Method: Following ethical approval, anonymised data from NHS Electronic Staff Records (ESR) were analysed. The proportions of support workers within the imaging workforce and their employment bandings were analysed at NHS Trust, regional and national level. Data for one region was analysed in detail to establish inclusion and exclusion criteria for the wider dataset; accuracy was checked with other workforce data dashboards.

Results: Data related to Imaging Services from 137 NHS Trusts in England demonstrated wide variations. In the pilot region presented (22 Trusts) the support workforce as a proportion of the wider workforce was a mean of 27.8% (SD = 9.3), with wide variations in utilised grades. Data differed from workforce data dashboards and resources.

Conclusion: Known data recording inaccuracies within the ESR system resulted in discrepancies between the different workforce data dashboards. However, this census provides vital evidence of the scope and scale of the support workforce which is the first step in a multi-method research programme to determine how they can best contribute to imaging delivery, improving the patient experience and reducing health inequalities.

1. Halliday K, Maskell G, Beeley L, Quick E. NHS. Radiology GIRFT Programme National Specialty Report. November 2020. https://www.gettingitrightfirsttime.co.uk/wp-content/uploads/2020/11/GIRFT-radiology-report.pdf
2. Richards M. NHS England. Diagnostics: Recovery and Renewal, October 2020. Independent Review of Diagnostic Services for NHS England . Prof Sir Mike Richards. https://www.england.nhs.uk/publication/diagnostics-recovery-and-renewal-report-of-the-independent-review-of-diagnostic-services-for-nhs-england/

Proffered papers: Radiotherapy technical

C5.1 Literature review: Is there a clinical need for carbon ion radiotherapy in the UK?

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Background: The biological characteristics of Carbon Ion therapy can lead to lower grade toxicities and increased tumour response. This has led to Kirkby et al (2020) proposing that the UK would benefit from a heavy ion centre. There has, however, been limited discussion of patient cohorts, associated side effects and overall benefit to treatment. This review aimed to investigate the potential clinical benefits of a heavy ion centre.

Method: A search of the literature was conducted using PubMed and Science Direct with the search term "Carbon ion therapy". A critical review of the evidence was performed to evaluate the current clinical use of carbon ion therapy through analysing the associated toxicities, overall survival (OS), local control (LC), progression-free survival (PFS) and the incidence of secondary cancers.

Results: After critical appraisal with CASP, data was extracted from 81 papers. The findings indicated that carbon ion therapy has proven to be a more clinically effective treatment for malignancies such as nasopharyngeal tumours, chondrosarcoma and chordoma, inoperable bone and soft tissue sarcomas, non-small cell lung cancer, liver cancer and prostate cancer. More work is needed to strengthen the evidence base for some other tumour types.

Conclusion Carbon ions show promising survivorship along with few adverse effects for some tumour sites, suggesting strong clinical gains for a carbon ion facility. Whilst other malignancies have shown promising data, higher quality evidence is needed to establish value for them.

1. Kirkby, K.J., Kirkby, N.F., Burnet, N.G., Owen, H., Mackay, R.I., Crellin, A., Green, S. (2020) Heavy charged particle beam therapy and related new radiotherapy technologies: The clinical potential, physics and technical developments required to deliver benefit for patients with cancer. Br J Radiol. 93(1116):20200247

C5.2 Using ProKnow to audit post implant dosimetry of I-125 prostate brachytherapy implants: DVH comparison with Oncentra Prostate and Variseed

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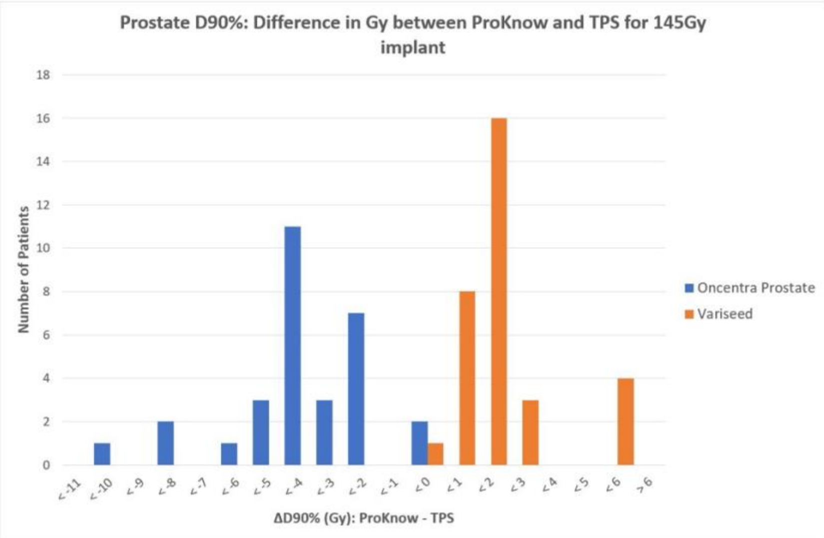
Background: A group of NHS Trusts would like to use the ProKnow software to audit post implant dosimetry for prostate patients receiving brachytherapy with I-125 seeds. Comparisons will be made between Trusts and against RCR minimum standards[1]. The impact of using ProKnow for this audit depends upon differences between its own DVH calculation engine and the participating Trusts' treatment planning systems' (TPS). An NHS task group has looked at these differences for EBRT, but brachytherapy plans have steeper dose gradients and higher maximum doses.

Method: Dosimetry from post implant CT scans was calculated for patients prescribed 145Gy using the Oncentra Prostate (v4.2.3) or Variseed (v9.00.30) TPS. The volume of the prostate and the D90% to the prostate was calculated. Structure sets and dose cubes were exported to ProKnow where each parameter was recalculated.

Results: The average prostate volume calculated by ProKnow was 0.8cc larger than Oncentra Prostate (n = 30, range: 0.3cc to 1.4cc) and 0.05cc larger than Variseed (n =32, range: -0.41cc to 0.19cc). This difference in volume leads to differences in measured values for D90% to the prostate between Oncentra and ProKnow, with ProKnow measuring 4.3Gy lower (range: -10.5Gy to -0.4Gy). Differences are smaller between Variseed and ProKnow, with ProKnow measuring 1.7Gy higher (range: -0.9Gy to +5.8Gy).



Conclusion This work will allow us to compare the dosimetry of prostate I-125 implants between centres while being aware of differences between ProKnow and various TPS DVH calculation algorithms.

1. The Royal College of Radiologists. *Quality assurance practice guidelines for transperineal LDR permanent seed brachytherapy of prostate cancer.* London: The Royal College of Radiologists, 2012.

C5.3 National survey to review radiotherapy centres image verification audit process

Louise McHugh; Xin Wang; John Rodgers; Gillian Court; Vicky Hughes; Cynthia Eccles

The Christie NHS foundation Trust

Background: The national guidance on image guided radiotherapy (IGRT), On-Target (2008) and On-Target 2 (2021), highly recommend implementing an audit process for selecting images at random, assess image quality and quality of analysis. To date, there is a paucity of literature on the development and implementation of an effective audit process for radiotherapy (RT)imaging.

Method: To gain a national overview of current RT imaging audit practice, a survey was created consisting of 16 short questions and disseminated by email to RT service managers of 59 UK RT centres.

Results: There has been a 53% (n=31) response rate with 36% (n=11) of centres confirming they carry out routine image verification audits. 29% (n=9) carryout adhoc audits, 19% do not carry out any form of RT image audit and one centre describes a process in place which they do not classify as an audit. Audits were undertaken by radiographers (n=11) and occurred anywhere from monthly to annually

Conclusion: Our survey reports the first evaluation of RT audit processes in UK centres. Further analysis is required to define the audit scope and objectives of an RT image verification audit at our institution. Using the description detailed in the survey responses, from centres undertaking routine RT imaging audits, we intend to implement local audits to confirm compliance with departmental protocols. The results may also help inform other centres in the development and implementation of an RT image audit process

C5.4 Implementation of the Integral Quality Monitor (IQM) for patient specific dosimetry

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Background: Patient specific dosimetry (PSD) of complex planning techniques require measurements that are resource and time intensive using the current phantom-based system within our radiotherapy department. This project aimed to implement IQM (iRT Systems GmbH, Germany) for PSD of all volumetric modulated arc therapy (VMAT) and stereotactic plans using locally derived action levels, to improve efficiency of the PSD workflow.

Method: Following system commissioning, small leaf position errors were introduced into a range of treatment plans and resultant IQM signal deviation was assessed. Correlation of IQM signal deviation with changes in plan dose-volume histogram (DVH) metrics was used to derive clinically relevant action levels[1]. These were checked using a retrospective audit of 32 clinical plans delivered on both phantom-based and IQM systems. Finally, a time efficiency audit was performed for a 3-month period.

Results: Strong linear correlation between deviation in IQM signal and DVH metrics was found across a range of sites. Asymmetric action levels of -6.3% and +4.0% were deduced, corresponding to a 5% reduction in planning target volume (PTV) metrics and a 5% increase in organs-at-risk (OAR) metrics respectively. No action levels were exceeded by the audited plans. Automation of the IQM software and reduced setup time contributes to an average monthly time saving of 31 hours.

Conclusion: IQM signal deviation correlates with variation of DVH plan metrics for treatment errors. The IQM is suitable for routine patient specific dosimetry across all tested sites. Implementation of the IQM has dramatically improved efficiency of the PSD workflow.

1. iRT Systems GmbH ed., (2019). *How to determine error tolerances for the IQM System (user training).* Koblenz, Germany.

C5.5 Radiographer IGRT training using "ProKnow contouring accuracy" to enhance online-adaptive workforce skills

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Background: Online-adaptive radiotherapy (OART) may become the new gold-standard for radiotherapy to complex cancers. Current IGRT training programmes do not confer skills in organ at risk (OAR) and target volume contouring or plan evaluation. This study evaluates web-based contouring tasks (ProKnow) in IGRT training; gaining experience with OAR and target volume contouring. ProKnow uses peer-reviewed, expert contours on anonymous CT data-sets, providing Dice scores, which may help to reduce training burden on clinicians.

Method: 10 radiographers undertaking prostate IGRT training completed ProKnow contouring tasks. An anatomy and IGRT overview was delivered for trainees and supplemented by contouring instruction within ProKnow. Trainees contoured 6 CT data-sets (2x prostate, 2x seminal vesicles, 1x bladder and 1x rectum). Mean Dice scores for initial and final contours were compared using paired *t*-tests in Microsoft Excel.

Results: Dice scores significantly increased for the prostate (0.739 vs 0.850, p=0.001), seminal vesicle (0.566 vs 0.794, p=0.007) and for rectum contours (0.720 vs 0.882 p=0.010) from initial to final attempts. All radiographers achieved satisfactory initial bladder OAR contours and therefore initial and final scores matched. The mean Dice score for the bladder was 0.943.

Conclusion: This study shows radiographers significantly improve their contouring accuracy using this self-directed approach, limiting the time burden on training staff. OART capable hardware requires large investments; so OART must be used clinically early in the implementation to justify higher investment. This study indicates integration of ProKnow tasks into radiographer IGRT training builds experience and skills in preparation for radiographer-led OART services.

Proffered papers: Chest

D5.2 Improving diagnoses with AI: Deep learning software for chest xray interpretation

Sarah Blake; Neelan Das

East Kent University Hospitals

Background: Chest radiograph reporting at hospitals is challenged by increasing wait times and reporting backlogs due to growing scan volumes. Artificial intelligence (AI) with accurate and rapid chest radiograph reporting capability can help improve efficiency and increase accuracy of initial diagnosis.

Methods: qXR, a deep learning AI system that is trained on 3.5 million chest radiographs with separate detection pipelines for 30 abnormalities. Chest radiographs (n = 1040) from accident & emergency (A&E) (n = 252), general