre where in-patients can take advantage of a number of contemporary, non-clinical spaces, quiet areas and a vast range of wellbeing and complimentary therapies. A survey was carried out to assess the positive effect the Wellbeing Centre had on the patient experience and a short film has been produced to showcase the voice of the patient, no-one else, just the patient.
Results: We have underestimated or forgotten that patient wellbeing, compassionate care and a holistic approach to healthcare are just so important and beneficial to patients. Significant learning has arisen from listening to the patients! This has directly influenced our often dismissive approach to complementary therapies and the holistic approach to patient care.
Conclusion and Discussion: There has been no standard approach to the way Holistic Needs Assessment are carried
1) Mackillop WJ (1996) The principles of palliative radiotherapy: a radiation oncologist's perspective. Can J Oncol. Feb;6 Suppl 1:5-11. 2) 2) National Cancer Survivorship Initiative (2013). National Cancer Action Team, Holistic Needs Assessment for people with cancer; A practical guide for healthcare professionals.

o014 **Compassion in healthcare: A concept analysis**

Amy Taylor [1]; Karen Collins [2]; Denyse Hodgson [2]; Melanie Gee [2]
[1]*Sheffield Teaching Hospitals NHS Trust;* [2]*Sheffield Hallam University*

Background The necessity to develop and subsequently utilise caring and compassionate behaviour within the healthcare workforce is central to radiographers' professional policy [1] and practice and is congruent with the core values of the NHS Constitution [2]. Cases of malpractice, poor care and neglect steered the Government to place compassion at the heart of its NHS strategy, and policies calling for improved compassionate care ensued [3-6]. However the policies provide limited definition and explanation of compassion, leaving the policies open to misinterpretation. Exploration and a contextual understanding was sought to refine the ambiguous, vague and often over-used term, compassion in healthcare.
Method Walker and Avant's Eight-step model [7] was used as the framework for the concept analysis. Data collection utilised a number of resources including online databases: Medline, CINAHL complete, Scopus, PubMed, PsycINFO, Science Direct, Cochrane and DARE; dictionaries, social media, internet sources, books and doctoral theses.
Results The concept analysis distinguishes the defining characteristics of compassion within a healthcare context, allowing for associated meanings and behaviours to be outlined aiding understanding of compassion. Compassion in healthcare requires five defining attributes to be present: Recognition, Connection, Altruistic desire, Humanistic response and Action.
Conclusion The findings identify the complexity of the term and subjective nature in which it is displayed and in turn perceived. The concept analysis forms the basis of further research aiming to develop a healthcare explicit definition of compassion within cancer care and radiography practices. Lucidity will enhance understanding, active engagement and implementation into practice.
1. Society and College of Radiographers. Code of Professional Conduct. 5th July 2013 2. The NHS Constitution for England. 26th March 2013. 3. Department of Health. Delivering high quality, effective, compassionate care: developing the right people with the right skills and the right values. England, Williams Lea for the Department of Health. 2013. 4. Department of Health. Education Outcomes Framework. England. 28 March 2013 5. NHS England. Putting Patients First: the NHS England business plan for 2014/15 – 2016/17 6. Department of Health. Compassion in Practice; Nursing, Midwifery and Care staff, Our Vision and Strategy. December 2012 7. Walker L & Avant K. Strategies for theory construction in nursing. Pearson Pretence Hall. Pearson Education. 2005

o015 **Mortality and survival differences between patients undergoing single and multi-fraction palliative radiotherapy - is there scope for optimisation of resource utilisation?**

James Price; Kirsty Clarke; Thomas Wolfe; Ewan Shawcroft; Santhanam Sundar

Nottingham University Hospitals NHS Trust

Background Palliative radiotherapy (RT) is becoming more technically complex and costly. The NHS is facing an unprecedented financial crisis and it is critical that our available resources are used in a cost-effective manner. We assessed for any survival benefit from multi-fraction palliative RT compared to single-fraction RT.
Method Patients undergoing either single- or multi-fraction palliative RT for all types of indications in all tumour sites over a 3 month at our institution were included in our analysis.
Results Table 1 details the median patient age (similar between the two groups), median total RT dose and median number of fractions. Dose per fraction ranged from 1.8Gy to 10Gy. Median overall survival was not different between the two groups.
On survival analysis by Cox regression, tumour site and histology were predictive of overall survival; but total radiation dose and dose per fraction were not. The hazard ratios for dose, number of fractions and dose per fraction were 0.956, 1.004, and 1.072 respectively.
Conclusion The lack of survival advantage for multi-fraction palliative RT suggests that prognosis is influenced by the biology of disease rather than radiation treatment modality. The appropriate use of highly technical radiotherapy needs accurate prognostication but the prediction of survival of cancer patients by radiation oncologists tends to be inaccurate[1]. Hence, lab-based prediction tools are needed to predict survival of patients undergoing palliative RT so that RT fractionation and the emerging complex palliative RT is used appropriately and cost-effectively in the palliative care of patients.

1. Chow et al. Int J Radiat Oncol Biol Phys. 2005 Mar 1;61(3):870-3

o016 **Curative radiotherapy in patients aged over 80, a single centre experience**

Anthea Cree; Ananya Choudhury; Richard Cowan

The Christie NHS Foundation Trust, Manchester

Background Half of all cancers are diagnosed in patients aged over 70 and the number of people in the UK over 85 years has increased to 1.5 million(1). In our centre, 10% of patients undergoing radiotherapy last year were over the age of 80. The aim of the study was to assess the tolerability of radiotherapy in this group.
Method All patients (82) over 80 years, treated with adjuvant or radical radiotherapy in January 2016, were identified, with a comparison group of 82 consecutive patients aged between 70-74 years. Details including demographics, tumour site, toxicity (CTCAE v4) and survival were recorded.
Results The median age of patient in over 80 group was 85 years (oldest 93).
In both groups radiotherapy was well tolerated with 81 (98%) of patients completing treatment.
With a median follow up of 313 days, there were 10 (12%) deaths in the 70-74 group and 12 (15%) in the over 80 group. 6 (7%) patients were admitted during treatment in over 80 group with only 1 (1%) in 70-74 group. Most patients who died had lung cancer. Cause of death was hard to establish although progressive disease or intercurrent illness was present in at least half of cases. In the over 80 group, early mortality was higher suggesting a possible relationship to radiotherapy.
Conclusion Direct comparison between the groups was not possible due to but radiotherapy appears to be reasonably well tolerated in the selected very elderly. Comprehensive geriatric assessment may improve patient selection(2).

1. Office for national statistics. Population Estimates for UK, England and Wales, Scotland and Northern Ireland: mid-20154. 2. Review of current best practice and priorities for research in radiation oncology for elderly patients with cancer: the International Society of Oncology (SIOG) task force I. H. Kunkler, R. Audisio, Y. Belkacemi, M. Betz, E. Gore, S. Hoffe, Y. Kirova, P. Koper, J.-L. Lagrange, A. Markouizou, R. Pfeffer, S. Villa On behalf of the SIOG Radiotherapy Task Force Ann Oncol (2014) 25 (11): 2134-2146

o017 **Better, quicker, safer - streamlined VMAT palliative radiotherapy at Newcastle's Northern Centre for Cancer Care**

John Byrne; Shahid Iqbal; Nick West; Neil Richmond; Audrey Ogilvie; Karen Pilling

Northern Centre for Cancer Care, Newcastle Upon Tyne

Current palliative treatment at NCCC, like most departments, uses simple parallel opposed pairs or single beams and a simple factor based calculation that estimates dose to a single point and ignores the presence of density heterogeneities. As a consequence, tumours, particularly in the thoracic region, often do not receive the prescribed dose and superficial tissues can receive significantly more. The process usually involves repeat attendance by the oncologist before the plan is complete. With modern planning tools and VMAT delivery there is now potential to quickly conform the prescribed dose distribution, reduce the plan preparation time and enable a quicker treatment delivery. In NCCC's pilot palliative pathway process, planners define the simple target volume and use Raystation to automatically create a VMAT plan that meets palliative-protocol goals. Automatic plan-QA scripts check that the steps meet the process requirements. The plan and prescription are approved in a single visit by the oncologist. Automating the planning process saves approximately 10 minutes per patient and involves only a single attendance in planning for the oncologist. On-treatment patient position is quickly verified with kV CBCT 3D-3D matching before patient treatment. Dose coverage is optimised, the dose distribution is accurately calculated, the need for manual MU check

calculations and manual data transcription is removed and staff time is used more efficiently. This approach will enable better correlation between prescribed dose and outcomes and will facilitate dose escalation or further hypofractionation for palliative patients.

o018 **Effect of minimum MLC leaf gap on plan quality and delivery accuracy in VMAT planning**

David Buckle; Emma Needham; Christine Lord; Colin Baker

Royal Berkshire Hospital

The minimum MLC leaf gap (MLG) in VMAT planning affects both the quality of the plan, and the accuracy of the predicted dose distribution[1]. The purpose of this study was to investigate the influence of MLG on a sample of treatment sites selected to provide a representative cross section of VMAT objectives. A mixture of 6MV and 10MV plans were chosen. All plans were planned in Monaco v3.3 (Elekta). Plans were created with MLG 0.5cm, 1cm and 2cm. Plan quality was assessed using Dose Volume Histogram (DVH) statistics, conformity index, number of segments and total Monitor Units (MUs). Accuracy of delivery was compared using a global gamma comparison (3%,3mm and 3%,2mm). It was found that, as expected, improved target coverage with better conformity is predicted as MLG is decreased; while MUs and number of segments increases. Gamma pass rate for simple treatment sites are generally excellent when planned with MLG 1cm and little benefit is seen above this, while reducing MLG was found to reduce gamma pass rate. For complex sites, it was not always possible to produce a clinically acceptable plan using a 2cm MLG. Good gamma pass rates were observed for plans produced with an MLG of 1cm, though there is more scope for plan improvement (by reducing MLG) than for simpler sites. As expected, the influence of the MLG appears to be more important for more complex treatment sites, however a setting of 1cm gives a good balance for the range of sites studied.

*1. Nithiyanantham, K et al (2014) Influence of segment width on plan quality for volumetric modulated arc based stereotactic bodyradiotherapy Reports of practical oncology and radiotherapy **19** 287-295*

o019 **Simulation of interplay effects in lung VMAT using dose deformation tools**

Frances Charlwood; Philip Whitehurst; Robert Chuter

The Christie NHS Foundation Trust, Manchester

Intra fraction motion induced by respiratory breathing can degrade intensity modulated treatments due to dose blurring, interplay and setup. To date, studies of tumour motion have mainly been limited to dosimetric verification with a variety of phantom measurements[1] and a couple of partial arc SBRT lung simulations[2,3].

Patients were scanned using a 4DCT respiratory gated system, binning data over 10 phases. To simulate respiratory breathing, sinusoidal motion was chosen and sampled over 10 equi-spaced points. Lung VMAT plans were created in Pinnacle^3 9.8 with the VMAT delivery split up into individual control points; monitor units were assigned to each of the 10 phases of the motion dependent on the amplitude, breathing rate and arc time. ITV amplitudes up to 1.3cm were considered. The starting breathing phase on the sine wave (for each fraction) was randomly generated.

The dose calculated on the average CT image was recalculated on each of the individual phases in Pinnacle^3 and exported to Mirada 1.6 (Mirada Medical, Oxford, UK). The individual phase doses were then individually deformed on to the midvent CT and weighted dependent on the assigned MU.

In conclusion the effect of breathing across all phases appears to wash out dose differences due the extremes of motion; ITV and CTV dose statistics for plans simulated with different amplitudes and breathing phases are within 1% of the original dose calculated on the midvent scan. The midvent dose statistics are within 4% of any given phase and 1% of the average.

*1. Jiang, S.B. et al. (2003) An experimental investigation on intra-fractional organ motion effects in lung IMRT treatments. Phys. Med. Biol. **48**(12) 1773-1784. 2. Zou, W. et al. (2014) Dynamic simulation of motion effects in IMAT lung SBRT. Rad. Onc. **9**225. 3. Li, X. et al. (2013) Dosimetric effect of respiratory motion on volumetric-modulated arc therapy-based lung SBRT treatment delivered by TrueBeam machine with flattening filter-free beam. J Appl. Clin. Med. Phys. **14**(6) 4370.*

o020 **Development of a simple single arc Elekta VMAT class solution for prostate treatments with hip prostheses using the Pinnacle TPS**

Alison Hand [1]; Michelle Sumner [1]; Michael Trainer [1]; Ananya Choudhury [2]; Philip Whitehurst [1]

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Background When treating patients with hip replacements it is common to use complex IMRT or multiple arc VMAT plans that avoid treating through the prosthesis, because of plan robustness and calculation accuracy issues[1-4]. In this study, our standard single arc prostate Elekta/Pinnacle VMAT class solution has been modified to reduce dose delivered through the prosthesis, simulating the use of avoidance sectors.

Method Twelve prostate patients with hip prostheses were selected. A sparing volume was produced using the intersection of an expanded prosthesis contour and a "rind" beneath the body surface. This volume was included in the optimisation parameters with a maximum dose constraint. Clinical assessment of plan suitability was completed by an oncologist. Robustness

to differences in prosthesis position was assessed by overriding the prosthesis to water-equivalent density and recalculating. Dose verification was performed by delivering plans to the OIS Delta4 phantom and to a PTW 2D array in the Octavius phantom.
Results All twelve VMAT plans were comparable to the original IMRT plans and acceptable in terms of target volume coverage and organ-at-risk doses (see figure 1(a)). All plans had a pass rate of >98% using 3%/3mm global gamma analysis in both verification phantoms and showed good robustness (see figure 1(b)).
Conclusion A single arc VMAT class solution has been developed that successfully delivers clinically acceptable prostate treatments. This simplifies the planning and verification procedure and allows prostate treatments to be standardised. This is achieved using a simple sparing volume and could easily be extended to alternate treatment sites.
1. Carolan, M. et al. (2000) Effect of hip prostheses on radiotherapy dose. Australasian Radiology, 44, pp. 290—295. 2. Peters, S. et al. (2014) A Treatment Planning Study Comparing Elekta VMAT and Fixed Field IMRT Using the Varian Treatment Planning System Eclipse. Radiation Oncology, 9, 153. 3. Rana, S. and Pokharel, S. (2014) A dosimetric study of volumetric modulated arc therapy planning techniques for the treatment of low risk prostate cancer in patients with bilateral hip prostheses. South Asian Journal of Cancer, 3(1), pp. 18—21. 4. Reft, C. et al. (2003) .Dosimetric considerations for patients with HIP prostheses undergoing pelvic irradiation. Report of the AAPM Radiation Therapy Committee Task Group 63. Medical Physics, 30(6), pp. 1162—1182.

o021 **Analysis of the dosimetric effect of seed-based prostate localisation on pelvic lymph nodes when treating high-risk prostate cancer with VMAT**

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Beatson West of Scotland Cancer Centre

Background Prostate movement is unrelated to pelvic lymph nodes (PLN) location. Therefore, for High-Risk Prostate Cancer radiotherapy, set-up corrections based on image-guided localisation of the prostate might not guarantee that the other nodal PTV receives the intended dose.
Method To evaluate the impact that couch shifts applied for prostate motion correction have on the dose delivered to the PLN, and to determine their ideal PTV margins: Retrospective analysis of 21 treatments using the interfraction prostate-based couch shifts as new isocentre coordinates in a verification plan. Then each fraction dose was recalculated and the dose coverage of the PLN CTV was assessed with DVHs. To reduce the geometric miss new PLN PTV margins were proposed using the Van Herk formula. Finally, treatment plans using current and proposed margins were compared based on the dose to OARs and PTVs.
Results The verification plans reported a mean PLN CTV D99% of 91.7% and this reduced between 4.8% and 9.0% ($p<0.001$) compared to the mean of the original plans. 51.3% of the verification plans did not meet the criteria, these showed a prostate vector displacement larger than 0.62 cm. The recommended margins: AP 0.91, SI 0.57, and RL 0.26 cm, reported no significant difference in the dose to OARs and PTVs compared to the current treatment plans margins.
Conclusions When daily position correction is made considering only the prostate there is potential dose degradation to the PLN. The proposed margins expect to improve its dose coverage, without significantly affecting the associated OARs.
*1. Adamczyk M, Piotrowski T, Adamiak E, Malicki J. Dosimetric consequences of prostate-based couch shifts on the precision of dose delivery during simultaneous {IMRT} irradiation of the prostate, seminal vesicles, and pelvic lymph nodes. Physica Medica. 2014;30(2):228-233. 2. Schallenkamp JM, Herman MG, Kruse JJ, Pisansky TM. Prostate position relative to pelvic bony anatomy based on intraprostatic gold markers and electronic portal imaging. International Journal of Radiation Oncology*Biology*Physics. 2005;63(3):800-811.*

o022 **A clinical evaluation of Varian smart segmentation software for the contouring of Organs at Risk (OAR) in radiotherapy treatment planning**

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Background: Varian Smart Segmentation® knowledge based contouring (SSKBC) software (version 13.6MR1) combines two auto-contouring tools, image intensity based (smart detection) and deformable registration based (propagation). Several studies have investigated the accuracy of generated contours however the aim of this study was to compare the structure generated by each algorithm to a reference to identify which algorithm optimally contours each OAR.
Method: In this retrospective study of 30 patient plans, the manually contoured OARs were used as a reference to compare the accuracy of the auto contours generated by each algorithm. Treatment regions included were head, thorax and pelvis. Each clinical plan was re-contoured using both algorithms. A quantitative appraisal of the automatically contoured structures with reference to the manually contoured structures was completed using the dice similarity coefficient (DSC) and centre of mass (CoM) shift.
Results: The mean DSC achieved by the smart detection and propagation algorithms were 0.79 (range: 0.41-0.98) and 0.77 (range: 0.3-0.96) respectively. The greatest shift in CoM was on average along the superior-inferior axis and were 0.44cm (range: 0cm- 3.2cm) for the smart detection and 0.58cm (range: 0cm-3.9cm) for the propagation algorithms. The smart detection algorithm created superior contours compared to the propagation algorithm for the brain and mandible, whilst the propagation algorithm created the superior contours for the eye structure. There was no significant difference between the two algorithms for the bladder, spinal canal and femurs.
Conclusion: This study concluded that for optimal contouring there should be organ-specific departmental guidance on which algorithm to use.

o023 **Using a TPS scripting interface to audit scanning practice**

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Worcestershire Oncology Centre

Background The Python scripting interface available in the RayStation treatment planning system enables efficient retrieval of data, making it possible to audit large volumes of patient data. In this work, data retrieved from RayStation has been used to assess acquisition and reconstruction fields of view (AFOV/RFOV) used for radiotherapy planning scans.
Method Data was retrieved for prostate and head & neck cases, covering a period of approximately 22 months. Scan data was used to deduce which AFOV was used (five discrete options). Minimum required AFOV and optimal pixel size (representing optimal RFOV) were calculated from maximum patient radius. The distributions of reconstructed and optimal pixel sizes were compared, as were discrepancies between AFOV used vs. required.
Results Reconstructed pixel sizes were >120% of optimal (i.e. too large an RFOV selected) in 50% of head & neck and 70% of prostate cases (n = 400, 109), with peaks at the AFOV limits (default RFOV sizes). A larger than required AFOV was used in 41% of head & neck and 31% of prostate cases.
Conclusion The peaks in reconstructed pixel size at AFOV limits suggest that the RFOV is often not optimised for the individual patient. Scans should also be optimised by using the smallest possible AFOV. Data retrieved via the RayStation scripting interface provides a valuable audit tool and assists in using departmental data to drive changes to practice. A future audit will assess the impact of refresher training in scan reconstruction.

o024 **Novel Minimal Point Volumetric Outlining and Editing Tools for Radiotherapy Treatment Planning**

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Purpose This novel application (1) uses emerging visualisation and modelling techniques to aid rapid manual segmentation of target structures. The tool uses a minimal point approach (2) across orthogonal planes to generate a mesh which is then edited across multiple slices using innovative 3D sculpting tools. This study aimed to compare bladder outlining times and volumes for the new tool with conventional manual outlining.
Methods and materials Participants were students undertaking their first planning module in a pre-registration University radiotherapy course; they first received bladder outlining training and at-elbow support from a tutor with each tool. Users were also provided with printed "gold standard" contours then when each user felt ready, they performed a timed outlining of the same patient. Users provided feedback on their preferred method and all contours were compared with a gold standard using DICE Similarity Coefficients (DSC) (3).
Results Comparison of times from the resulting 10 datasets showed a significant time saving with the new tool with a mean time of 11.9 minutes compared to 19.2 minutes (p = 0.03). The users expressed a preference for the new tool (8 users) and the mean DSC for both contour sets was identical.
Conclusions A minimal point 3D volumetric manual outlining tool demonstrated significant time saving for bladder segmentation compared to axial-based outlining within a group of novice outliners. Generated volumes were equivalent to gold standard with both outlining tools.

1. Bridge P, Fielding A, Pullar A, Rowntree P. (2016). Development and initial evaluation of a novel 3D volumetric outlining system. J Radiother Pract 15(1), 38-44 2. McBain CA, Moore CJ, Green MML, et al. (2008). Early clinical evaluation of a novel three-dimensional structure delineation software tool (SCULPTER) for radiotherapy treatment planning. Brit J Radiol, 81(968), 643-52 3. Zou K, Warfield S, Bharatha A, et al. (2004). Statistical validation of image segmentation quality based on a spatial overlap index: scientific reports. Acad Radiol. 11,178-189

o025 **Using in-house software for auditing and troubleshooting breathing traces for the real time positional management system**

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Background: RPM is used for providing respiratory breathing information for the reconstruction of 4DCT scans, or for the treatment of gated radiotherapy. The acquisition of these traces is not without complication and can lead to undetected errors if used incorrectly. A means of providing more insight and Quality Assurance (QA) of RPM traces was required.
Method: A tool (The RPM analyser) has been developed in Matlab V2012b to query the clinical RPM database for a selected patient and then analyse all of the acquired sessions. Two main objectives were to be addressed using the software; to provide meaningful interpretation of breathing trace information for 4DCT scans when artefacts were present in reconstructed images and to be used as a QA tool for RPM use across all sessions. The tool was used for a Deep Inspiration Breath Hold (DIBH) pilot study of 10 patients.
Results: The software works as an effective means for auditing practice shown during the implementation of DIBH. We have highlighted minor baseline shift issues on 6 of 157 sessions that were investigated and fed back to the staff involved. It also identified a procedural issue whereby incorrect reference traces were chosen for treatment on 5 occasions of 157.

Conclusion: The RPM analyser provides an effective means of auditing the use of the RPM within the local department, reducing time and increasing the likelihood of identifying clinically significant deviations in practice.

o026 **How useful is Elekta XVI large field of view?**

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Background Small or medium field-of-view (S/MFOV) cone-beam CT with Elekta XVI are routinely used for on-treatment imaging. Large FOV (LFOV) may be required to properly assess change (e.g. weight change) in larger pelvis patients, however little data is available regarding LFOV image quality, dosimetry, and usage.
Method Three phantoms (maximum diameter 30cm) were imaged using four LFOV protocols and a pelvis MFOV protocol for reference. High contrast spatial resolution (HCSR), low contrast visibility (LCV) and uniformity were compared; surface representation fidelity was assessed relative to CT scans.
Experiences of using LFOV were solicited via the medical physics mailbase. An audit of prostate patients in our centre was performed to estimate how frequently LFOV is required.
Results A 'rod' artefact was seen at isocentre and reported in 2/6 mailbase responses; LFOV uniformity was consequently poor (magnitude 80-480% vs. 20% MFOV). LCV and HCSR were similar for all protocols.
LFOV was used for soft-tissue matching in one centre and for contour only in one centre. Two respondents raised concerns about LFOV contour fidelity; phantom measurement error was ≤3mm except for the highest dose LFOV protocol (maximum error 11mm; additional artefacts seen at phantom edges).
Retrospective audit showed some patient volume outside MFOV in 50% of prostate cases.
Conclusion For a fixed-size phantom, LFOV and MFOV scans have similar HCSR, LCV & phantom contour uncertainty. However, the rod artefact decreases LFOV uniformity and may impair image matching around isocentre; clinical images are needed to assess this. Further work with larger phantoms may also be useful.

o027 **Assessment of Varian's auto beam hold feature: a phantom study**

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The London Radiotherapy Centre

Purpose: Assess the ability of Varian's Auto Beam Hold feature to identify fiducial markers in kV triggered images during volumetric modulated arc therapy (VMAT) treatment.
Methods: The CIRS dynamic thorax phantom was used throughout this study. Three gold fiducial markers (3mmx1mm) were implanted into a wax cylinder. This was inserted into the phantom. A VMAT plan was then delivered. Triggered kV images were acquired every 90 degrees of gantry rotation with the expectation that the software should locate each fiducial on the kV images; if the fiducial location is within a defined search region, treatment continues. Otherwise, treatment is paused. The phantom was initially aligned correctly. The VMAT plan was delivered multiple times, changing the diameter of the search region incrementally from 2.5cm to 0.5cm. The insert was then moved 1cm in the superior direction; again, the size of the search region was varied. This was repeated with the insert shifted 1cm in all other translational directions.
Results: When the phantom was correctly aligned, fiducials were identified, and treatment was delivered for all search region diameters. With the fiducials shifted, the software correctly identified the mismatch in the majority of instances, pausing the treatment correctly. However, when the image was acquired at an angle parallel to the shift, the software did not detect the error, so continued to treat.
Conclusions: Initial phantom studies suggest that intrafraction triggered kV images can be used to detect a change in fiducial location. However, the limitations of the approach much be taken into consideration.

o028 **Auto-contouring comparison between Mirada and SPICE for brain SRS patients**

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Purpose: To compare the auto-contoured structures created from Mirada RTx v1.6 (Mirada Medical, Oxford, UK) and Smart Probabilistic Image Contouring Engine (SPICE) (Philips Radiation Oncology, Andover, MA) for brain patients.
Method: An atlas was created using Mirada from 13 SRS Brain VMAT patients with clinician reviewed contours. This atlas was used to auto-contour 5 additional patients (on CT: 0.5mm axial resolution and 1mm slice thickness) using Mirada. These patients were also auto-contoured using SPICE within Pinnacle 9.10. The auto-contours from both were then compared to the clinician drawn contours using DICE and Distance to Agreement (DTA) metrics. The contours were additionally blindly assessed by clinicians for suitability.
Results: The contours for the brainstem, optic chiasm, eyes and optic nerves were analysed. There was no significant difference between Mirada and SPICE for all of the contours apart from the optic chiasm which showed significant discrepancies with both methods but Mirada was closer to the clinicians' contours. The DICE for brainstem was 0.84 and 0.81 for SPICE and Mirada

respectively in comparison to the clinicians' contours. The average DTA for the eyes and optic nerves was 0.82mm and 1.3mm for SPICE, and 0.81mm and 1.4mm for Mirada.
Conclusion: The auto-contours from SPICE and Mirada are comparable over the 5 patients that we have currently analysed. Initial analysis indicates that the eyes, optic nerves and brainstem auto-contours can be used to aid the contouring workflow but further work will be done to expand the sample of patients that the auto-contours are tested on.

o029 **Implementing and evaluating an Aria Island**

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Background: Treatment equipment at our hospital comprises 2 Tomotherapy units, 5 ageing Siemens units and 2 Varian True beam STx units The department is linked by Mosaiq oncology information system as the result of an upgrade to the previously installed LANTIS Siemens product. The remaining 5 Siemens linacs will reach end of life by 2018 and will require a planned programme of replacement. Thus the department at NCCC is currently undergoing a major equipment replacement programme.
Method: The future needs of the department were thoroughly evaluated. The legacy of ageing mismatched equipment has partly hindered the use of Mosaiq. As a result we are heavily paperbased. Any solution would have to include an ambitious paperlight project. Through multiple site visits, we evaluated a number of replacement equipment and software options.
Results: The decision was made to install an Aria "island" for evaluation purposes on the TrueBeams whilst leaving the rest of the department utilising Mosaiq. As a result we were able to start the implementation using a paperlight workflow from the beginning, in a controlled environment.
Conclusion: Having evaluated an Aria Island, we have been able to implement paperlight working, before a potential gradual roll out to the rest of the department. As part of the evaluation we be assessed the positive and negative aspects of the implementation in comparison with Mosaiq. We have also looked at issues associated with running a department with 2 R&V systems and how we have overcome this, by utilizing the best aspect of both

o030 **Performance differences between early- and late-model ArcCHECK devices**

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Background An investigation was undertaken at two UK radiotherapy departments to quantify differences in patient -- specific quality assurance results when using ArcCHECK devices of different ages. Devices manufactured after November 2014 have modified construction in order to comply with EU regulations.
Method At both departments, measurements were performed for a range of clinical VMAT plans with both old- (pre Nov. 2014) and new-style ArcCHECK devices. Results of gamma analyses for each plan were compared between the old- and new-style devices.
Results A clear pattern emerged; in the vast majority of cases, better gamma passing rates were obtained with the new-style devices. The greatest differences were exhibited for more complex head / neck and dual - arc plans, where gamma passing rates (3% local / 3 mm) were up to 15% higher with a new-style device.
Conclusion An application note from the manufacturer was released, acknowledging small differences in gamma passing rates between the two versions of ArcCHECK. However, the tests performed at the two departments show that the differences in gamma passing rates between the two versions are significant, and greater than indicated by the manufacturer.
Users of the ArcCHECK and other comparable devices are encouraged not to rely on manufacturer specifications, but to carry out full and detailed assessment of any new device before it is brought into clinical use. This investigation shows that the same advice applies even when commencing use of a second device that is nominally the same as an existing device.
1]Directive 2011/65/EU of the European parliament and of the council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast) [electronic version]. O J. 2011; L 174/88 - L 174/110 2]Low D A, Harms W B, Mutic S, Purdy J A. A technique for the quantitative evaluation of dose distributions. Med Phys. 1998; 25(5): 656 – 661. 3]Shi, J. Application Note #01-15: Differences Between Original and New ArcCHECK and Clinical Impact [electronic version]. Sun Nuclear Corporation, 2015.

o031 **An assessment of interfractional vaginal motion and the effect on clinical target volume to planning target volume margins for endometrial cancer using weekly cone beam computed tomography scans**

Clare Knee; Gemma Eminowicz; Edward Chandy; Edward Park; Katie Perkins

Imperial College Healthcare NHS Trust, London

Background; Acute and chronic side effects, especially gastrointestinal, can be reduced when patients with gynaecologic malignancies are treated with intensity modulated radiotherapy (IMRT) rather than conventional four-field arrangements. Due to the increased conformity of IMRT over conventional field arrangements it is essential to understand the magnitude of internal-organ motion. This ensures the safe application of IMRT through calculation of appropriate margins. The purpose of this study is to quantify vaginal movement for post-operative endometrial cancer patients and assess if our current departmental margins are adequate. **Method**; A total of 20 patients, each with at least 5 weekly cone beam computed tomography (CBCT)

scans acquired throughout their treatment, have been retrospectively reviewed. CTV vagina was delineated on each individual CBCT by at least 2 experienced clinicians and deviation from the planning CTV was measured in the anterior posterior, superior inferior and right left directions. Using these deviations from planning CTV a van herk calculation was performed in each direction to calculate the margin necessary to account for target motion.
Results; The results from this study will allow us to assess our departmental margins for endometrium cancer. Full results from this study are awaited.
Conclusion; Derivation of margins applicable to our department has allowed us to confidently deliver IMRT for this patient cohort.
1. Ahamad, A., D'Souza, W., Salehpour, M. et al. Intensity-modulated radiation therapy after hysterectomy: Comparison with conventional treatment and sensitivity of the normal-tissue-sparing effect to margin size. Int J Radiat Oncol Biol Phys. 2005; 62: 1117–1124 2. Jhingran A, Salehpour M, Sam M, Levy L, Eifel PJ. Vaginal motion and bladder and rectal volumes during pelvic intensity-modulated radiation therapy after hysterectomy. Int J Radiat Oncol Biol Phys. 2012 Jan 1;82(1):256-62. 3. Jürgenliemk-Schulz IM, Toet-Bosma MZ, de Kort GA, Schreuder HW, Roesink JM, Tersteeg RJ, van der Heide UA. Internal motion of the vagina after hysterectomy for gynaecological cancer. Radiother Oncol. 2011 Feb;98(2):244-8.

o032 **An audit evaluating repeat cbct due to variation in bladder and bowel preparation during prostate IMRT**

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Background/Purpose: kV-CBCT is routinely used to verify prostate radiotherapy and changes in bladder and rectal volume affecting the position of the target are seen. This leads to variations in PTV coverage which may contribute to treatment toxicity and biochemical failure. It is important to reduce rectal distension and minimize prostate movement and ensure this is reproduced during treatment.
Method: During a one month period all CBCTs for patients receiving prostate IMRT on one linear accelerator were examined. The departmental prostate radiotherapy Bladder/Bowel preparation and CBCT protocol were followed. Details of re-prep following CBCT analysis were recorded with explanation for this action
Results: 137 scan sets were acquired. 89.78% treatments were delivered after analysis of initial CBCT. 14 cases (10.22%) after CBCT acquisition patients were taken off the treatment couch; 3 due to urinary urgency; 11 with variation in rectal distension and/or bladder filling seen on CBCT (Figure 1).
Summary of results are in Figure 2.
The mean delay on the unit was 15 minutes (mins) (range 0-20); or 210 min per month/21 treatment slots; time from image acquisition to decision=3.21mins (mean) (range 1-6mins). Scheduled appointment to CBCT acquisition mean= 7.6mins (range 1-18mins)
Conclusion: This small sample highlighted important issues with this patient population. Patient compliance with preparation and consistent re-prep instructions are important. The increasing demand for IGRT will continue to have an impact on Linac workflow. CBCT planning studies are necessary to discover what benefit to the delivered dose re-preparation has and evaluate if the time taken is justified

o033 **The impact of intra-fractional bladder filling on adaptive bladder radiotherapy**

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Aims: To assess the effect of intra-fractional bladder filling on adaptive bladder radiotherapy and investigate whether current departmental adaptive bladder treatment-planning margins and plan selection options are appropriate.
Method: A retrospective audit was carried out on 38 pairs of pre-treatment and post-treatment cone-beam computed tomography scans (CBCTs) from 20 adaptive bladder radiotherapy patients. The bladder was contoured on pre and post-treatment CBCTs to quantitatively analyse the differences in bladder volume and bladder wall expansion over the treatment fraction. Treatment time was established from acquisition of pre-treatment CBCT and post-treatment CBCT. Non-parametric Spearman's Rank correlation test was conducted to investigate if there was a relationship between intra-fractional bladder filling and treatment time.
Results: A variety of intra-fractional bladder filling and bladder wall expansions were observed. Mean intra-fractional filling volume was 10.2cm3(standard deviation(SD)=7.1cm3;range=0.3-26.9cm3). Average treatment time was 8.9 minutes(SD=1.8mins;range=6.5-13.6mins). Intra-fractional bladder filling resulted in expansion of the bladder predominately in the superior and anterior directions with mean translations 2.5mm(SD=1.9mm;range=0-6mm) and 1.5mm(SD=1.4mm;range=0-5mm) respectively. An increase intra-fractional bladder filling was associated with an increase overall treatment time (rs=0.323, p=0.048). All plan selection options chosen adequately covered the bladder target volume.
Conclusions: Despite the effect of intra-fractional bladder filling, current use of the adaptive bladder treatment-planning margins and decision-making for all plan selections sufficed. All treatments were delivered within an appropriate time-frame for the hospital department. Due to limited expansion of the bladder wall laterally, consider reducing the lateral margin requirement if a more conformal plan could be selected whilst minimising dose to normal tissue.

o034 **Implementation of RTT led 'plan of the day' adaptive radiotherapy in cervical cancer**

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Mount Vernon Cancer Centre – East and North Herts NHS Trust

Purpose: Plan of the day (PoD) ART for cervical cancer patients can potentially reduce toxicity and the risk of geometrical miss but may be resource intensive. In order to implement accurate PoD for these patients this study aimed to assess the accuracy of adaptive online plan selection and linac resource impact.

Methods: An initial patient cohort had planning CTs acquired with an empty and full bladder and an intermediate MRI. CTVs were outlined on each of the datasets to include uterus and proximal vagina, from which an ITV and PTV were defined with further nodal volumes as required. VMAT plans were created depending on the amount of uterine movement, with a further plan using the previous standard technique as a backup.

Online daily CBCT was performed for all patients with additional kV planar images used for nodal positioning in one patient and for pelvic tilt in another. Plan selection following online registration using a combination of bony anatomy and soft tissue was performed by 2 members of the project team (observers) who had attended an anatomical training session and had a range of experience with female pelvic CBCT analysis. A 3mm margin between the visible target anatomy and the PTV contour was allowed for intrafraction motion. This was assessed through the addition of weekly post-treatment CBCTs. In-room time (patient enter to exit) was recorded at each session and patients were booked into the departmental 20 minutes time slot for ART.

A consensus standard PoD was agreed offline by an experienced clinician and RTT. Offline analysis was performed to measure concordance with the consensus standard PoD and the online decision.

Results: A total of 100 online PoD evaluations plus 600 offline evaluations, by 6 observers, were used for the analysis. The median concordance between the consensus standard PoD and the online plan selection was 98%. Where poor concordance was observed between online plan selection and the consensus standard PoD, a safe larger volume option was chosen online. Post-treatment CBCT's showed target anatomy was covered in all but 1 case. In-room timing ranged from 10 – 30mins with a median time of 19mins. The median score of the 4 observers offline compared to the consensus standard was 86%. The range between individuals was 76%- 96% and between patients was 78 – 96%.

Conclusion: High online concordance of 98% with the consensus standard PoD demonstrates that the initial training equipped the team with appropriate knowledge to perform accurate plan selection. A combination of 2 observers online achieve closer results to the consensus standard rather than individually. The joint decision making can be performed within the standard departmental ART time slot of 20 minutes. The CBCT data, consensus standard PoD and anatomy training can be used as part of the assessment programme for future RTT observers. Greater confidence in choosing smaller volume plans needs to be built to achieve the full potential of ART.

o035 **A critical review of ovarian preservation techniques for female pelvic radiotherapy.**

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Introduction: Recent advances in treatment have increased long-term survival of young, female cancer patients; unfortunately these treatments bring a significant risk of ovarian failure and infertility. This literature review evaluates techniques for ovarian preservation in pre-menopausal women receiving pelvic radiotherapy. Methods include conventional (surgical transposition) intensity modulated radiotherapy and other emerging techniques aiming to minimise ovarian dose.

Methods: A critical review of the evidence pertaining to pelvic radiotherapy and ovarian sparing was performed. Evidence was subjected to critical appraisal using the CASP tool and thematic analysis of the findings identified key issues.

Results: Surgical transposition appears to be a successful method of preserving ovarian function (1-2) depending on the position of the ovaries outside of the radiation field (1), the age of the patient and the total dose received by the ovaries. There is limited modern evidence concerning its usage in relation to emerging techniques and technology. The use of IMRT is certainly widespread in the treatment of female pelvic cancers, however, there is limited evidence (3-4) supporting its use for reduction of ovarian dose. Several other studies (5-6) have attempted to demonstrate new techniques to preserve ovarian function but no functional outcome measures have reinforced their results.

Conclusions: Ovarian transposition has a proven track record for preservation of ovarian function but the potential value of IMRT as a viable alternative to date remains unexplored. New work should be encouraged to determine the potential value of IMRT as a non-surgical alternative.

1. Chambers S, Chambers J, Kier R, Peschel R. Sequelae of lateral ovarian transposition in irradiated cervical cancer patients. Int J Radiat Oncol Biol Phys 1991; 20(6): 1305-1308 2. Morice P, Juncker L, Rey A, El-Hassan J, Haie-Meder C, Castaigne, D. Ovarian transposition for patients with cervical carcinoma treated by radiosurgical combination. Fertil Steril 2000; 74(4): 743-748 3. D'Souza D, Rumble R, Fyles A et al. Intensity-modulated Radiotherapy in the Treatment of Gynaecological Cancers. Clin Oncol 2012; 24(7): 499-507 4. Fiorino C, Valdagni R, Rancati T, Sanguineti G. Dose-volume effects for normal tissues in external radiotherapy: Pelvis. Radiother Oncol 2009; 93(2): 153-167 5. Oktay K, Bedoschi G Oocyte Cryopreservation for Fertility Preservation in Postpubertal Female Children at Risk for Premature Ovarian Failure due to Accelerated Follicle Loss in Turner Syndrome or Cancer Treatments. J Pediatr Adol Gynec 2014; 27(6): 342-346 6. Lee C, Bilton S, Famigliettie R et al. Treatment planning with protons for pediatric retinoblastoma, medulloblastoma, and pelvic sarcoma: How do protons compare with other conformal techniques? Int J Radiat Oncol Biol Phys 2005; 63(2): 362-372

o036 **Choice of CT reconstruction algorithm and the affect on radiotherapy treatment plan dose calculation; what level of Hounsfield unit (HU) change is acceptable?**

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Background: The selection of different reconstruction algorithms can change Hounsfield units in CT scans. This work determined the level of HU change which can be tolerated if planning dose change is to be kept within 1%.
Method: Five planning CT scans (2 head and neck, 1 prostate and 2 lung) were acquired on a Toshiba Aquilion LB scanner. Each was reconstructed using four CT reconstruction algorithms. HU values for bone, soft tissue and air were measured on all scans. Treatment plans (IMRT or VMAT) were produced using a Pinnacle system (version 9.6) with either the Collapsed Cone Convolution or Adaptive Convolve algorithms. For each patient, a single treatment plan was applied to the four different reconstructions. The dose levels at defined points within the plans were noted. The levels of HU change and planning dose change were compared.
Results: 15 plans were compared against 5 baseline plans with default reconstruction algorithm. HU difference was: -51 to + 35 for soft tissue, -58 to +33 for air, -34 to +142 for bone. Dose change was -2.2% to +1.0%. Where HU change was within +/-20 for soft tissue and +/-50 for bone and air, planning dose change was within 1%.
Conclusion: Changes in HU of +/- 20 for soft tissue and +/- 50 for bone and air are likely to cause <1% change in calculated dose in radiotherapy treatment plans.

o037 **Evaluation of non-uniform backscatter correction of aS1000 EPID for in vivo dosimetric verification**

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Background: EPID-based patient dose verification had been widely discussed and yet to be the key topic of interest to avoid dosimetric errors**[1]**and protocols for in vivo verification is practically demanded**[3]**. In this presentation, we emphasized on the commissioning and implementation of the commercially available Dosimetry Check (DC)**[2, 5]** system to address the significant of non-uniform backscatter effect from the VARIAN aS1000 EPID support arm**[4, 7]**.
Method: A backscatter correction matrix was developed by combination of dosimetric information from a set of segmented fields sampling on different positions around the active area of the imager. The matrix was then used to correct raw EPID images and create corrected images in DICOM format while export them to Dosimetry Check (DC) to read and analyse. The same planned fields were generated in Oncentra MasterPlan, OMP subsequently to obtain several comparative dosimetric assessment between TPS and DC.
Results: By using the correction; **(i)**overall agreement between fields generated in OMP and those recorded in DC improved from more than 3% to better than 1%, **(ii)** agreement between OMP and DC for IMRT dose profiles with a sample Head & Neck case was improved by approximately 3%, **(iii)**pass rates of 3%/3mm gamma criterion**[6]** verified by DC were improved from around 80% to around 90%.
Conclusion: The correction method implemented herein for the DC system has proved to be an effective way to reduce verification inaccuracy caused by backscatter from the Varian EPID arm as well as enhancing the previously established portal verification method for IMRT.

1. *Towards Safer Radiotherapy. 2008, Royal College of Radiology: London.* ***2.*** *Dosimetry Check Software. 2011-2016 2016; Available from: http://www.osl.uk.com/DC.* ***3.*** *Donaldson, S.L., On the state of public health: Annual report of the Chief Medical Officer 2006 2007, London Department of Health.* ***4.*** *Joseph, A.M. and V.S. Jeffrey, 2005, Verification of the optimal backscatter for an aSi electronic portal imaging device. Physics in Medicine and Biology. 50(10): p. 2341.* ***5.*** *Renner, W.D., K. Norton, and T. Holmes, 2005, A method for deconvolution of integrated electronic portal images to obtain incident fluence for dose reconstruction. J Appl Clin Med Phys. 6(4): p. 22-39.* ***6.*** *Spezi, E. and D.G. Lewis, 2006, Gamma histograms for radiotherapy plan evaluation. Radiotherapy and Oncology. 79(2): p. 224-230.* ***7.*** *Van Esch, A., et al., 2013, Optimized Varian aSi portal dosimetry: development of datasets for collective use. 2013. Vol. 14. 2013.*

o038 **Implementation of transit in-vivo dosimetry for treatment verification in a new radiotherapy service**

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Background: A transit in-vivo dosimetry system was implemented using the Electronic Portal Imaging Device (EPID) to verify safe treatment delivery in a new radiotherapy service.
Method: The commercial product SNC PerFraction was selected because of its fully automated workflow and collapsed-cone dose reconstruction. The treatment beam is captured after it has passed through the patient and the integrated image back-projected to determine the dose distribution delivered to the patient. This provides spatial dosimetric information which cannot be obtained with more traditional methods. Treatments were performed using Varian TrueBeam linacs with aS1200 EPIDs. A completely independent calculation is performed using a generic linac model that is fine-tuned using local calibration data and CT-electron density curves. 3D analysis protocols were established for VMAT, IMRT and 3D conformal treatments that closely reflected planning criteria for the targets and OARs. Transit dosimetry was undertaken for all fractions (n=43) of the first cohort

of prostate patients. Dose was calculated on the planning CT dataset, allowing comparison of DVHs for each fraction against the planned DVH.
Results: The average point-dose difference from the planned reference dose was 0.9±0.8%, with an average gamma pass-rate of 99.94±0.06% at 3%/3mm. DVH comparisons and protocol goals indicated close agreement with planned clinical goals. EPID measurements had negligible impact on treatment workflow or delivery times.
Conclusion: Transit dosimetry gives confidence of safe delivery of radiotherapy. Visualisation of treated dose distributions stimulates clinical engagement. Full automation encourages routine adoption, facilitating an adaptive workflow with recalculation on daily CBCT images.

o039 **In-vivo EPID transit dosimetry using an in-house and a commercial system for radical and palliative radiotherapy**

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Edinburgh Cancer Centre

Background In-vivo transit dosimetry (IVD) can be a useful tool for error detection in radiotherapy [1]. A commercial system (Dosimetry Check (DC), MathResolutions) has been in use at the clinic since 2011 to perform IVD for radical treatments. However, DC cannot be used on plans without a volumetric dose calculation (usually palliative), for which a simple in-house system has been developed.
Method A simple transit dosimetry system has been implemented to calculate the delivered dose at the prescription point using a measurement from an integrated EPID image. The calculation uses a table of transmitted intensity per unit midplane dose for a range of water separations and field sizes, similar to the approach described by Piermattei et al [2]. Work is ongoing to use scripting to integrate the IVD within the Oncology Information System.
Results Initial phantom testing showed that the in-house system to have a measurement accuracy of -0.4%±2.5%, with DC giving -2.3%±4.1% (1SD, comparison with TPS). From April to December 2016, 802 clinical fields were measured with the in-house system, with a mean measured dose versus the prescription of -1.4%±5.2% (1SD). The current mean difference for DC vs TPS is -1.9%±4.5% (1SD, >3500 plans). Results categorised by site are also available for both systems.
Conclusion These results show that the in-house method has the accuracy required to detect gross errors and anatomical changes in palliative patients where 3D plans are not available. It can complement the use of commercial systems and allow transit IVD for all plans.
[1] Bojechko et al., A quantification of the effectiveness of EPID dosimetry and software-based plan verification systems in detecting incidents in radiotherapy, Medical Physics 42, 5363 (2015); [2] Piermattei et al., Application of a practical method for the isocenter point in vivo dosimetry by a transit signal, Phys. Med. Biol. 52, 16, 5101, (2007).

o040 **Impact of 18F-Choline PET scan acquisition time on delineation of GTV in Prostate cancer**

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Background: Dose painting radiotherapy requires accurate outlining of primary tumour volumes in the prostate. MRI is considered the best imaging method for delineating the GTV. The role of Choline PET is uncertain and image acquisition differs between published studies. One study found that 18F-Choline PET/CT with late image acquisition has superior accuracy to MR imaging alone. We investigate whether increasing 18F-Choline PET scan acquisition time from 60 (PET-60) to 90 (PET-90) minutes improves GTV target volume delineation.
Methods: Analysis was performed on 9 18F-Choline PET scans. Three clinicians (C1, C2 and C3) independently contoured GTVs on MRI and PET scans acquired at 60 and 90 minutes (PET-60 and PET-90). The treating clinicians (C1) MRI contour was used as the reference GTV. Scans were registered using rigid co-registration. Analysis was performed on PET-60 and PET-90 scans. Dice Similarity Coefficient (DSC), Specificity (Sp) and Sensitivity (S) were calculated for C1, C2 and C3.
Results: Table 1 shows the mean and range DSC, S and Sp scores on MRI, PET-60 and PET-90. A 2 sampled T-test ($P < 0.01$) showed, no significant difference in the Sp, S and DSC between GTVs on PET-60 and PET-90. Figure 1 shows that variability in GTV delineation is significant between observers in a singular case as well as across imaging modalities.
Conclusion: Compared to MRI delineated GTVs, 18F-Choline PET GTVs are different. However in these cases, increasing the PET acquisition time did not improve GTV TVD performance in comparison to MRI delineated GTV.

o041 **Low acute toxicity is predictive of low 2 year late toxicity, but not the reverse, in patients receiving helical image-guided IMRT for prostate cancer**

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Purpose/objective Many patients undergoing radical radiotherapy (RT) for prostate cancer develop some acute toxicity, and others also suffer these long term side. This study determined whether there is a link between significant acute rectal toxicities (gr. 2+) and late rectal toxicities at two years post RT in patients received helical IG-IMRT for prostate cancer.
Materials and methods This was a sub-study of the VoxTox programme and focused on those treated for prostate cancer & prescription dose 74Gy/37# (76) or 60Gy/20# (31). Patients were reviewed acutely a two weekly during RT upto 4 weeks post-treatment and for late toxicities at month 24. 3 key rectal toxicity endpoints using CTCAE v4.03 were considered: rectal frequency, urgency and bleeding, plus the maximum of any reported rectal toxicity within the VoxTox assessment. Only one maximum reported toxicity rate for each endpoint was recorded acutely and compared to the grade of toxicity at month 24.
Results For all endpoints it was found that a low grade acute toxicity (gr 0 or 1) was a predictor of low grade late toxicity (figure 1). But conversely experiencing a higher grade of acute toxicity (gr 2+) was not a predictor of high grade late toxicity. This was statistically indicated for the maximum of reported rectal toxicity within the VoxTox assessment with a sensitivity of 78% but a specificity of 29.5%.
Conclusion While these finding were not expected, they do provide an interesting link that requires further investigation that will be completed within future studies currently in development.

o042 Radiation protection post permanent iodine-125 seed prostate brachytherapy

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Background: Permanent implant Iodine-125 seed brachytherapy is a widely accepted treatment for early stage localised prostate cancer (NICE, 2005). Iodine-125 produces very low energy X-rays and these are not very penetrating. The activity content of each seed used at this hospital is between 14MBq (0.38mCi) and 16MBq (0.43mCi) so the total implant activity will be approximately 0.8 - 1.6GBq. There is no radiation hazard except when in contact with the patient area immediately surrounding the implant site (between navel and groin) or if a seed is passed out in the urine.
Purpose: This poster is primarily intended for use as Educational Media, to provide Aide Memoire guidance to the oncology ward nursing staff in their provision of postoperative care for Iodine-125 seed brachytherapy patients. As it will be displayed in a public area, therefore viewable by patients and their visiting relatives, the content will be presented in a format that is also suitable for non-staff.
Summary: The main themes of the poster will aim to alert individuals to essential radiation protection measures necessary to ensure compliance with EA permit terms for safe clinical use of Iodine-125 seeds, whilst drawing attention to the statutory legislation that must be observed during the hospital stay. The poster will refer to the documentation to facilitate the safe custody of the seeds during the post-operative period, and the patient discharge. As well as providing the patient with basic radiation safety to protect young children and pregnant women in the initial period post-implant.
Nice. (2005) Low dose rate brachytherapy for localised prostate cancer: Interventional Procedure Guidance 132. National Institute for Health & Clinical Excellence. London

o043 Proton computed tomography for proton therapy range calculations

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Proton computed tomography promises to reduce uncertainties associated with proton therapy treatment planning introduced during the conversion of X-ray Hounsfield Units to proton stopping powers. The PRaVDA collaboration has developed the world's first fully solid-state instrument for proton CT [1], which is expected to produce accurate stopping power maps with an uncertainty of 1%, less than the uncertainty associated with the conversion of HU->SP, which is calculated to be 1.6-5.0%, depending on the tissue type [2][3].
A phantom has been developed to be imaged using both X-ray CT and proton CT imaging modalities that also allows the range of a proton beam to be measured, such that an observable proton range difference should be seen between Monte Carlo simulations based on both X-ray CT and proton CT images. This can be compared with a delivered proton dose in order to quantify the benefit of proton CT in proton therapy treatment planning.
The phantom was imaged on the proton therapy beamline at iThemba Labs, South Africa in November 2016, and a dose was delivered to the phantom. A precision cut piece of film was used to measure proton range in polyethylene with two heterogeneities inserted into the phantom. Monte Carlo simulation was used to inform the design of the phantom and further analysis will follow. The phantom will provide an absolute measure of range uncertainty introduced by the conversion of X-ray Hounsfield units to proton stopping power.
1. Poludniowski, G., Allinson, N. M., & Evans, P. M. (2015). Proton radiography and tomography with application to proton therapy. The British Journal of Radiology, 88(1053) 2. Yang, M., Virshup, G., Clayton, J., Zhu, X. R., Mohan, R., & Dong, L. (2010). Theoretical variance analysis of single- and dual-energy computed tomography methods for calculating proton stopping power ratios of biological tissues. Physics in Medicine and Biology, 55(5), 1343–1362.. Paganetti, H. (2012). Range uncertainties in proton therapy and the role of Monte Carlo simulations. Physics in Medicine and Biology, 57(11), R99-117

o044 **Assessment of patient stability resulting from six degrees of freedom repositioning in lung SABR treatments**

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The work assesses whether the accuracy of patient positioning for lung SABR radiotherapy treatments is improved by applying image-guided corrections in six degrees of freedom (6DoF) compared to corrections in three translational degrees of freedom (3DoF). There is limited data in the literature on the accuracy of 6DoF corrections for lung patients and specifically for patients immobilised in custom vacuum cushions. This analysis included 89 patients: 21 receiving 3DoF corrections and 68 receiving 6DoF corrections. On their first treatment fraction, all patients received a kV CBCT before treatment to correct setup and mid-way through the treatment to monitor positioning. The mid-treatment CBCT provides information on residual errors, which are any changes in patient positioning following the application of movements to correct setup. Residual errors for 3DoF and 6DoF methods were compared. Errors for 6DoF corrections were also analysed to assess for any correlations with applied setup corrections. The residual errors for 6DoF treatments were not significantly different from those for 3DoF treatments. A significant correlation between applied pitch and residual longitudinal error (1.0mm/1°) and applied roll and residual lateral error was found (0.7mm/1°). This work complements the literature by assessing 6DoF corrections for a large cohort of lung SABR patients. Lung patients immobilised using a customised vacuum cushion have no significant decrease in treatment accuracy when using 6DoF corrections, however a correlation was found between applied pitch and residual longitudinal error and applied roll and residual lateral error. Use of 6DoF corrections for lung SABR is under review.

1. Cao, M., et al. 2012. Radiation Oncology 84 520-526 2. Guckenberger, M., et al. 2007. Strahlentherapie und Onkologie 6 307-311 3. Linthout, N., et al. 2007. Radiotherapy and Oncology 83 168-174

o045 **Initial clinical experience of using SABR on oligometastases from primary gastrointestinal cancer**

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Background: The standard treatment for oligometastases originated from primary gastrointestinal (GI) cancer is systemic therapy. By contrast, current evidence suggests that Stereotactic Ablative Body Radiotherapy (SABR) is a new treatment modality for local extra-cranial metastases, which has shown favourable clinical results. This study aims to demonstrate the efficiency of SABR treatment of GI oligometastases in terms of acute toxicity and local control.

Methods: A retrospective review of SABR patients with GI primary was carried out to assess each patient's post treatment toxicity (PROMS) and local control (LC). Patient's demographic data including age, histopathology of primary disease and anatomical location of sites treated were reviewed.

Results: Between September 2015 and November 2016, 22 consecutive patients with oligometastases from primary GI cancer were treated with SABR. The median follow-up is 6 months and the median of patient's age is 67.8 years old. Histopathology of Primary: Colon (n=6), Rectum (n=13), and Anus (n=3). The metastases sites include lung (n=1), liver (n=3) node (n=10) pelvic mass (n=6) and bone (n=2). Overall, acute toxicity occurred in 18% (4/22) of patients 6 months post SABR; No grade ≥3 toxicities were recorded. The local control at 6 months is 86% (19/22). Significant differences were found in local control rates between the patients with different histopathology of primary ($p<0.05$).

Conclusion: In conclusion, the use of SABR has shown great potential and benefit. Our cohorts of patients with GI oligometastases have shown acceptable acute toxicities and promising local control rates.

o046 **Prostate SABR - dosimetric impact of on treatment organ motion on OARs**

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Beatson West of Scotland Cancer Centre

Background It is essential when implementing a highly conformal technique with steep dose gradients such as Prostate SABR, to consider the effect of geometric uncertainties on the delivered dosimetric plan. With this highly conformal technique it is necessary to ensure toxicities are within the acceptable range.[1] This study evaluates CBCT images for Prostate patients who had treatment within a local safety, feasibility and efficacy study. There is little published evidence on the true dose received by organs at risk. Currently the dosimetric impact of organ motion on OAR constraints is not well understood.

Method: 11 patients treated using Prostate SABR linac based technique, 35Gy/5#. Prostate tracked pre delivery matching to fiducial markers on CBCT. Bladder and rectum delineated retrospectively on 55 pre CBCT images. CBCT registered to planning CT. CBCT contours overlayed for dosimetric analysis. Recalculation to evaluate the DVH's for each structure using the 'original plan' as the comparator to evaluate the impact of inter fraction motion of internal organs. Planning constraints evaluated to ensure these are being met despite OAR motion.

Results Rectum constraint V18<35 % was the only the constraint achieved on treatment by all patients. In 3 patients 10 % of the rectum received >28Gy. In 4 patients 5 % of the rectum received >32Gy and in 5 patients 1 % of the rectum received >35Gy(Fig. 1) . In 2 patients 1 % of the Bladder received >35Gy(Fig. 2).

Conclusion Due to organ motion, Rectal and Bladder constraints were not met for some patients. Applying strict dose constraints at the planning stage ensures dose received by OARs are kept to a minimum on treatment.

1. Tree, A.C et. al. (2013) Biological dose escalation and hypofractionation: What is there to be gained and how will it best be done? Clinical oncology, 25 (8), 483-498.

o047 **Establishing a new Peptide Receptor Radionuclide Therapy service and outcomes from the first patient cohort**

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Royal Surrey County Hospital

Peptide Receptor Radionuclide Therapy (PRRT) is a promising Molecular Radiotherapy technique for the treatment of inoperable, symptomatic neuroendocrine tumours (NETs). PRRT exploits the over-expression of somatostatin receptors in NETs by utilising peptides chelated to beta-emitting radionuclides to selectively target tumour cells and deliver a cytotoxic radiation dose. The radiopeptides are administered intravenously over four cycles, typically at eight week intervals. We present our experience of establishing a new service to deliver PRRT at our institution, including regulatory requirements, financial planning, clinical protocol development, training and implementation. To date, we have completed treatment of 6 patients. For each patient, haematological, renal and hepatic function was monitored every two weeks. Gamma camera imaging was completed 24 hours post-injection and used to quantify the uptake in tumour sites over the course of therapy. Radiological response was assessed using follow-up CT and SPECT or PET scans. Patients were also assessed clinically after each cycle. All patients showed stable or decreased tumour uptake over four cycles, indicating reduced volume of disease, with the best responder showing a 43% decrease. All patients demonstrated radiological and/or symptomatic responses. The treatment was well tolerated with minimal toxicity observed in our cohort. Some treatment cycles were delayed due to thrombocytopenia, raising the question of the possible role of transfusion in PRRT patient management. PRRT is a complex procedure requiring close integration of the multi-disciplinary team. Clinical trials of PRRT are ongoing, and its efficacy is currently being assessed by NICE before commissioning guidelines are published in July 2017.

o048 **Assessing plan quality and delivery verification of stereotactic ablative body radiotherapy to spinal metastases across different provider landscapes**

Maeve Smyth; Matthew Williams; Andrew Bryant; Tony Millin

Velindre NHS Trust, Cardiff

Background: The aim was to provide an evidence base for introduction of Stereotactic Ablative Body Radiotherapy (SABR) to treat spinal metastases. Both plan quality and delivery across two manufacturers, Varian TrueBeam STx and Elekta Agility, was assessed. In particular the Varian HD120 MLC including 2.5mm leaves in the centre, and the Elekta Agility with 5mm leaves, could be compared.

Method: Clinically commissioned models for both the TrueBeam and Agility within Oncentra MasterPlan were utilised to plan four test case spinal volumes. All plans were optimised using a standard VMAT solution, developed in house. Plan quality assessment was performed using metrics outlined in the UK SABR consortium guidelines [1]. Plans were then verified using IBA CC01 ionisation chamber measurements, in the centres of both the target volume and the spinal cord, and using Ashland Gafchromic film.

Results: Both machine models produced clinically acceptable plans which have been reviewed externally (Commissioning through Evaluation (CtE), Radiotherapy Trials QA (RTTQA)). The delivery of each plan was successfully verified using film, where the resolution of the dose calculation grid was found to have a notable effect on gamma analysis. Measurements using the CC01 chamber were acceptable, with discrepancies in the spinal cord region. This is possibly due to the large dose gradient across the chamber in this region of the plan.

Conclusion: Creating an evidence base to implement new protocols is an essential component of developing a clinical service. This work has highlighted that clinically acceptable plans can be produced and delivered using either provider.

1. SABR UK Consortium (2016) Stereotactic Ablative Body Radiation Therapy (SABR): A Resource, Version 5.1.

o049 **Developing an in-house, automated and efficient verification process for stereotactic radiosurgery (SRS) brain treatments**

Jonathan Sutton; Anna Bangiri; Jonathan Littler; Katya Gnutzmann

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Introduction SRS is a hypofractionated radiotherapy technique commonly used to treat brain metastases. Prescribed doses of around 20 Gy are typical, often delivered in a single fraction. The high doses and small field sizes heighten the need for accurate delivery. We present a method for verification using a point dose measurement, combined with coronal and sagittal 2D film distributions analysed using gamma analysis.

Method For every patient, each PTV is verified separately with an A26 ionisation chamber [6] (tolerance ± 10%) and EBT-XD Gafchromic film [5] measurements in an anthropomorphic phantom, STEEV [1]. Film data is compared with data from the planning system using a 2D global gamma analysis (5% / 2 mm) [2], [3] written in MATLAB 2013 [4]. A pass rate of 95% is

required.
Results Delivering the QA beams is a time consuming process which takes approximately 1 hour per PTV. The analysis workflow is highly automated and can be performed in less than 10 minutes per PTV. After 12 patients with a total of 19 PTVs, the mean gamma pass rate (5% / 2 mm) was 98.9% (range: 92.0% to 100%, SD: 1.5%). For the absolute dose measurements, the mean difference from expected was +1.2% (range: -6.5% to +9.5%, SD: 3.8%).
Discussion The efficiency of our patient specific QA process for SRS brain treatments has been greatly increased through the introduction of an in-house automated analysis technique. Work is ongoing to further reduce QA time by implementing independent dose calculation software combined with linac log file analysis.
*1. CIRS, Norfolk, United States. 2. Ju, T., Simpson, T., Deasy, J. O. and Low, D. A. (2008) Geometric interpretation of the γ dose distribution comparison technique: Interpolation-free calculation. Med. Phys. **35**(3), 879-887. 3. Low, D. A., Harms, W. B., Mutic, S. and Purdy, J. A. (1998) A technique for the quantitative evaluation of dose distributions. Med. Phys. **25**(5), 656-661. 4. MathWorks, Natick, United States. 5. MediTron, Frauenfeld, Switzerland 6. Standard Imaging, Middleton, United States.*

o052 **Soft tissue image matching for oesophageal cancer: To use or not to use, that is the question?**

Zankhana Jani; Justine Mooney; Mark Elsworthy; Lucinda Melcher; Tim Hosking

North Middlesex University Hospital

Background Oesophageal radiotherapy has evolved significantly over the past 5 years with the use of VMAT, dose escalation and 4DCT. Volumetric imaging is commonly used for treatment verification but the limited soft tissue contrast means visualising the oesophageal tumour can be challenging. Consequently bony anatomy is used in combination with the soft tissue to verify treatment position. The aim of this study is to evaluate differences in terms of set up errors between the bony and soft tissue match and correlate these differences in relation to tumour position to ascertain the optimal imaging protocol in terms of frequency and matching methods.
Method A retrospective study was conducted of 10 patients with a variety of tumour positions. The magnitude of set up errors wasere compared using both a bony match and a soft tissue match. Intra-fractional variations in surrounding tissues as well as any tumour deformations were noted. The correlation between tumour position and set up error was determined.
Results Initial results showed that the use of bony anatomy is still the preferred matching option for proximal tumours as difference between the soft tissue and bony match was minimal ($P<0.1$) regardless of any deformation of tumour and surrounding tissues. However for distal tumours the variation between bony anatomy and soft tissue was significantly larger ($P>0.0001$) suggesting a daily soft tissue match would be a superior method of verification. Deformations of anatomy were also more prevalent and the variations in shape and volume of the stomach had substantial impact on set up reproducibility.
Conclusion Suggests different matching strategies would be beneficial for oesophageal tumours based on position.

o054 **Image guided adaptive radiotherapy for bladder cancer using 'plan of the day' and the impacts on staff training**

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Curative radiotherapy (RT) to the bladder is complex due to the geometric uncertainty of inter and intra-fraction organ motion. Bladder size variations from planning studies provide evidence that adaptive strategies are needed to improve target coverage and dose escalate. Non-adaptive conventional techniques (including IMRT) allow the use of large isotropic margins, resulting in unnecessary normal tissue irradiation. Plan of the day (PoD) is an adaptive solution utilising the use of multiple approved CTV-PTV margins, selected daily, based on the acquisition of online volumetric imaging. The RAIDER trial aims to assess the practicalities of dose escalation using multiple plan selection and confirming the severity of toxicities are acceptable for Bladder cancer. Planning studies have outlined the advantages and limitations of the 'Plan of the day' technique which are outlined in table 1. Recent studies have shown the importance of staff training. Online and offline verification and plan selection had concordance rates of more than 90% when in-house or ethics-approved training regimes were undertaken and 70-75% when they were not. This highlights whether experience or competence should be used to form the basis of confident decision-making actions relating to plan selection. Researchers surveyed sixty-five radiographers who had volumetric imaging training and found that senior therapists were less confident with volumetric imaging than junior therapists ($P = .016$). The evidence shows that the confidence and knowledge needed to make the clinical decisions for adaptive RT are gained through structured learning, which could be a mixture of different grades throughout the workforce.

o055 **CTE implementation: Challenges, solutions and progression**

Alison Blower; Andrew Jepson; Helen Kerr; Hazel Newcombe; Jonathan Poole; Catherine Wilson

South Tees Hospitals NHS Foundation Trust

The CtE program has now been running for over a year. During this time we have treated over 45 oligometastatic cases with SABR. These treatment sites have presented new challenges and opportunities for improvement to this service. The SABR treatment team at JCUH have expanded their knowledge base and worked well together in all aspects of the patient pathway. Sites treated include Adrenal, Lung, multiple Lung lesions, Nodes, Liver and Bone. Summary: We have gained significant

experience over the last year, and grown with confidence in every new case. Some cases have been more challenging than others which we have had to adapt working practices. Communication and guidance from the consultants and the physics team have helped to overcome these challenges.