2A Brachytherapy

Evaluation of MR-CT fusion for image guided brachytherapy for gynaecological cancer

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Background Image guided brachytherapy is well-established for the treatment of gynaecological cancers. ICRU Report 89 recommends delineating the target volume on MR to utilise the superior tumour visualisation. At our centre, a para-axial T2 volumetric MR image taken after applicator insertion is fused with CT to enable the HR-CTV to be transferred for organs at risk contouring and treatment planning. This process needs to be accurate and streamlined. The fusion functionality from three commercially available programmes were analysed and compared.

Methods The fusion feature on Oncentra Brachy version 4.5.1 was compared with the fusion on Prosoma version 3.3 and Mirada RTx Advanced 1.4. Six patients with Elekta Utrecht or Ring applicators were included. The accuracy achieved was compared by quantifying any difference in applicator positioning once a best-fit fusion had been achieved. Ease of use was also compared.

Results Prosoma and Mirada acheive similar standards of fusion (within 1.0mm) for both ring and Utrecht applicators. Oncentra Brachy does not currently offer manual fusion adjustment, and this results in increased time spent and discrepancies of up to 3mm. Prosoma version xx does not import highly oblique MR scans, although this has been corrected in later versions. Mirada Rtx offers a fusion package which is customisable and flexible.

Conclusion The disadvantages in using an extra computer programme are outweighed by the time saved and the superior result obtained. Prosoma has the advantage of familiarity within our department, but the fusion and contour transfer process in Mirada is more straightforward and intuitive.

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3B Molecular radiotherapy

Two-year outcomes of Radium 223 Therapy in metastatic castrate resistance prostate cancer: The Northern Centre for Cancer Care (NCCC) experience

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Introduction: Radium 223 is an alpha particle emitting radiopharmaceutical which is used in the treatment of adults with castration resistant prostate cancer with symptomatic bone metastases and no known visceral disease.

In the Alpharadin™ in Symptomatic Prostate Cancer (ALSYMPCA) phase III study, radium-223 was associated with significantly improved overall survival compared with placebo, making it the first bone-targeted CRPC therapy for which an overall survival benefit has been demonstrated. It also demonstrated the beneficial effects of radium-223 on disease-related symptomatic skeletal events, pain and health-related quality of life.

Radium 223 first became available via CDF funding in Feb 2014 and we started our first patients in March 2014. NICE approval was granted for the treatment in Feb 2016. It is administered intravenously in the Nuclear Medicine Department; and consists of 6 cycles at 4 weekly intervals. We report our experience of treating 143 patients over 2 years with over 600 doses of Radium 223 delivered. We aimed to review our clinical outcomes including survival data.

Methods: Baseline pre-treatment data was collected. This included patient's age, performance status and pre or post docetaxel status. Blood parameters were evaluated both at the start and end of treatment and survival information was also extracted from the data. We also measured quality of life during the treatment of these patients, using an abbreviated FACT-P QOL questionnaire and collated the information alongside the survival data.

Results: Total number of patients treated n= 143, mean age 71 years (medium 72 years, range 51-84 years). Overall median survival was 8.5 months (c.f ALSYMCA 14.9 months) however patients that completed all 6 cycles of treatment had a median survival of 12.4 months (HR 0.33, 95% CI, P value 0.0001) compared with those patients that did not complete all 6 cycles (4.7 months). There appeared to be benefit with each additional cycles completed (Logrank test for trend, p<0.0001).

Survival by PSA showed those who had a PSA response of >50% from base line (8 patients) have a median survival of 26.8 months. Alkaline Phosphatase reduction during treatment does not correlate with a survival advantage although a clinically significant Alkaline Phosphatase reduction was seen in almost 50% of patients.

Other predictors of survival were performance status with patients who had a survival status of 0-1 at the start of treatment having almost double the median survival (11.9 v 6.6 months). Over 2/3 patients (62.5%) reported improvement in pain levels over the course of treatment with 45.8% reported functional improvement.

Conclusion: Our overall survival times did not reach those published but this was calculated from when patient commenced the treatment rather than time of randomisation as was in ALSYMPCA trial. Our quality of life data shows a clear improvement in pain management within this patient population which conforms with the main indication of this treatment.

Impact of non-rigid registrations for a clinical trial in Peptide Receptor Radionuclide Therapy

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Peptide Receptor Radionuclide Therapy (PRRT) is currently the most effective therapy for the treatment of patients with neuroendocrine tumours (NETs).

To determine the cumulated activity in volumes of interest, serial measurements of activity should be performed following the administration of the radiopharmaceutical, through the analysis of multiple quantitative functional imaging. When sequential scans are tomographic, they should be co-registered to calculate an accurate and reliable patient specific 3D dosimetry. Registration algorithms are normally applied to activity maps. The aim of this study was to investigate the application of deformable image registration algorithms to dose maps, instead of activity maps. The two different workflows used in this study are shown in figure 1.

The accuracy of the registration was quantified using the Dice Conformity Index and verified as excellent in all cases.

Twenty patients treated with PRRT were imaged five times, post-injection of therapeutic administration of 177Lu-labeled peptides with a SPECT/CT scanner. 3D dose calculations were carried out using Raydose Monte Carlo code for both image registration work.

Mean doses to organs at risk calculated with the dose deformation workflow were consistently higher than those calculated with the activity deformation workflow. Such a correlation was not found for the mean dose to the lesions. The percentage difference between the mean dose to organs and lesions is shown in figure 2.

Deformable image registration algorithms were significantly influenced by the different integration method used. A possible optimization to the dose deformation workflow is to use effective decay constants in dose deformation workflow.

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Comparison of quantitative lutetium-177 (177Lu) measurements in European hospitals

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Molecular radiotherapy (MRT) is prescribed in terms of administered radioactivity, but this method takes no account of differences in pharmacokinetics between patients, which results in wide variations in absorbed doses. As a result, the dose-effect correlation for many of these therapies are poorly characterised. There is growing demand to perform accurate dosimetry in order to better optimise MRT treatments. One of the therapies for which this is of interest is 177Lu peptide receptor MRT, used to treat neuroendocrine tumours. MRT dosimetry calculations are highly dependent on the quantitative accuracy of the images used to measure the organ-level pharmacokinetics of the radiopharmaceutical. To assess this key step in the dosimetry process, we provided seven clinical centres across Europe with an accurately calibrated 177Lu source consisting of two concentric spherical compartments filled with different radioactivity concentrations, placed within a water-filled phantom to represent a patient's abdomen. The centres were unaware of the true concentrations, and were asked to report their best estimate of the radioactivity concentrations in the two sections of the source, using their own protocols. For the inner source compartment, which contained the higher concentration, all hospitals reported values that were within 20% of the true value, whilst for the outer compartment, deviations of up to 100% from the true value were reported. Our work demonstrates the

need for the development of standardised protocols for both camera calibration and patient acquisitions to enable accurate quantitative imaging, in order for accurate patient dosimetry to be performed that is comparable between hospitals.

4E Data

Effects of registration uncertainties in image-based data mining

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University of Manchester

Objective: Image-based data mining identified dose to the base of the heart as an important predictor for survival in lung cancer patients receiving radiotherapy [1]. Data mining relies on non-rigid registration (NRR) to set inter-patient images into a common reference. Uncertainties in NRR may affect results. We quantified registration uncertainties for two popular NRR open-source packages and assessed the effects on our data mining results.

Material/methods: CT data and heart delineations of 386 lung cancer patients were used to estimate NRR uncertainties. An initial affine registration was initialized by scaling based on the lung contours, followed by automatic intensity-based registration. Subsequently, a NRR was performed using two open-source packages: NiftyReg (http://cmictig.cs.ucl.ac.uk/wiki/) and Elastix (http://elastix.isi.uu.nl/). All registrations ignored bony anatomy. Random registration uncertainty was estimated by quantifying the standard deviation of all centres of mass of the heart after registration. Data mining was then repeated with each registration method using a data of 538 patients.

Results: The random uncertainties for all registrations are summarized in the following table.

Clearly, NRR uncertainties are significant, and differ considerably.

Large changes are visible in the data mining results, however the same anatomical region was identified for predicting survival for all NRR methods:

Conclusion: Registration uncertainties related to NRR vary depending on the registration method. In our results, NiftyReg outperformed Elastix and Elastix was also outperformed by affine registration only, which suggests overfitting of the input data. Results clearly identify the base of the heart as a dose sensitive region affecting survival regardless of the NRR.

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Towards a state-wide distributed learning and datamining network in radiation oncology to support clinical decisions

David Thwaites [1]; Lois Holloway [2]; Matthew Field [3]; Samir Barakat [3]; Shalini Vinod [2]; Geoff Delaney [2]; Martin Carolan [4]; Michael Bailey [4]; Andrew Miller [4]; Jonathan Sykes [5]; Roland Alvandi [6]; Eric Hau [6]; Verity Ahern [6]; Joerg Lehmann [7]; Jane Ludbrook [7]; Aditya Ghose [3]; David Stirling [3]; Tim Lustberg [8]; Johan Van Soest [8]; Sean Walsh [8]; Andre Dekker [8]

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Introduction: Radiotherapy treatment guidelines are based on randomised clinical trial (RCT) evidence. However, many patients are not eligible for RCTs. The concept of a distributed learning network, where data remains at local centres but can be modelled and learnt from jointly, has been reported (1,2) and can provide additional clinical evidence.

Method: A NSCLC radiotherapy dataset of 298 patients was evaluated at a single centre to determine the percentage of patient numbers meeting RTOG 9410 criteria. Based on initial single centre machine learning and modelling (3,4), a distributed learning network has been established in NSW, linking to international partners. It has been tested on NSCLC patient datasets across four centres, using lung radiotherapy data extracted and modelled at each centre and then sharing and combining models.

Results: Only 25% of patients within the cohort met RCT criteria. Lung cancer radiotherapy data was successfully extracted at the four centres and modelled in each. Imputation of missing values allows more data to be used. Transfer of model learning parameters has been demonstrated between centres.

Conclusion: Many patients don't meet RCT criteria on which clinical guidelines are based. A distributed learning radiotherapy data network for datamining and machine learning is shown to enable generation of additional clinical evidence to support treatment decisions for such patients. Models of other treatment sites and the inclusion of more centres are being developed, including exploring the potential for radiomics to inform the models. This can impact on clinical practice and also on improvement of data collection and data quality.

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4F Proffered papers

Clinical implementation of a knowledge based planning tool for prostate VMAT

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Background: Full optimisation of VMAT radiotherapy plans is a complex process with final plan quality dependent upon numerous factors including patient anatomy and planner experience. A knowledge-based planning tool, based upon the work of Moore et al. [1], has been developed and clinically implemented to guide the plan optimisation process for prostate VMAT by highlighting plans that are suboptimal in terms of average rectum dose.

Methods: A data mining script was written within the RayStation scripting interface and used to collate plan data for a historical cohort of 97 VMAT prostate plans. This data formed a knowledge base that was used to develop a local model for predicting optimum average rectum dose based on the extent of PTV-rectum overlap. The predictive model was incorporated into a second RayStation script and used during the clinical planning process to provide a patient specific-prediction of average rectum dose enabling the planner to efficiently optimise the plan.

Results: Clinical implementation of the knowledge-based planning tool reduced the population averaged mean rectum dose by 5.6Gy. There was a small but statistically significant increase in total MU and femoral head dose and a reduction in conformity index however these did not affect the clinical acceptability of the plans. No significant changes to any other plan quality metrics were observed.

Conclusions: The knowledge-based planning tool has enabled substantial reductions in average rectum dose for prostate VMAT patients, particularly those exhibiting low PTV-rectum overlap. This suggests plans are improved when planners receive quantitative feedback on plan quality against historical

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Evaluating a fully automated VMAT planning system with a clinically intuitive site-based calibration

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Background Automated planning has shown to yield high quality treatment plans and improve efficiency [1-3], however incorporating oncologist's knowledge and decision making within the autonomous process is a non-trivial problem. This work evaluates a fully automated VMAT planning solution where a novel, clinically intuitive, site-based calibration has been implemented.

Method An automated solution was developed using scripting in RayStation. Calibration was performed on a small cohort of patients for each site, using a GUI to navigate between plans with differing trade-off emphasis. Observing the effect on the DVH and isodoses in real-time during this navigation allowed the operator to precisely select the optimum clinical trade-offs. The calibration was then used for fully automatic, patient-specific, planning.

Automated plans were generated for 40 randomly selected patients (20 prostate & seminal vesicles (PSV) and 20 prostate & pelvic nodes (PPN)). Plans were compared against current clinical practice and ideal plans created by expert dosimetrists in the absence of time pressure. Plan quality was assessed using DVH metrics and a blind qualitative comparison by an oncologist.

Results Automated plans met clinical constraints and were dosimetrically equivalent to ideal plans (Table 1). Mean time to create clinical plans was 22mins for PSV and 42mins for PPN. Automated plans were generated in 12 and 32mins respectively with no user interaction.

Conclusion Our solution offers a practical approach to include clinical expertise in automated planning, yielding high quality plans. Automated planning reduces dosimetrist workload and can run on a 24h basis, resulting in significant efficiency savings.

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The impact of electron return effect on radiotherapy plan quality for peripheral sarcomas

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Background: The electron return effect (ERE) can cause an increase in dose at tissue-air interfaces. Certain cancer types, such as sarcomas, can benefit from on-line MR imaging, with improved soft tissue definition, though it is essential to understand the effect of the magnetic field on plan quality. This study aims to evaluate the impact of the ERE on plan quality parameters such as skin dose and dose to target volumes for peripheral sarcomas.

Method: A retrospective analysis of 5 patients was performed using Monaco v5.19 (ELEKTA AB, Stockholm, Sweden) to determine the dose to the skin and the target volume for peripheral sarcoma plans. Simple and complex IMRT plans were created using 8MV beams with a 60Gy in 30# prescription initially at 0T. The magnetic field was then applied and the plans were re-calculated. Finally, the plans were fully re-optimised with the magnetic field on. Plan quality parameters were evaluated to determine the impact of the ERE and whether plans should be fully re-optimised once the field is applied.

Results: The mean of the dose to 98% of the CTV over all patients was ~55.5Gy for all simple plans and ~57.5Gy for all complex plans. The max dose to 2cc of the skin was lowest (~59Gy) for plans optimised at 0T and was highest for plans recalculated at 1.5T (~67Gy). This reduced to ~60Gy after re-optimisation.

Conclusion: The effect of the ERE on plan quality can be decreased by fully re-optimising plans once the magnetic field has been applied.

Volumetric modulated arc therapy (VMAT) for complex breast radiotherapy treatments - planning, delivery and QA experience

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Ipswich Hospital NHS Trust

Background During the past 12 months, VMAT has been utilised to treat eight complex whole breast cases (four right and four left) where our standard tangential technique could not be clinically utilised. The main reasons for not being able to use conventional tangents included medial tumour beds, proximity of heart to chest wall, involvement of IMC nodes, and previous treatment to contralateral breast. This work presents our experience in the planning, delivery and QA of complex whole breast VMAT treatments.

Method Our complex whole breast planning technique utilises a method outlined by Nicolini et al [1] to account for intrafractional respiratory motion and uses 2-4 partial arcs. The number of arcs and collimator settings are determined by the distance that the MLCs need to travel to cover the PTV. Location of the isocentre is very important for arcs that need to rotate under the treatment couch and avoid the patient's elbows. Organ at risk (OAR) doses were optimised using IMPORT HIGH dose constraints and evaluated using QUANTEC data. VMAT is delivered using Varian RapidArc. Verification QA is performed using the PTW 2D array and Octavius phantom.

Results Clinically acceptable plans were achieved in all cases. Clinical summary and dosimetric data are outlined in Tables 1 & 2.

OAR doses were comparable to those published in literature. The QA results showed a mean gamma result of 94.2%±2.3% using a DTA of 3%/2mm (Local dose).

Conclusion We are now able to treat complicated whole breast volumes in a safe and effective manner.

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Hypofractionated dose painting IMRT with 20 fractions for intermediate to high risk prostate cancer

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Background The CHHiP trial has shown non-inferiority of 60Gy/20# schedule compared to conventional 74Gy/37# for biochemical control at 5 years. Prostate dose-painting (boosting intra-prostatic tumour volumes, standard dose to the prostate outside the boost volume) may improve biochemical relapse-free survival similar to whole organ dose-escalation, whilst avoiding increased associated toxicity. We present dose painting radiotherapy results for a prospective phase II trial: intermediate to high risk patients treated with 60Gy/20# and concurrent 68Gy boost to intra-prostatic lesions.

Method Patients had a multi-parametric MRI and ^{18}F choline PET/CT prior to androgen deprivation (ADT), and planning MRI and CT following 2 months' ADT. Registration used fiducial markers. Intra-prostatic boost volumes were outlined by combining visually identified lesions on MRI and PET. Rotational IMRT planning was performed. Patients with unexpected regional lymph

node PET uptake also received pelvic radiotherapy with boost. Toxicity evaluation was performed with the IPSS and RTOG scale. Endpoint was acute toxicity at 18 weeks.

Results 61 patients have been planned and treated, 5 with concurrent pelvic radiotherapy. At 18 weeks, median IPSS score was 5.5 (range 0 to 28). Worst acute bladder and bowel was grade 2 which returned to pre-treatment levels by week 18. GU toxicity was more prevalent than bowel toxicity.

Conclusion Prostate radiotherapy with hypo-fractionated dose painting schedule of 60Gy/20# with 68Gy boost to intra-prostatic lesions was technically feasible and well tolerated in this cohort study.

6B Adaptive IGRT

Spotlight mode: reducing imaging time and dose to improve the patient experience

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Background Progress in radiotherapy is driven by the need to increase tumour dose whilst decreasing the dose to surrounding structures. On-treatment imaging enables greater precision and accuracy of radiotherapy. With the advent of Cone-Beam CT (CBCT) it is possible for Therapy Radiographers to visualise soft tissue and correct for discrepancies on-line. With the Varian Truebeam it is possible to take a Spotlight image.

Method Truebeam V2.6 Spotlight modes for Thorax and Pelvis were introduced in January 2016 for all SABR patient images beyond the first CBCT and for 4 out of 5 days a week for prostate patients respectively. Full CBCT for prostate patients weekly was maintained for the assessment of shape change. Spotlight Pelvis was introduced for prostate only due to concerns regarding visualising PTVs and OARs for larger nodal volumes.

Results Spotlight reduced CTDI significantly by 25% and 40% for SABR and Pelvis respectively. The 44% faster quicker timescan reduced motion blurring for lung patients as fewer respiratory cycles are observed, ultimately providing sharper tumour visualisation. Anecdotally, prostate patients tolerated treatment imaging better where repeat scans were necessary. A move to more patients imaged using Spotlight can reduce treatment times and improve machine availability.

Conclusion Spotlight imaging can improve image quality, reduce concomitant dose and improve the patient experience. Care should be taken in application as it may not be suitable for all patients e.g. where the external contour is pertinent. Future developments include optimising spotlight imaging parameters, introducing them to other suitable patient groups and developing modes.

Reduced 4D CBCT scan time in lung cancer patients

Abigail Bryce-Atkinson [1]; Alan Mcwilliam [1]; Tom Marchant [2]; Corinne Faivre-Finn [1]; Gillian Whitfield [2]; Marcel Van Herk [1]

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Background Image guided radiotherapy based on respiration correlated cone-beam CT (4D CBCT) provides accurate tumour localisation by taking into account respiratory motion when deriving setup correction[1]. However, normal scan times are quite long, e.g. 4 minutes. This study aims to assess the feasibility of reduced scan times by evaluating the effect on image quality, registration accuracy and tumour motion detection.

Methods 4D CBCT images were reconstructed from 8 lung cancer patients with minimum 800 projections (120kV, 16mA, 10-40ms), sorted into 10 respiratory phase bins. Reduced scan time and dose was simulated by discarding projections for every other respiratory cycle, equivalent to halving scan time. Image quality was assessed by visual comparison and testing registration accuracy for bone (3D) and tumour (4D), assessing tumour motion in superior-inferior direction in comparison to full projection scan.

Results Discarding half the respiratory cycles had little impact on registration accuracy or ability to detect tumour motion. The maximum discrepancy compared to the full projection scan for tumour registration was 0.7mm and 1mm for tumour amplitude, with all others below 0.5mm. All visual image quality was poorer in the simulated 2 minute scans; however both tumour and bony anatomy remained visible.

Conclusion We used a new simulation method to evaluate the effect of halving the scan time on 4D CBCT. With half the scan time, registration and motion detection accuracy is maintained, while image quality remains acceptable. Halving the scan time improves patient throughput (especially when multiple scans are made) and limits radiation exposure by half.

1. Sonke, J. J., Zijp, L., Remeijer, P. and van Herk, M. (2005) Respiratory correlated cone beam CT. Med Phys, 32(4), pp. 1176-86.

Modelling daily anatomical changes in patients undergoing radical radiotherapy for head and neck squamous cell carcinoma

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Background Patients undergoing radical radiotherapy (RT) for head and neck squamous cell cancer (HNSCC) undergo substantial anatomical change during treatment. Adaptive RT can mitigate this risk, but data to guide when this should take place is scarce. We sought to model intra-treatment anatomical change in a population of HNSCC patients.

Method We devised a measure, lateral neck diameter (LND, the skin-to-skin distance of a line passing behind the mandibular rami and anterior to the C1 vertebra), to approximate mid-parotid level. Daily LND measurements were made on every image-guidance mega-voltage CT from 66 patients with HNSCC in the [*name removed*] study who had undergone IG-IMRT with TomoTherapy.

Results Kolgomorov-Smirnov testing showed daily separation reduction data were normally distributed. Mean final reduction in LND was 12.9 mm (95% CI ±1.9). LND stayed approximately static until fraction 4, after which it followed an overall downward trend (approximating line of best fit $y = 0.0068x2 - 0.4903x + 0.1493$, $R^2 = 0.98$). 45% of this change occurred by the start of week 3 (fraction 11). Interestingly, a greater drop occurred over weekends; whilst LND was static or increased slightly over weekdays (see Fig. 1).

Conclusion The overall trend of our results supports previous studies, but our finer temporal resolution reveals a previously unreported 'weekend effect'. Much of the reduction in LND occurs early, which is mechanistically interesting and has implications for timing of adaptive RT. Further research will aim to explore this 'weekend effect', and link anatomical changes with toxicity outcomes.

9A UKRO proffered papers

Clinical outcome and hippocampal dosimetry in patients treated with stereotactic radiosurgery for brain metastases across South Wales

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Stereotactic radiosurgery (SRS) has demonstrated improved survival and neurocognitive function (NCF) in patients with 1-3 brain metastases and high functionality compared to whole brain radiotherapy (WBRT) [6]. Significant proportion of patients experience worsening neurocognition post-treatment despite its precision [3]: 63.5% of patients undergoing SRS alone had neurocognitive decline [2]. The hippocampus has been implicated in neurocognitive impairment following radiation although the tolerance dose of hippocampus remains unclear for SRS. A dose of >7.3Gy delivered to >40% of the hippocampi during fractionated radiotherapy correlated with worsening neurocognition [3,4]. In animals, low dose of 2Gy exhibited increased apoptosis in hippocampi [1].

We performed a retrospective review of all patients treated with SRS without WBRT over 1year. Patients with 1-3 brain metastases and WHO performance status 0-2 were included. We studied dose delivered to hippocampi. Bilateral hippocampi were outlined manually according to RTOG0933-atlas and dose volume histograms were recreated using iPlan-RT-Dose4.5[4]. 30 patients were treated between January2015-2016. Mean age was 61years. Common primary sites were lung, kidney and melanoma. 19 patients had a single metastasis. 70% patients were alive for more than 6-months after SRS; median survival was not reached. Dose to 0.1cc of the hippocampus was >5Gy in 8 and 2-4.9Gy in 12 patients. 6 patients received >5Gy and 8 received 2-4.9Gy to 50% of the hippocampus.

Objective neurocognitive assessment was not attempted due to the challenges of collecting such data retrospectively. We are about to launch a prospective study in patients undergoing SRS to correlate detailed radiation dosimetry, NCF and functional MRI measurements of the hippocampus.

1. Acharaya M. M. et al (2010) Consequences of ionizing radiation-induced damage in human neural stem cells. Free Radical Biology and Medicine 49: 1846–1855 2. Brown P. D. et al (2016) Effect of radiosurgery alone vs radiosurgery with whole brain radiation therapy on cognitive function in patients with 1 to 3 brain metastases: A randomized clinical trial JAMA 316(4):401-409. 3. Chang, E. L. et al (2009) Neurocognition in patients with brain metastases treated with radiosurgery or radiosurgery plus whole-brain irradiation: a randomised controlled trial. Lancet Oncol 10:1037-44 4. Gondi V. et al (2013) Hippocampal dosimetry predicts neurocognitive function impairment after fractionated stereotactic radiotherapy for benign or low-grade adult brain tumors. Int J Radiat Oncol Biol Phys 85(2):348-54 5. Gondi V. et al (2010) Hippocampal contouring: An contouring atlas for RTOG 0933 6. Tsao, M. et al (2012) A meta-analysis evaluating stereotactic radiosurgery, whole-brain radiotherapy, or both for patients presenting with a limited number of brain metastases. Cancer 118: 2486-93

Implementation of sabr for pancreatic tumours

Peter Enever; Richard Garratt ; Kelly Picken ; Catriona Buchan

Leeds Cancer Centre

Introduction - Radiotherapy for locally advanced pancreatic cancer is rapidly gaining interest with advancements in patient immobilisation, planning and imaging. Through strong MDT collaboration at Leeds Cancer Centre we have implemented SABR for pancreatic tumours.

Methodology - To enable SABR for pancreas we purchased immobilisation equipment including Elekta Bodyfix vac bags and the CIVCO compression arch. New contrast enhanced CT scanning protocols along with abdominal 4DCone Beam CT (4DCBCT) were developed and tested.

Outcome - Although abdominal compression offers a reduction in organ motion for some patients it presents many challenges. The requirement for 4DCBCT due to organ motion has a reduced image quality making anatomical visualisation harder. Due to these challenges a full MDT presence was required at each treatment to aid in tumour and organ at risk matching.

Discussion - Pancreatic radiotherapy is very challenging however with our MDT approach we can optimise the radiotherapy delivery. Increased accuracy of radiotherapy allows dose escalation and availability for patients who would have been ineligible previously; consequently the increase in knowledge and skills has led to the introduction of abdominal SABR and recruitment in to the SPARC trial. As a result radiotherapy becomes a more viable option for patients with pancreatic cancer.

A UK collaborative approach to MR-only radiotherapy treatment planning: improving the patient experience and treatment accuracy

Richard Speight [1]; Hazel Mccallum [2]; Jonathan Wyatt [2]; Emily Johnstone [3]; Charles Kelly [2]; Ann Henry [3]

[1]Leeds Cancer Centre; [2]Northern Centre For Cancer Care; [3]Leeds Institute of Cancer And Pathology

An MR-only based radiotherapy planning process offers advantages in treatment accuracy and improved patient experience over conventional CT-MR based techniques. The Leeds Cancer Centre and Northern Centre for Cancer Care are collaborating to implement an MR-based planning pathway which can be adopted by other NHS hospitals. This approach is intended to be suitable for those with conventional linear accelerators with X-ray-based image guidance, as well as centres with access to MR-guided treatment machines. The project covers a number of studies which will investigate clinical, technical and practical aspects of MR only planning throughout the patient pathway:

- The impact of geometrical distortion on the production of individual treatment plans
- Methods of generating pseudo CT from MRI for treatment dose calculation
- The accuracy of dosimetric calculation for patient plans
- Development of a rigorous quality assurance program to ensure the accuracy of a single modality pathway
- Evaluation of auto-contouring options to optimise clinical volume delineation
- Investigation of methods of treatment verification to ensure accurate treatment delivery

An overview of the overall project will be presented, providing an outline of the technical and practical challenges which the sub-studies seek to address. Initial results from work performed in the first year of the three year project will be described including:

- Early results in developing an MR-only prostate cancer planning technique
- Initial investigations into an MR-only solution for brain cancer patients
- Quality assurance developments required to provide clinical confidence in an MR-only pathway.

Assessment of the effect of geometric distortion in diffusion-weighted magnetic resonance imaging on positional errors in a bladder phantom

Jane Rogers [1]; Victoria Sherwood [2]; Spyros Manolopoulos [2]; Jon Duffy [1]

[1]University of Warwick; [2]University Hospital Coventry and Warwickshire

There is increasing interest in the use of multi-parametric magnetic resonance imaging (MRI) such as diffusion weighted imaging (DWI) and the resulting apparent diffusion coefficient (ADC) maps for informing radiotherapy treatment and assessing tumour burden or response [1]. The next step is to assess the feasibility of using this information to directly influence radiotherapy planning. However, the relatively large inherent geometric distortions in such images mean it is difficult to use them to directly infer position of tumour volumes. This study assesses the magnitude of geometric distortion using a clinically appropriate in-house phantom designed to mimic the bladder and muscle-invasive bladder cancer. Using CT, T2-weighted MR and DWI, the position of 17 markers on the surface of the 'bladder' was assessed and correlated using rigid and deformable registration algorithms.

The position of each marker on the surface of the spherical bladder was identified, and positional agreement found to be on average (range) 2.6 +/- 0.9 mm (1.2 - 4.7) with rigid registration and 1.8 +/- 0.7 mm (0.6 - 2.9), 1.8 +/- 0.6 mm (0.4 - 2.8), 1.8 +/- 0.7 mm (0.2 - 2.6) with various deformable registration algorithms.

These results are in keeping with others in the literature [2] and indicate that there is potential to incorporate the added information from DWI into the radiotherapy treatment plan, provided such errors are further quantified and accounted for.

1. Malayeri, A. a, El Khouli, R. H., Zaheer, A., Jacobs, M. a, Corona-Villalobos, C. P., Kamel, I. R., & Macura, K. J. (2011). Principles and applications of diffusion-weighted imaging in cancer detection, staging, and treatment follow-up. Radiographics: A Review Publication of the Radiological Society of North America, Inc, 31(6), 1773-91. 2. Weygand, J., Fuller, C. D., Ibbott, G. S., Mohamed, A. S. R., Ding, Y., Yang, J., ... Wang, J. (2016). Spatial precision in magnetic resonance imaging-guided radiation therapy: The role of geometric distortion. International Journal of Radiation Oncology Biology Physics

11H UKRO proffered papers

Dose to patients from X-ray imaging in Radiotherapy -- an update from the IPEM working party

Tim Wood [1]; Matthew Williams [2]; Mark Cowen [3]; Anne Davis [4]; Rosy Plaistow [5]; Rebecca Lindsay [6]

[1]Hull And East Yorkshire Hospitals NHS Trust; [2]Velindre Cancer Centre; [3]Peterborough NHS; [4]Portsmouth Hospitals NHS Trust; [5]Cambridge University Hospitals; [6]Leeds Teaching Hospitals NHS

In June 2016, a new working party was formed by IPEM to audit typical imaging doses and image quality for the full range of X-ray imaging procedures undertaken in Radiotherapy departments. This includes planning CT scans, on treatment CBCT imaging, and may also consider other modalities such as planar X-ray and fluoroscopy. As there is currently no definitive guidance on radiation dose levels for the numerous imaging procedures associated with modern radiotherapy, this working party will aim to publish a range of typical doses for common procedures (in much the same way as PHE do with national reference doses in diagnostic imaging). It is hoped that making this data available to the UK Radiotherapy community will enable better optimisation of imaging to ensure doses are ALARP, whilst maintaining image quality that is sufficient for the clinical task (so in some cases, doses in some centres may need to increase!). It is hoped this work will identify best practice that will ultimately benefit patients. This talk will discuss the background to project and give a brief overview of the plan for data collection and analysis, including dose audit and image quality assessment. An overview of initial results for CT planning scans will be presented and the plan for CBCT audit will be outlined.

Utilising non-invasive mechanical ventilation to facilitate rapid shallow breathing: controlling motion in radiotherapy

Nicholas West [1]; Shahid Iqbal [1]; Christopher Walker [1]; Michael Parks [2]; James Prentis [1]; Christopher Snowdon [1]; Jill McKenna[1]

[1]Newcastle Upon Tyne Hospitals NHS Foundation Trust; [2]School of Sport Exercise And Rehabilitation Sciences. Birmingham University

Background In radiotherapy, accounting for respiratory motion increases the volume of normal tissues irradiated, increasing radiation induced complications. There has been limited work using mechanical ventilation to control breathing in a radiotherapy setting with previous studies utilising frequency transrespiratory techniques which are invasive, uncomfortable and impractical for routine use. This study evaluates a new rapid shallow non-invasive ventilation (rsNIV) technique to regularise and minimise lung volume variations over a period long enough to deliver complex high dose radiotherapy.

Method rsNIV was used on normal volunteers in 2 respiratory modes; eupneic frequency and rapid shallow cycles, up to a maximum of 35 cycles per minute. Sagittal datasets, focussed on the diaphragm, were acquired on an MR scanner to assess respiratory motion in eupnea and mechanically ventilated modes. Repeat scans were performed to assess reproducibility over multiple sessions.

Results Subjects reported rsNIV to be comfortable and tolerable with basic physiological responses measured during and after controlled respiration periods, confirming no adverse effects.

Motion analysis of the diaphragm in the superior-inferior direction (largest component of tumour motion), showed that rsNIV was successful in both regularising and reducing respiratory motion.

Conclusion For the first time, rsNIV has demonstrated feasibility and reproducibility in regularising and minimising lung volume variations in a radiotherapy setting. This work will be extended to patients undergoing radiotherapy and if successful, used to reduce uncertainty margins, doses to normal tissues and hopefully complications associated with radiotherapy to thoracic and abdominal regions.

Cost effectiveness analysis of PET-CT for oesophageal cancer

Nor Aniza Azmi [1]; Hairil Rashmizal Abdul Razak [2]; Sobhan Vinjamuri [3]

[1]University of Technology Mara Malaysia; [2]University Technology of Mara, Puncak Alam, Selangor, Malaysia; [3]Royal Liverpool Broadgreen University Hospital Trust, L7 8Xp Liverpool, United Kingdom

Background: Review of publication and retrospective data to develop decision making model-based economic evaluation to investigate the relative cost-effectiveness of PET/CT in oesophageal cancer management staging compared with conventional pathway.

Materials & methods: Retrospective analysis of patient data from 2001-2008 taken from medical records and Cancer Intelligence Services database. A decision tree was developed using TREEAGE software. The model estimated the mean cost associated with each diagnostic procedure and assumed that patients entering the model were aged 35-75 years. The results of the cost-effectiveness analysis are presented in terms of the incremental cost-effectiveness ratios (ICERs).

Results: The ICER for the strategy of PET compared with conventional work-up was estimated at £29,300 per QALY; the ICER for PET/CT compared with PET was £ 31,000 per QALY; and the ICER for PET/CT combined with conventional work-up versus PET/CT was £ 42,100. Clearly, for each additional diagnostic test that is added to PET, the more expensive the package becomes, but also the more effective it becomes in terms of QALYs gained. The probabilistic sensitivity analysis shows that at a willingness-to-pay threshold of £ 20,000 per QALY.

Conclusions: Result of the current analysis suggests that the use of PET/CT in the diagnosis of oesophageal cancer is likely to be cost-effective given the current willingness-to-pay thresholds that are accepted by decision-making bodies. Future studies need to secure robust cost data that can be verified from more than one source for the diagnostic tests and reliable and verifiable data on quality of life.

Developing a communication tool for assessment and mobilisation of patients with metastatic spinal cord compression

Chowdhary, Rahul; Cornelius, Nicola; Pitts, Deborah; Ward, Erica; Wilkinson, Jenni; Carr, Leanne
Lincoln County Hospital

Aim and objectives: The aim of this review was to develop a reliable tool to assess spinal stability and establish the optimal timeline to mobilise the patient, leading to the development of a guideline for consistency of care.

Background: Assessment of spinal stability is vital to plan for treatment and mobilisation strategy in patients with metastatic spinal cord compression (MSCC). There is evidence to indicate that care for patients with unstable MSCC is based on individual clinician preference rather than evidence-based guidelines which has been shown to cause delays and discrepancies in patient treatment. This institution established a multi-disciplinary group to develop a tool to assess stability and aid communication to ensure clarity of patient mobilisation and avoid unnecessary bed rest.

Results: The review identified that evidence relating to spinal stability, bracing, patient mobilisation and positioning is limited. However, using the spinal instability in neoplastic disease (SINS) criteria, as a key resource, a multidisciplinary team within this institution was able to develop a guideline which assessed spinal stability and gave clear indications for mobilisation with or without brace

Conclusion: An institutional guideline was developed for identifying unstable spine and treat patients accordingly so as to cause minimum delay in treatment and minimally disrupt quality of life of a patient balanced against patient safety.

Currently, the evidence base to plan care is limited, and further research in this area is necessary

Fourney D; Frangou E; Ryken T et al; (2011) Spinal instability neoplastic score: An analysis of reliability and validity from the spine Oncology Study Group: Journal of Clinical Oncology: 29 (22) 3072-3077 Sheehan C. (2016) Defining spinal instability and methods of classification to optimise care for patients with malignant spinal cord compression: A systematic review Radiography 22 77e83 Lee S, Grant R, Kennedy C, Kilbride L (2015); Positioning and spinal bracing for pain relief in metastatic spinal cord compression in adults (Review) National Institute for Health and Clinical Excellence (2008). Metastatic spinal cord compression: diagnosis and management of adults at risk of and with metastatic spinal cord compression. London. The Association of Chartered Physiotherapists in Oncology and Palliative Care (2014) GAIN MSCC Rehabilitation Guidelines

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Potential impact on patients of proposed reconfiguration of radiotherapy provision in England

Katharine Chase ; Andrew Bird ; Richard Hayden ; Gareth Webster

Worcestershire Oncology Centre

Background Recent proposals for Modernising Radiotherapy services [1] suggest smaller radiotherapy centres could treat only a sub-set of eligible patients within their population, the justification being that for less-frequent indications centralised expertise could enhance treatment quality. However, for indications where sufficient expertise can be assured locally, patient experience must be considered. This work uses patient demographic data to quantify the impact of the proposed change on patient travel time and distance.

Method Postcodes for all (n=50) upper GI patients treated over a 12 month period at a centre with catchment population of approximately 500,000 were obtained from the Oncology Management System. Distance and time of travel was established using Python scripting and Google Maps API [2] for each patient journey assuming treatment (i) locally, (ii) at a neighbouring regional centre (Centre 1) and (iii) at the likely regional Lead Provider (Centre 2).

Results Mean additional daily travel distance to Centre 1 was 66.8 miles (i.e. 1336 miles for 20 fractions) and 18.7 miles to Centre 2 (i.e. 374 miles in total). 10% of patients would have to travel an additional 49.5 miles or more per fraction to reach their closest alternative centre. Mean additional daily travel time is approximately 1.2 hours (24 hours overall) to Centre 1, 0.6 hours (12 hours overall) to Centre 2.

Conclusions The proposed changes by NHS England could have significant negative impact on patient experience. Provider networks should strive to establish governance measures that will enable high-quality local provision wherever it can be safely

1. NHS England. 2016. Modernising Radiotherapy Services in England – developing proposals for future service models. Specialised Commissioning. https://www.engage.england.nhs.uk/survey/264ceb37/supporting_documents/rtdiscussionguide.pdf 2. Google maps API Documentation https://developers.google.com/maps/documentation/

2B Proffered papers: clinical — Monday 11.30-12.50

Interpretation of TMJ pathology - a jaw-dropping review

Gary Cross [1]; Joseph Barnett [2]; Fern Adams [2]; Kevin Lotzof [3]

[1]London Deanery; [2]Royal Free Hospital; [3]Barnet Hospital

The TMJ is a joint with complex and dynamic anatomy. Disease of the joint is common and present in up to 28% of the adult population. The most frequent pathology is internal derangement, although the joint is also subject to systemic and congenital diseases. The Wilkes classification is the clinical and radiological classification of TMJ disorders that is widely accepted by oral and maxillofacial surgeons, but under-utilised by radiologists. It provides a logical and systemic approach to the radiological interpretation of TMJ pathology. We first demonstrate the dynamic anatomy of the joint and optimal imaging protocols. We will provide an overview of the Wilkes classification and its utility as an approach to interpretation of the joint. A radiological pictorial review of TMJ internal derangement is then presented, covering each stage of disease as classified by Wilkes. We provide examples of internal derangement that fall outside of the classification. Finally we present differential diagnoses, including the TMJ manifestations of systemic and congenital diseases.

*1. Sommer, O., Aigner, F., Rudisch, A., Gruber, H. et al (2003). Cross-sectional and Functional Imaging of the Temporomandibular Joint: Radiology, Pathology, and Basic Biomechanics of the Jaw. Radiographics **23**(6), e14. 2. Wilkes, C.H. (1989). Internal derangements of the temporomandibular joint. Pathological variations. Arch Otolaryngol Head Neck Surg.**115**(4), 469-77.*

Assessing the appropriateness of requests for lumbar spine radiography for low back pain in the community

Ken-Win To; Jonathan Delf ; Leena Naidu

Kettering General Hospital NHS Foundation Trust

Background: The 2009 NICE guidance on management of persistent non-specific low back pain proposes no useful role for lumbar radiography. iRefer limits indications for lumbar radiography in chronic back pain lasting between 6 weeks and 12 months with no red flags if presentation suggests osteoporotic collapse in the elderly. This study retrospectively assesses the appropriateness of the indications provided in plain lumbar spine X-ray requests in the community, as per RCR iRefer guidelines.

Method: 108 lumbar X-ray referrals from General Practitioners (GPs) performed by local radiology departments were included over a 3 week period. The clinical history and clinical question were compared against the RCR iRefer guidelines for appropriateness. Target was 100% to meet iRefer criteria, and 0% lumbar radiographs performed for non-specific low back pain or insufficient clinical details.

Results: Overall 69% of requests were inappropriate according to iRefer guidelines. 36% did not specify the duration of low back pain. 42% did not ask a specific clinical question. 69% of requests were for chronic, long term or unspecified duration of low back pain. Of these 61% were for non-specific low back pain, and 12% mentioned or implied ?osteoporotic collapse.

Conclusion: The 100% iRefer criteria was not met and NICE guidelines have not been completely followed. With appropriate education, there is a huge scope for improvement.

Renal disease in northern territory, Australia - a matter of life choices?

Tu Anh Dao; Cherie Kim

Alice Springs Hospital, Northern Territory, Australia

At Alice Springs Hospital, Northern Territory, Australia, 70 percent of hospital admissions, and 93 percent of renal dialysis services are provided to patients of Indigenous background . Moreover, the Northern Territory's Indigenous population reportedly has the highest incidence rate and prevalence of chronic kidney disease (CKD) in Australia . Unfortunately, there is a stigma associating CKD solely with alcohol abuse and high risk life-style choices. Hence, it is crucial for us as radiographers at Alice Springs Hospital to gain an insight on the underlying causes of this complex disease. From our investigation, it is not just a single factor that causes such high incidence of CKD in Central Australia. It is rather a constitution of multiple risk factors that our patients are exposed to throughout different stages of their lives. Amongst these, biomedical and socioeconomic factors have the most significant impacts. Studies suggested that Indigenous patients may suffer from a genetic condition of nephron deficiency . In addition, poor hygiene, poor infrastructure, poor nutrition and limited access to health services are the most predominant issues on the socioeconomic platform . Together, this leads to low birth weight, high rate of acute and chronic infections, diabetes and obesity. These are the major risk factors to the development of CKD. Perhaps it takes more than an effective alcohol intervention program to reduce the incidence rate of CKD in Central Australia.

Department of Health Northern Territory Government 2014 , Annual Report 2013-14, Department of Health Northern Territory Government, . Australia& New Zealand Dialysis& Transplant Registry (ANZDATA Registry) 2016, 38th Report, Chapter 12: Indigenous People and End Stage Kidney Disease, ANZDATA, Adelaide, Australia, viewed 3 March 2016 < http://www.anzdata.org.au>. Brenner BM, Garcia DL, Anderson 1988, 'Glomeruli and blood pressure: Less of one, more of the

other?', Am J Hypertens, vol. 1, pp. 335 –34. Brenner BM, Mackenzie HS 1997, 'Nephron mass as a risk factor for progression of renal disease', Kidney Int Suppl ,vol. 63, pp.124 –127. Hoy, W., White, A., Tipiloura, B., Singh, G., Sharma, S., & Bloomfield, H. et al. 2014, 'The influence of birthweight, past poststreptococcal glomerulonephritis and current body mass index on levels of albuminuria in young adults: the multideterminant model of renal disease in a remote Australian Aboriginal population with high rates of renal disease and renal failure', Nephrol. Dial. Transplant., vol.31,no.6,pp. 971-977. http://dx.doi.org/10.1093/ndt/gfu241

Mature and immature ovarian teratomas: A spectrum of features and multimodality problem solving

Kelsey Watt ; Bramham Marc ; Diane De Friend

Plymouth Hospitals NHS Trust

Background: Ovarian teratomas are derived from the three germ cell layers of pluripotent stem cells, and thus exhibit a broad spectrum of imaging appearances, which may be confusing for less experienced practitioners. Many sonographers, registrars and consultant radiologists are expected to undertake general lists which include gynaecological cases. Therefore, recognising the broad spectrum of appearances of these common conditions is crucial. Accurate and timely diagnosis, appropriate follow-up and recognition of complications are where those working in general ultrasound and radiology add value in patient management.

Purpose: 1. Recognise the broad spectrum of appearances of mature and immature ovarian teratomas on ultrasound, CT and MRI. 2. Describe the potential complications and sequelae of ovarian teratomas.

Summary: We retrospectively review over 10 years of multimodality imaging of ovarian teratomas to present a pictorial review of their characteristic appearances, primarily on ultrasound, but also CT and MRI. We discuss atypical features, appropriate follow-up imaging, and appearances of associated complications. Mature teratomas are the most common germ cell neoplasm, accounting for up to 20% of ovarian neoplasms, and will be encountered by most practitioners who undertake pelvic ultrasound. Immature teratomas are histologically closely related and far less common than mature teratomas, but are just as important to recognise on ultrasound, particularly as they demonstrate clinically malignant behaviour.

MRI-TRUS fusion-guided prostate biopsy - initial clinical experience

Maeve O'Sullivan ; Mary-Louise Gargan ; Ciara O'Brien ; Elizabeth McEvoy ; Barbara Loftus ; Ted McDermott ; Robert Flynn ; Rustom Manecksha ; William Torreggiani ; Ronan Browne ; Emily Ward

Tallaght Hospital, Dublin

Background Magnetic resonance imaging (MRI) has evolved to become an integral component in the diagnosis of prostate cancer. The PIRADSv2 MRI scoring system is in widespread clinical use, however few studies have validated it's accuracy in detecting clinically significant cancers. Targeted biopsy of the prostate using MRI data has also been shown to improve detection of significant cancer [1]. We correlate the histology from our MRI-US fusion guided prostate biopsies with PIRADS-v2 scores.

Method We reviewed patients who underwent fusion biopsy between August 2015 and November 2016. We collected data on age, prior TRUS biopsy results, lesion location on MRI and subsequent fusion biopsy histology. Each MRI had a PIRADSv2 score prospectively assigned by two consultant radiologists in consensus. Histological results were reviewed and correlated with PIRADSv2 score.

Results 51 patients total, mean age 66.2 years.
31/51 had positive histology (61%). 20/51 had negative histology (39%).
Of 31 patients with positive histology, 8 had prior positive TRUS biopsies. All 8 (100%) were upgraded to a higher Gleason score following fusion biopsy.
Lowest grade of disease detected G3+4.
PIRADS-v2 Score Number of patients % with positive histology
P1 0 0%
P2 3 0%
P3 14 7%
P4 12 75%
P5 22 95%
Conclusion Our results to date add to the burden of proof that MRI-TRUS fusion biopsy can be a very useful tool in the diagnosis and management of prostate cancer, with significant potential to change management. We have also demonstrated excellent correlation between high PIRADSv2 scores and positive histology.

1. Pokorny, M.R. (2014) Prospective Study of Diagnostic Accuracy Comparing Prostate Cancer Detection by Transrectal Ultrasound Guided Biopsy Versus Magnetic Resonance Imaging with Subsequent MRI-Guided Biopsy in Men Without Previous Prostate Biopsies. European Urology Volume 66, Issue 1, July 2014, pages 22-29

MRI characterisation of incidentalomas in the liver: Is intravenous contrast required?

Vincent Leung ; Sahithi Nishtala ; Jonathan Dawkins ; Biju Thomas

University Hospitals of North Midlands

Background: Our institution performs MRI without intravenous contrast as a first line for characterisation of incidentalomas detected on ultrasound or CT. Patients are recalled for contrast MRI if the non-contrast scan returns either an indeterminate result or identifies a lesion needing further assessment. The overall benefit of this approach depends on recall rate.

Method: Retrospective review at a single UK-based university hospital. All non-contrast MRI liver examinations performed for incidentaloma characterisation in the period 01/01/14 to 01/01/15 were included. Data collected on whether or not patients were recalled, the final MRI diagnosis and any further imaging diagnoses at 1 year follow-up.

Results: 79 patients were included, of which only 13 required recall for contrast. The most common non-contrast diagnoses were T2 light bulb intense lesions (33 of 69 cases) and fat deposition (14 of 69 cases). The most common diagnosis following recall was FNH (4 of 13 cases). Over a 1 year follow up period of imaging records, none of the lesions classified as benign on non-contrast imaging were proven to be malignant.

Conclusion: Our experience shows that intravenous contrast is not essential in characterising incidentalomas in the liver. Most lesions have non-contrast characteristics of benign or malignant aetiologies. This approach reduces the need for intravenous contrast, and the associated risks. It also has cost implications, directly by reducing the use of intravenous contrast and indirectly in reducing examination duration, radiologist supervision time and reporting time.

Aunt Minnies of uroradiology

Jonathan Bevan ; Alistair Cowie ; Catherine O'Dwyer ; Syahminan Suut

Salford Royal Foundation Trust

Throughout radiology there are many examples of metaphorical radiological signs which aim to associate the familiarity of everyday objects to patterns of disease seen in imaging. Uroradiology is no exception, and from the bear's paw and manta ray sign to perirenal cobwebs and the spotted nephrogram, there are a wide variety of distinctive "Aunt Minnies" within this specialty that add colour and aid in recognition and interpretation. An Aunt Minnie is a term used to describe a distinctive, recognisable finding that cannot be mistaken for anything else.

By presenting a pictorial review of many of the Aunt Minnies of uroradiology we aim to educate and add insight for those who may not be familiar with some of these signs and to enthuse our colleagues to seek them out within their own practice. All images have been obtained from within the last five years within the North West region and are accompanied by a short description to add context and clinical information to the picture.

Metaphorical and eponymous signs aid in learning, recall and recognition and although by no means comprehensive, this article may act as an educational tool to showcase some of the more striking and memorable signs encountered in uroradiology.

4G Proffered papers - service optimisation and innovation Monday 16.10-17.20

On call provisional CT reporting - are we getting it right?

Harmeet Chana ; Jaymini Patel ; Rajiv Patel ; Gillian Bain ; Arun Gupta ; Maureen Quigley

London North West NHS Trust

Background Following the introduction of Seven Day Services, Health Education England Standards and Royal College guidelines, the importance of identifying the reporting discrepancy rate between registrar and consultant emergency computed tomography (CT) scan has been highlighted. No large recent UK studies address this. We propose a robust grading system and aim to identify factors to improve patient safety and report accuracy.

Methods All out-of-hours CT scan reports in a two-month period were retrospectively reviewed for discrepancies between provisional and final reports. Two consultant radiologists independently graded potential severity of discrepancies according to the proposed grading system: no change; 'minor' (wording/potential clinical nonsignificant impact); 'major' (potentially serious/potentially life threatening). Inter-reader discrepancies were consensed by a third subspecialist consultant radiologist.

Results Of the 1416 on call scans, 964 (68%) were reported by supervised pre-FRCR SpRs. 857/964 (89%) of these were unchanged on consultant review. 80 (8.3%) were graded as 'minor' discrepancy; 27 (2.8%) as 'major'. The 'major' discrepancy rates vary according to body part, highest for abdominopelvic scans (9.6% 'error rate) but only 2/47 (4.3%) for post-FRCR SpRs.

CT heads were reported accurately (1% 'major' error rate). Individual SpR 'major' discrepancy rates ranged from 0 to 6% (median 1.4% [0-3.2%]).

Conclusion This large study demonstrated interobserver variability between consultants and registrars for acute CT reporting to be within accepted standards. The 'major' error rate diminishes with experience. Several opportunities for focused training/improved patient safety have been identified. The described grading system allows report accuracy to be monitored.

1. RCR Guidance regarding on call for clincal radiology trainees, Jan 2015,

Automatically populated worklist enhances safety of on call CT scan checking systems

Rajiv Patel ; Nemi Gandy ; Harmeet Chana

London North West NHS Trust

Background Registrar learning opportunities in the out-of-hours (OOH) setting are highly valuable in radiology training. Consistent with Royal College guidelines, feedback should be provided and cases should be checked the following working day to ensure patient safety. Many review systems require any examination performed OOH to be manually flagged up, either using paper form, or by populating an electronic worklist - complicated by varying levels of autonomy of on call registrars. We examine the impact of changing from a manual, electronic system to an almost completely automated system, and the impact of safety net features.

Methods Retrospective analysis of all OOH CT scans performed in February-March 2016 (period 1) and post-intervention in September-October 2016 (period 2) with analysis of the presence/absence of a consultant review, and the time taken for each scan to be checked. The intervention included implementation of an automated keyword-populated worklist. Results Initial audit in period 1 showed that 15/1115 (1.35%) OOH CT scans went unchecked compared with 7/1531 (0.46%) following implementation of the electronic system (p=0.01). 1015/1115 (91%) were checked the next working day in period 1 compared with 1399/1531 (91.4%) in period 2 (p>0.05). The rate of SpRs failing to flag up reports as a provisional report fell from 0.63% to 0.26% (p=0.15).

Discussion This study demonstrates that a technologically driven solution for automation of worklist population can facilitate enhanced safety in OOH reports checking. This brings new efficiency and reliability to a risk-prone system and should be considered in other centres and wider workflows.

An audit of waiting times for patients with known or suspected malignancy undergoing CT-guided percutaneous biopsy

Frances Sheehan ; Sue Buckingham ; Donna Piper

East and North Hertfordshire NHS Trust

Background: Lengthy waiting times have been associated with poorer outcomes in cancer patients. The NHS Cancer Plan outlines waiting time targets for all cancers of 14 days from receipt of GP referral to first outpatient assessment, and 62 days to commencement of treatment. CT-guided percutaneous biopsies are performed as part of the diagnostic work up for various types of malignancy. Here we determine whether requests received for CT-guided biopsy for cancer patients are acted upon in a timely manner.

Method: Data was collected for 391 patients with known or suspected malignancy referred for CT-guided biopsy over a 3 year period. The number of days between date procedure requested, date request received, date appointment booked and date appointment attended were calculated for each patient then compared for each year and procedure type.

Results: Overall 23% procedures were not performed within 14 days of receipt of request (15% lung, 33% renal and 46% bone biopsies). Delays frequently occurred between date appointment booked and date appointment attended with moderate correlation between the total number of requests received per month and the incidence of delays > 14 days occurring in that month (r = 0.482, P = 0.0039). Peaks of delays occurred around key holiday periods and during junior doctor strikes.

Conclusion: Results suggest that not enough appointment slots are available to handle all requests within 14 days at current levels of demand. By re-structuring service delivery and re-auditing in 1 year, we hope improvements will be made.

1 Department of Health. (2000) The NHS cancer plan: a plan for investment, a plan for reform. London: The Stationery Office. 2 Department of Health. (2007) Cancer reform strategy. London: The Stationery Office. 3 Elit L. (2015) Wait times from diagnosis to treatment in cancer. J Gynaecol Oncol. Oct;26(4): 246-248.

The consultant breast radiographer - a role innovation exemplar

Anne-Marie Culpan ; Paul Marshall

University of Leeds

Aim This study explored the evolving role of consultant radiographers in symptomatic breast services.

Methods Unstructured interviews with radiologists and radiographers (n=39); non-participant observation of clinics and MDT meetings (8 NHS Trusts in England); mixed method framework analysis.

Findings After formal task-specific training and extended periods of practical experience, consultant radiographers undertook and reported the full range of routine diagnostic tests performed in symptomatic clinics. Expertise across all diagnostic techniques in a single clinical (breast) domain gave consultant radiographers a holistic overview of the patient journey; multiskilling enabling a single practitioner to perform all examinations for an individual patient. Specialisation in breast imaging enabled development of expertise across all technical disciplines (radiography, ultrasound, intervention, MRI, clinical examination) but required consultant radiographers to give up tasks they were trained for originally - general radiography and other non-breast imaging. Backfilling with lower grade assistant / radiographer practitioners gave experienced radiographers enough time to undertake the training and repetition (volume of cases) needed to develop expertise in advanced breast diagnostic techniques. As consultant breast radiographers took on more tasks usually performed by radiologists, they also gave up mammography image acquisition. Although consultant radiographers were able to lead symptomatic MDT meetings, lack of expertise in whole body cross-sectional and non-breast imaging was a barrier to contributing to clinical decision making for cancer staging and cases with co-existent non-breast disease.

Conclusion Consultant breast radiographers had created a new innovative technical-clinical hybrid role in which they were 'more than a radiographer, but not quite a radiologist'.

A five year longitudinal evaluation of the impact of a bespoke professional development programme for consultant radiographers

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Background Radiographer consultant practice is not yet embedded within many radiology departments, and the role has been criticised for not truly encompassing all four domains of consultant practice. A large acute NHS Trust seconded five radiographers to an apprenticeship-style consultant development programme, and the outcomes of the secondment were evaluated via a longitudinal qualitative research study.

Methods The host organisation created secondment objectives linked to the four domains of consultant practice. Individual semi-structured interviews were conducted at 1, 6 and 12 months to assist consultant trainees to benchmark their achievements against the objectives. Group interviews were conducted at 18 months and 5 years to enable validation of findings and impact analysis. Qualitative analysis generated themes relating to process, outcomes, barriers and facilitators.

Results All five radiographers secured a consultant post. The 0-18 month period was a highly emotional personal development journey. While secondment objectives were achieved between 12-18 months, the five year review demonstrated much deeper engagement with the objectives. Consistent themes observed at 5 years included growth in confidence, leadership, proactive approaches and recognition of 'being consulted'. These culminated in a well-recognised increase in maturity and differentiation of the role.

Conclusion Radiographers require an 18 month period of preceptorship and systematic objective setting to prepare them for this challenging role, with a further 2-3 years of supported development. The secondment objectives are an appropriate tool for initially benchmarking progress at the apprenticeship stage, and subsequently assessing the impact of consultant practice in more experienced consultants.

Is radiography ready for apprenticeships? A critical review of the evidence and reflection on its implications

Denise Baker

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The introduction of the Apprenticeship Levy in April 2017 appears to be driving a significant and fundamental change of the way in which pre-registration education could be funded in the future. The nursing degree apprenticeship was announced in November 2016 and there is already an indication that radiography will look to become an apprenticeship quickly. When coupled with the removal of commissioning of training places and the student bursary, the pace and scale of change is significant. Research into apprenticeships has demonstrated positive and negative impacts to this model. (Fuller & Unwin, 2003a). Evidence suggests that the apprenticeship model offers many opportunities to learners but only when the employer is engaged and committed to this model. Additional evidence from (Fuller & Unwin, 2003b) describes the expansive / restrictive continuum in relation to apprenticeships and explores how different communities of practice will influence the apprentice's learning experiences. This paper will explore the government's mandate to increase apprenticeship places (which also obliges

public sector employers to assure a growth in apprenticeships set against an ambitious target. (Burnett et al., 2016) explore many facets to the current apprenticeship agenda, many of which will have implications for radiography: How will apprenticeships differ from current pre-registration education? How can communities of practice support or scupper apprentices? Will radiography be able to support the on programme learning required for apprenticeships? How will putting the employer in the driving seat impact on pre-registration education? Do we have enough and suitably qualified mentors and assessors in practice?

Burnett, K., Clarke, L., Fuller, A., Keep, E., Lanning, T., McCormick, D., & Relly, S. J. (2016). Apprenticeships, Where Next. Cipd, (August). Retrieved from http://www.cipd.co.uk/binaries/where-next-for-apprenticeships_2016.pdf Fuller, A., & Unwin, L. (2003a). Creating a "Modern Apprenticeship": a critique of the UK's multi-sector, social inclusion approach. Journal of Education & Work, 16(1), 5. https://doi.org/10.1080/1363908022000032867 Fuller, A., & Unwin, L. (2003b). Learning as Apprentices in the Contemporary UK Workplace: creating and managing expansive and restrictive participation. Journal of Education and Work, 16(4), 407–426. https://doi.org/10.1080/1363908032000093012

An audit on the impact of a regional collaborative out of hours service on trainee feedback

Christopher Keegan [1]; Shruthi Patel [1]; Fatma Bayam [2]

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In August 2015 the Merseyside collaborative out of hours (OOH) service was formed, providing a central hub for OOH reporting within the region. This enabled registrars to work a less frequent rota, increasing time for training at their base hospital. Traditionally OOH reporting feedback was given in person at the base hospital. This is now no longer practical due to the scale of the collaborative system.

An online survey was distributed amongst the 35 registrars in the region who participated in OOH provision. The questions were concerned with the frequency and quality of consultant feedback from OOH reports from the collaborative, as well as for individual trusts.

Of the 35 registrars, 21 responses were received (60%). 15% stated they received feedback always or frequently, 60% occasionally or rarely and 25% stated they never received feedback. 63% of respondents felt that checking consultant's addendums on their reports was insufficient feedback. 37% report not always checking these addendums. If feedback was given explicitly, 58% of the time it was via email. Since forming the collaborative, consensus amongst the registrars is that feedback has deteriorated.

The collaborative benefits trainees by reducing the on call frequency and increasing training opportunities during working hours. However this has had a negative impact on individual feedback for trainees. As a result of this survey, trainees email addresses have been distributed to each trust and clinical supervisors are encourage to feedback directly via email. A regular discrepancy meeting is in progress to encourage learning for all trainees from on call studies.

Variations in reporting radiographer report structure

Anthony Manning-Stanley

University of Liverpool

Background: Radiographer reporting is a well-established advanced practice in the United Kingdom. No studies have examined variations in report content for this group, specifically report structure, word count and word length.

Method: The radiology information system for a major trauma centre in the north-west of England was interrogated for a 12-month period; data including report text for every radiographic knee examination performed via A&E was obtained (Microsoft Excel spreadsheet). For five reporting radiographers, report text was copied and pasted into Microsoft Word, with word and character counts (without spaces) for the overall report, the report title/header, the main body of the report and the report signature recorded. Word length was calculated.

Results: 1,530 reports were analysed. Overall variation in report structure was found; 83.1% of reports included a title, whilst 55.4% included a signature. Individually, 4 out of 5 radiographers always included a report title; 3 out of 5 never included a signature. For 2 of 10 radiographer pairings, the mean overall report length demonstrated significant differences (range 17.8 to 60.8 words per report, ANOVA t-test; $p<0.001$); for 3 out of 10 radiographer pairings, mean word length for the overall report demonstrated significant differences (range 5.5 to 6.2 characters long, ANOVA t-test $p<0.001$).

Conclusion: Significant variations exist in report structure in a group of five reporting radiographers from a single Trust. This has implications for communication with referrers. Similar trends should be investigated for other examinations, other Trusts and for other reporting groups.

6D Proffered papers - science, education and radiation protection Tuesday 11.20-12.40

Writing about radiation in your IRAS application

Andrea Shemilt

Nottingham University Hospitals NHS Trust

There are many guidance documents relevant to ionising radiation used in medical research. In the process of approval and set-up for research involving the NHS, the IRAS [1] application is reviewed by the HRA [2], incorporating ethics review. It's submitted to the competent authority, if relevant, and the NHS Trust sites involved, to obtain Organisation Confirmation of Capacity and Capability (previously known as NHS Permission). This means that the content of the IRAS form is vital in getting all the elements of approval in place for recruitment to commence.

The author describes the requirements to communicate radiation procedures in the IRAS application in light of the changing HRA guidance. This includes discussion of the role of the Lead Medical Physics Expert and Lead Clinical Radiation Expert, the various legislations and policies applicable to the context, and discusses the rationale behind articulating radiation exposures in the process of ethical review. Examples are given of the radiation questions in the IRAS application and how they may be accurately completed.

1. Integrated Research Application System https://www.myresearchproject.org.uk/ 2. HRA Approval http://www.hra.nhs.uk/about-the-hra/our-plans-and-projects/assessment-approval/

An audit into radiation awareness and a qualitative assessment into requesting and interpretation of common imaging modalities: A junior doctor and final year medical student survey

Ahmed Ali [1]; Muhammad Khan [1]; Sam Booth [2]; Aniket Sonsale [2]; Reshma Bharamgoudar [2]; Shahid Hussain [1]

[1]Birmingham Heartlands Hospital; [2]University of Birmingham

Introduction: An essential component of patient safety is the clinician's understanding of risks associated with imaging, including radiation exposure. Evidence suggests that only a third of clinicians receive formal training in radiation dosing and protection[1]. Additionally, effective communication with the radiology department and the ability to refer patients 'effectively, timely and appropriately' are vital as per the Royal College of Radiologists (RCR) Undergraduate Curriculum[2]. Junior doctors must also be able to perform basic interpretation of radiographs with an emphasis on spotting common emergencies.

Aims and methods: A survey based on the RCR audit-live template 'Awareness of Radiation Doses Incurred in Diagnostic Investigations[3](Standard: 50% cohort awareness) was circulated around to all foundation year doctors and final year medical students in a UK based Trust. The survey was modified to include assessment of radiation doses, radiation legislation awareness, subjective confidence in the interpretation of basic imaging modalities and ability to appropriately request imaging.

Results: There were 71 respondents, 80.28% were not aware of any governmental regulations regarding radiation. Majority of respondents failed to correctly identify radiation doses of commonly requested imaging with 14.08% correctly identifying the radiation dose of a CT head. 36.62% felt confident or very confident in their ability to request appropriate imaging. Over 45% did not feel confident in interpreting skeletal and abdominal radiographs. Action plan: A one day radiology teaching day addressing the above themes will be organised in March 2017. The survey will be recirculated and the outcomes re-audited.

1.Soye & Paterson. A survey of awareness of radiation dose among health professionals in Northern Ireland. BJR 2008; 81: 725-729. http://bjr.birjournals.org/cgi/content/abstract/81/969/725. 2. The Royal College of Radiologists. Undergraduate Radiology Curriculum. London: The Royal College of Radiologists, 2012. 3. Duncan K, Remedios D. Awareness of Radiation Doses Incurred in Diagnostic Investigations | The Royal College of Radiologists [Internet]. rcr.ac.uk. 2008 [cited 9 December 2016].

Radiation safety culture initiatives in X-ray imaging optimisation

Hugh Wilkins

University of Exeter

Background Risks from radiological imaging are generally poorly understood by patients and many healthcare professionals. The familiarity of X-ray imaging procedures in modern medical practice and the evident benefits of imaging, coupled with the absence of immediate adverse effects of exposure to radiation, can lead to complacency. The breaking of the link between over-exposure and image quality deterioration associated with the transition from screen: film radiography to digital imaging can lead to the phenomenon of dose creep, with doses to patients not as low as reasonably practicable.

Method Whilst never losing sight of the benefits of medical imaging, there is increasing recognition that radiation safety practice in medicine is markedly more lax than in other industries where people are exposed to radiation, notably in comparison with the

nuclear power sector. This has led to a number of global developments in recent years aimed at improving radiation protection in medicine, such as the Bonn Call for Action[3]. However, some individuals who have championed improvements in this area have encountered surprising resistance when seeking to encourage optimisation of X-ray imaging.

Results Such experiences have created an increased focus on improving radiation safety culture in medicine. IRPA guiding principles[4] have led to UK initiatives, such as those published by Croft et al[2] and Chapple et al[1], which not only outline the problem but suggest novel solutions.

Conclusion There is growing recognition of the need to improve radiation safety culture in X-ray imaging, to protect patients from unnecessary exposure to radiation.

1. Chapple C-L., Bradley A., Murray M. et al (2016). Radiation safety culture in the UK medical sector: a top to bottom strategy. Rad. Prot. Dos. advance access published 1 December, 1-7 2. Croft J, Coates R, Edwards C et al (2016). Promoting radiation safety culture in the UK. IRPA14 Conference Proceedings. Available from https://srp-uk.org/resources/radiation-safety-culture (accessed 18.12.16) 3. International Atomic Energy Agency and World Health Organisation (2013). Bonn Call for Action. Available from https://rpop.iaea.org/RPOP/RPoP/Content/News/poster-on-bonn-call-for-action.htm (accessed 18.12.16) 4. International Radiation Protection Association (2014). IRPA guiding principles for establishing a radiation protection culture. Available from http://www.irpa.net/page.asp?id=54669 (accessed 18.12.16)

A review of MR labeling information related to IEC 62570 labeling requirements of commercially available MRI accessories

Gina Stateczny [1]; Gregor Schaefers [2]

[1]MRI-Tec; [2]MR:comp GmbH

Commercially medical accessories such as furniture, wheel chairs, instruments, gas cylinders, etc. can be ferromagnetic or electrically conductive. Those are not designed, thus contraindicated to be used in the MR environment (MRE). Several health injuries have been reported by use of incorrect or unlabeled MR devices. Outcome: MR safety labeling MR Safe, MR Conditional and MR Unsafe are the standardized terms used in MR labeling, which is created for MR product approval at worldwide regulatory agencies.

Methods About 96 conventional available MRI products have been selected randomly and from throughout the daily use of MR clinical application:

* MRI audio and video systems
* MRI gurneys
* MRI goggles
* MRI injection systems etc.

The product documentation has been investigated for required MR marking/labelling and the completeness of MR labelling information 96 Products have been analyzed. More than half of the investigated products have never been properly tested and assessed for safety in the MR environment. There could be fatal consequences if products contain ferromagnetic materials, be conductive, thus hurt the patient or have its function affected as well as Interfere the MR system, if a device is not fully tested. ASTM F2503-13 and IEC 62570:2014 require that all medical devices/accessories entering the MRE have to be tested at least to the following MR safety test methods dependent of the position of use of the accessories inside the MRE and marked comprehensively for MRE safety required.

[1] ASTM F2503-13 standard practice for marking medical devices and other items for safety in the magnetic resonance environment [2] IEC 62570:2014 Standard practice for marking medical devices and other items for safety in the magnetic resonance environment [3] Guidance for Industry and FDA Staff; 2014; Establishing Safety and Compatibility of Passive Implants in the Magnetic Resonance (MR) Environment [4] Curr Radiol Rep (2016) Planning an MR Suite: What can be done to ensure MR safety? Gregor Schaefers, Björn Mierau Published online: 10 May 2016 [5] ÖNROM S 1125-1. Safety officer for magnetic resonance equipment for medical diagnosis-part 1; responsibilities and competences. Vienna: Austrian Standards Institute; 2009 [6] DIN 6876. Operation of medical magnetic resonance systems. Berlin: German Institute for Standardization; 2014. [7] Kanal E, Barkovich AJ, Bell C, et al. ACR guidance document on MR safe practices: 2013. J Magn Reson Imaging. 2013;37:501-30.

Improving from an IR(ME)R inspection

Toni Hall

Oxford University Hospitals NHS Foundation Trust

Background In August 2016 we received 72 hours notice of an IR(ME)R inspection. The feedback had positive elements but resulted in the issuing of an improvement notice over 8 specific areas

Method A comprehensive action plan was developed alongside the Trust assurance team Weekly progress meetings were held involving Radiology, Medical Physics and the assurance team Tasks were focused on achieving compliance with the improvement notice across all 8 sites Results Due for reinspection in January 2017, although significant improvements shown by internal audit

Conclusion We share our experience and the positives learning from receiving an improvement notice. We show how our department is now more resilient.

Image quality: Old vs new

Stephen Wolstenhulme ; Kate Langstaff

Leeds Teaching Hospitals NHS Trust

Background: Ultrasound studies with good image quality (IQ) is a requirement when examining patients with suspected abdominal disease and in the fetal anatomy screening programme (FASP). PURPOSE: To enhance the delegates learning when reviewing twelve images to evaluate the impact of four important ultrasound equipment technology parameters on IQ.

Methods: One experienced sonographer obtained comparable images (six renal and six fetal head) from one adult volunteer, using three different ultrasound machines and a trans-abdominal transducer. The following parameters were manipulated : compound imaging, frequency, speckle reduction and harmonic imaging. The presentation will allow you to review and evaluate the images, which will allow the delegates to determine the impact of these important factors on IQ.

Discussion : Direct comparison of the images produced will show the profound effect modern ultrasound technology has on IQ. After evaluating these images consider in your own department the impact of these parameters on your levels of diagnostic confidence.

Conclusion: 21st century medicine requires high resolution ultrasound image quality (IQ) to aid patient diagnostic pathway. This interactive e-poster highlights the difference between aging and new equipment, using a simple experiment to directly compare images from one healthy volunteer. It demonstrates the importance of leading edge technology when undertaking diagnostic imaging.

1. NHS (England) Fetal Anomaly Screening Programme - 18+0 - 20+6 week fetal anatomy scan (2016/17) http://bit.ly/28MSLEM (accessed 07 December 2016 2. SoR. 2015. Standards for the provision of an ultrasound service. http://www.sor.org/learning/document-library/standards-provision-ultrasound-service (accessed 07 December 2016)

A method to model the influence of beam quality on image noise in a digitally reconstructed radiograph (DRR) based computer simulation for optimisation of digital radiography

Craig Moore; Tim Wood

Hull and East Yorkshire Hospitals NHS Trust

Background: Computer simulation of digital x-radiographs has become widespread in recent years. It is vital simulated radiographs contain adequate anatomical and system noise to make optimisation investigations realistic. Recently, our group has produced a computer algorithm capable of simulating x-radiographs but the method used to add (non-anatomical) noise only modelled the incident detector X-ray intensity ('dose') and neglected X-ray beam quality. However, it has been shown recently for digital mammography imaging that beam quality is an important factor when modelling noise in simulated images but there are no such studies for diagnostic imaging of the chest/abdomen/pelvis; this study aims to address that.

Method: On a real DR imaging system image noise was measured as a function of dose over a range of clinically relevant beam qualities. Simulated 'dose' and 'beam quality' images were then created per patient per tube voltage under investigation. Simulated 'noise' images were subsequently produced from the simulated 'dose' and 'beam quality' images, using the measured noise/dose/beam quality relationships. The 'noise' images were added over the noiseless 'dose' images to create images with noise correct for dose and beam quality.

Results: Signal and noise measurements in simulated chest, abdomen and spine images are within 10% of the corresponding measurements in real images. This compares favourably to our older algorithm where images corrected for dose only were all within 20%.

Conclusion: An image simulator that corrects noise for dose and beam quality has been produced and validated for diagnostic imaging. This can be used for optimisation purposes.

The efficacy of routine radiographer QA testing

Shahed Khan [1]; Natalie Thring [2]

[1]Radiation Consultancy Services Ltd.; [2]RCS Ltd

Ionising Radiations Regulations 32 requires that the employer has in place a quality assurance programme, which includes radiographers performing routine tests on all X-ray producing equipment. The current best practice standard is IPEM Report 91.

Modern X-ray systems come with maintenance contracts either from the manufacturer or third party and these generally include remote diagnostics. This allows for the monitoring and to some degree online maintenance of the equipment, to help limit equipment downtime in the event of reported faults. We review the routine quality assurance tasks conducted at a number of sites by radiographers/operators, focusing on the faults identified during the routine testing and analyse the downtime due to faults not identified during these routine tests, to determine the efficacy of the QA testing. The results indicate that there exists a number of difficulties including time management and local Operator expertise which confound the efficacy of routine QA programmes. The routine testing appears to have no real significance in terms of fault prediction or downtime reduction, leading to the mistaken perception QA can be a 'waste of time' and complacency, which may in turn lead to real safety issues as equipment ages. The supplier remote diagnostic schedules were also examined. It would appear that the full potential of remote diagnostics is not being utilised. An improved solution would involve reducing the number of operator tests to ensure equipment is fit for purpose, more effective use of the available manufacturer remote diagnostics functionality and the use of medical physics support.

Institute of Physics and Engineering in Medicine (2005) Report 91 Recommended Standards for the Routine Performance Testing of Diagnostic X-Ray Imaging Systems, 4-20, 41-48

7F Proffered papers – clinical Tuesday 14.10-15.30

Value of invasive angiography following negative CT angiogram in the haemodynamically unstable patient with pelvic trauma

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[1]Aintree; [2]University Hospital Aintree

Multidetector CT scanning of trauma patients has rapidly become the norm, and is often the first imaging modality carried out ahead of plain film radiography or FAST scanning [1]. High-energy pelvic trauma in particular, given the close relationship between bony and vascular structures, may have several sites of injury [2] necessitating rapid diagnosis and intervention. Despite the high negative predictive value of CT [3], a negative trauma scan might not conclusively rule out vascular damage in a small number of patients. The effects of immediate resuscitative measures such as the use of pelvic binders and "shock-packs", and the physiological effects of haematoma formation and vasospasm, may mask vascular damage at the time of scanning. The relatively poor prognosis of this subset of trauma patients [4] necessitates more aggressive investigation and intervention to improve their chances of survival. The trend towards centralised, and specialised trauma centres will mean that these patients will be seen more often in these hospitals. As a major trauma centre we present and analyse cases over a 3 year period where invasive angiography has complemented the investigation and treatment of haemodynamically unstable patients with pelvic trauma, with negative or equivocal CT traumogram, underscoring the importance of an interventional radiology service in hospitals that serves as part of the major trauma network. Pelvic vascular anatomy will be reviewed, as will a variety of cases demonstrating the use of invasive angiography in diagnosing and treating pelvic vascular trauma, with an overview of both technical and service delivery considerations.

[1]. Standards of practice and guidance for trauma radiology in severely injured patients. The Royal College of Radiologists https://www.rcr.ac.uk/sites/default/files/docs/radiology/pdf/BFCR(11)3_trauma.pdf [2]. Woong Y et al. Pelvic Arterial Hemor- rhage in Patients with Pelvic Fractures: Detection with Contrast-enhanced CT. RadioGraphics 2004; 24:1591–1606 [3]. Hamilton J et al. Multidetector CT Evaluation of Active Extravasation in Blunt Abdominal and Pelvic Trauma Patients. RadioGraphics 2008; 28:1603–1616 [4]. Scemama U et al. Pelvic trauma and vascular emergencies. Diagnostic and Interventional Imaging 2015; 96:717-729

The current state of MRI in vascular access imaging

Conor MacDonald [1]; Rose Ross [2]; J G Houston [3]

[1]University of Dundee; [2]NHS Tayside, Vascular Clinic; [3]NHS Tayside, Radiology

Introduction Failure rates in arterio-venous fistulas (AVFs) remain high, and it is important that preoperative predictors of failure are identified. MRI offers strong angiographic capabilities, but has not seen great usage in vascular access (VA) imaging. A review was conducted to determine the state of research in this field, and to identify the advantages and disadvantages of using MRI to image VA.

Methods A literature search was performed on PubMed. One reviewer (CM) identified and examined 126 studies that focused on MRI imaging of the VA. Studies on non-imaging factors, phantom imaging, other types of AVFs, computational simulations and animals were excluded. Endpoints such as staging, contrast use, and cohort size were analysed.

Results 19 studies were identified between 2002 and 2015. Collectively, the studies analysed 595 patients: 280 with AVFs, 138 with AVGs and 21 with CVCs. 10 without VA, and 123 awaiting VA creation. 15 studies were post-operative and 4 were pre-operative. All studies used MRI: 9 compared MRI with DSA, 2 with US and 1 with CT. 2 studies compared MRI with both US and DSA. 2 compared MRI sequences, and 3 did not compare modality or sequence. 16 studies used contrast enhancement.

Conclusions Only 4 of the studies utilised MRI as a pre-operative imaging modality. The pre-operative benefit of MRI as a potential predictor of AVF outcomes may not have been realised. The prevalent use of contrast in these studies would now be considered an unacceptable rick due to the association with renal failure and NSF.

1. Bode, (2012), Feasibility of Non-contrast-enhanced Magnetic Resonance Angiography for Imaging Upper Extremity Vasculature Prior to Vascular Access Creation, European Journal of Vascular and Endovascular Surgery 43, 88-94 2. Doelman, (2005) Stenosis detection in failing hemodialysis access fistulas and grafts: Comparison of color Doppler ultrasonography, Journal of vascular surgery, 42, 4, 739-46 3. Duijm, (2006), Inflow stenoses in dysfunctional hemodialysis access fistulae and grafts, American Journal of Kidney Diseases, 48, No 1, 98-105 4. Froger, (2005) Stenosis detection with MR angiography and digital subtraction angiography in dysfunctional hemodialysis access fistulas and grafts, Radiology: 234: 1; 284-291 5. Gao, (2012), Three dimensional gadolinium enhanced MR venography to evaluate central venous steno-occlusive disease in hemodialysis patients, Clin. Radio. 67, 560-563 6. Han, (2003), Failing hemodialysis access grafts: Evaluation of complete vascular tree with 3D contrast-enhanced MR angiography with high spatial resolution: Initial results in 10 patients, Radiology; 227:601–605 7. Jin, (2015), Non-contrast-enhanced MR angiography for detecting arteriovenous fistula dysfunction in haemodialysis patients, Clinical Radiology, 70, 852-857 8. Mende, (2007), Time-Resolved, High-Resolution Contrast-Enhanced MR Angiography of Dialysis Shunts Using the CENTRA Keyhole Technique With Parallel Imaging, Journal of magnetic resonance imaging, 25, 832.840 9. Nayak, (2014), High-resolution, whole-body vascular imaging with ferumoxytol, as an alternative to gadolinium agents in a pediatric chronic kidney disease cohort, Pediatric nephrology, 30, 3, 515-21 10. Paksoy, (2004), Three-dimensional contrast-enhanced magnetic resonance angiography (3-D CE-MRA) in the evaluation of hemodialysis access complications, and the condition of central veins in patients who are candidates for hemodialysis access, J NEPHROL; 17: 57-65 11. Pinto, (2005), Time-Resolved Magnetic Resonance Fistulography with TREAT and GRAPPA for Surveillance of Hemodialysis fistula, Proc. Intl. Soc. Mag. Reson. Med. 13, 12. Pinto, (2006) Time-resolved MR angiography with generalized autocalibrating partially parallel acquisition and time-resolved echo-sharing angiographic technique for hemodialysis arteriovenous fistulas, 17, 6, 1003-9 13. Planken, (2008), Contrast-enhanced magnetic resonance angiography findings prior to hemodialysis vascular access creation: a prospective analysis, The Journal of Vascular Access, 9, 269-277 14. Planken, (2008), Magnetic resonance angiographic assessment of upper extremity vessels prior to vascular access surgery: feasibility and accuracy, Eur Radiol, 18, 158–167 15. Planken,(2003), Stenosis detection in forearm hemodialysis arteriovenous fistulae by multiphase contrast-enhanced magnetic resonance angiography: Preliminary experience, JOURNAL OF MAGNETIC RESONANCE IMAGING, 17, 54–64 16. Sigovan, (2012) USPIO-enhanced MR Angiography of Arteriovenous Fistulas in Patients with Renal Failure, Radiology, 265, 2, 584-90 17. Smits, (2002), Hemodialysis access imaging: Comparison of flow-interrupted contrast-enhanced MR angiography and digital subtraction angiography, Radiology, 225, 829–834 18. Tanju, (2005), Direct contrast-enhanced 3D MR venography evaluation of upper extremity deep venous system, Diagn Interv Radiol, 12, 74-79 19. Zhang (2005) Time-resolved 3D MR angiography with parallel imaging for evaluation of hemodialysis fistulas and grafts: Initial experience, AJR, 186, 1436–1442

MRI evaluation of epicardial adipose tissue in patients with cardio-metabolic disease: Potential pathophysiological links with inflammation and vascular dysfunction

Shaween Al-Talabany [1]; Ify Mordi [1]; Graeme Houston [1]; Helen Colhoun [2]; Jonathan Weir-McCall [1]; Shona Matthew [1]; Daniel Levin [1]; Jill Belch [1]; Fiona Dove [1]; Faisel Khan [1]; Chim Lang [1]

[1]University of Dundee; [2]University of Edinburgh

Background: Epicardial adipose tissue (EAT) is an emerging cardio-metabolic risk factor and has been shown to be correlated with coronary artery disease and left ventricular dysfunction. It has been suggested that EAT can exert local effects on the coronary arteries and the myocardium and could potentially exert harmful effects systemically; however the underlying pathophysiology of this link is not well understood. Arterial stiffness is implicated in both coronary artery disease and in heart failure pathophysiology. We have examined the relationship between EAT and arterial stiffness, measured by pulse wave velocity (PWV) in a cross sectional study of patients with cardio-metabolic disease and controls.

Methods: 145 participants (61.4 % male, with mean age of 63.9 ± 8.1 years) were categorised into four groups: (1) type 2 diabetes mellitus (T2DM) with cardiovascular disease (CVD); (2) T2DM without CVD; (3) CVD without T2DM; (4) controls. Measurements were performed on 4 chamber cardiac MR images to define EAT. Arterial stiffness was assessed by carotid-femoral PWV. Blood from participants was analysed with the Olink Proseek Multiplex immunoassay platform.

Results: EAT were higher in T2DM with CVD group (15.9±5.5 cm^2) and in CVD without T2DM group(15.1±4.3 cm^2) in comparison to T2DM without CVD group (13.6±3.5 cm^2) ,and controls(11.8±4.1 cm^2) (P=0.001).There was a significant correlation between PWV and EAT (R= 0.28, p=0.002).

Conclusion: EAT showed an association with arterial stiffness which is pathophysiologically linked to both coronary artery disease and heart failure. EAT appears to be associated with systemic inflammation and increase cardiovascular risk.

1-Mazurek T et al Human epicardial adipose tissue is a source of inflammatory mediators. Circulation. 2003;108(20):2460-6. 2-Baker AR et al Human epicardial adipose tissue expresses a pathogenic profile of adipocytokines in patients with cardiovascular disease. Cardiovascular diabetology. 2006;5:1.Epub 2006/01/18. 3-Kocaman SA et al The independent relationship of epicardial adipose tissue with carotid intima-media thickness and endothelial functions: the association of pulse wave velocity with the active facilitated arterial conduction concept. Blood Press Monit. 2013;18(2):85-93.

Nebulised 18f-fluorodeoxyglucose (18f-fdg) assessment of pulmonary drug deposition: Proof of concept

Shamsuddeen Ahmad Aliyu [1]; Glenn Woolley [2]; Ged Avery [2]; Simon Hart [3]; Chris Cawthorne [1]; Steve Archibald [1]; Alyn Morice [3]

[1]University of Hull; [2]Hull and East Yorkshire NHS Hospital Trust; [3]Hull York Medical School

Introduction: Drugs for patients with lung diseases are frequently administered by inhalation, but the delivery to specific areas of the lungs is poorly understood. This phantom study aims assess the feasibility and radiation safety of a system to visualise lung deposition of nebulised 18F-fluorodeoxyglucose. Methods: Using an in-house lung phantom 4.22 MBq 18F-FDG was dispensed into a LCD PERI nebuliser. a 1 minute nebulisation procedure was carried out whilst mimicking normal human tidal

breathing (16 breaths per minute). Four expiratory filters were used to stop radiation contamination. Imaging performed on a Siemens Biograph mCT PET/CT Flow scanner. Attenuation correction CT and 3-D PET images obtained using Continuous Bed Motion (CBM) for 17 mins at 0.5mm/s. Exhalation filters and environmental swabs assessed using a sample counter.

Results: After the one minute nebulisation 500 KBq of 18F-FDG was nebulised, 69.0 KBq (14%) was deposited into the phantom. The remainder was captured within the closed system. Deposition in the phantom was predominately central in the proximal one-third. Significant activity was deposited in the artificial trachea, 55% on the inner filter, 0.29% on the middle two and 0.1% on the outer filter. No contamination of the room or personnel detected.

Conclusions: Lung distribution and quantification of nebulised 18F-FDG is feasible. This may be an effective way of measuring uptake and distribution of aerosol drugs and determining the efficiency of aerosol drug delivery devices. The next stage is a pilot study comprising healthy volunteers

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Low-dose CT screening for lung cancer: Are we truly achieving a low-dose?

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[1]Lungs for Living, UCL Respiratory; [2]Homerton University Hospital; [3]University College London Hospital; [4]Health Behaviour Research Centre; [5]David Evans Research Centre

Background: Low-dose CT (LDCT) screening is effective within at-risk populations at reducing morbidity and mortality from lung cancer. A spectrum of CT equipment is used across the NHS. Many sites do not have the latest dose reduction technology.
Methods: Data were collected as part of the Lung Screen Uptake Trial. LDCT chest was performed at two study sites (S1/S2) using different CT scanners: S1 Toshiba Aquilion 320 (2014) and S2 Toshiba Aquilion 64 (2006). Dose monitoring was performed according to protocol, and optimised if a maximum threshold was reached (2mSv). The mean effective dose overall, per site, and by study period, was analysed using a t-test.

Results: 334 baseline LDCT were performed; 232 (S1, 9 months) and 102 (S2, 4 months). Combined mean effective dose remained within the acceptable threshold (1.45mSv; 0.6 -- 11.8) and no significant difference found between study sites (S1 mean 1.43mSv; S2 mean 1.51mSv; p=0.384). Ten of the initial 21 scans performed at S2 exceeded the maximum effective dose (mean 2.22mSv, maximum 3.8mSv). Scanner calibration, and alteration of reconstruction and noise reduction algorithms reduced the mean effective dose to 1.43mSv (p<0.0001) for further scans at S2. No significant difference was found at S1 (initial scans 1.37mSv; subsequent scans 1.49mSv; p=0.29).

Conclusion: Initial effective dose data demonstrate that LDCT chest can be performed regardless of equipment age. To ensure compliance with dose requirements, close monitoring, QA and technique optimisation is required. Restrained capital investment for replacement CT equipment is not a barrier to implementation of LDCT screening.

Ipsilateral dual-site, same-sitting percutaneous lung biopsy: A feasibility study

Joseph Barnett ; Aniket Tavare ; Ash Saini ; Sam Hare

Royal Free Foundation Trust

Background Patients with thoracic malignancies often have more than one site of pulmonary, nodal or pleural disease within one hemithorax. In addition, large heterogeneous lesions may comprise distinct, mixed pathological entities. Histological analysis of these lesions can alter tumour staging and treatment options. We investigated the feasibility, safety and benefit of performing image guided percutaneous lung biopsy (PLB) of two lesions in the same hemithorax at a single sitting.

Methods Ten consecutive outpatients with two or more potential disease foci within the same hemithorax were analysed over a 15 month period. The mean age of the patients was 66 years (range 46 -- 81 years). Patients underwent CT-guided co-axial 20G core biopsy of both lesions, with separate co-axial punctures for each lesion. Patients were managed as per established local institution ambulatory lung biopsy protocol using small-caliber Heimlich-valve chest drain (HVCD) to treat significant post-PLB pneumothorax in an out-patient setting. Data regarding lesion characteristics, diagnoses and complications were recorded.

Results All 10 patients (n=20 biopsies, 100% technical success) received informative histological diagnosis on both lesions. This altered management in all cases. Although a high rate of pneumothorax occurred (60%; 6/10), only two of these patients required treatment with HVCD. No other significant complications occurred in those patients with small asymptomatic pneumothoraces nor those that required HVCD placement.

Conclusions Dual-site lung biopsy, performed as a single procedure, is potentially a safe and effective technique for diagnosing patients with multiple thoracic lesions; and can provide useful staging information to guide patient

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10F Proffered papers - clinical

Diagnostic paediatric imaging out of hours: A quality improvement project

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Chelsea & Westminster Hospital

Background: Currently, no national guideline exists outlining the provision of out-of-hours paediatric diagnostic imaging services and "access to these services has been described as patchy, especially out of hours" (Paediatric Emergency Services Survey 2011). The PESS reported "a significant proportion of inaccurate reporting is due to misinterpretation of results by non-specialist or trainee radiologists," concluding that access to a consultant radiologist is "an important marker of a quality service." We sought to review whether consultant presence out-of-hours impacts clinical outcome in the management of paediatric patients.

Methods: Retrospective audit of all out-of-hours diagnostic paediatric studies performed at a tertiary paediatric-referral hospital, over 6-months. Recorded whether imaging was routinely reviewed by a paediatric consultant radiologist and if so, whether changes to the preliminary report were made and if this altered contemporaneous patient management.

Results: A total of 94 studies, including 24 fluoroscopic, 33 computed tomographic, 37 sonographic studies were reviewed. Overall, 83% of all studies were independently performed by radiology trainees. No significant changes to reports were made upon consultant review in 94% of cases and there was no appreciable impact on overall patient management. Of the 24 fluoroscopic studies, intussusception and malrotation were queried in 5 and 19 cases respectively. All intussusceptions were successfully reduced, regardless of consultant presence. The reason for a lack of consultant review in 7/94 cases requires further clarification.

Conclusions: The incidence of major discrepancies between the initial out-of-hours report and subsequent consultant review was virtually non-existent in our study, and did not lead to any significant clinical deterioration.

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Quantitative and qualitative values for the different T2W image sequences used for fetal MRI

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[1]University of Sheffield; [2]Sheffield Teaching Hospitals NHS Foundation Trust; [3]Sheffield Children's Hospital

Aim To assess and compare the visual quality of images produced by 3 different T2 weighted sequences; HASTE, STIR and FISP. To perform quantitative analysis by calculating contrast ratios between body areas and contrast to noise ratios for each sequence and to compare these between the sequences.

Methods 97 patients scanned on a 1.5T Siemens Avanto MRI system were included. Visual quality of these images was assessed jointly by 2 experienced radiologists and graded 0-3 (0 - non diagnostic and 3 - excellent). Image quality was compared between sequences. Regions of interest were drawn on three anatomical structures in the brain: grey matter, white matter and cerebrospinal fluid, and in the body in three organs: right lung, left lung and liver. Background noise was also measured. These values were used to calculate contrast ratio and contrast to noise ratios and results compared for the 3 sequences.

Results STIR and HASTE sequences showed superiority over FISP in providing better image visual quality. STIR and HASTE sequences had higher contrast ratios in brain images than FISP. For body images, contrast ratios by STIR were superior to HASTE, which was superior to FISP. HASTE sequence contrast to noise ratios were higher than STIR which were higher than FISP sequence.

Conclusion STIR and HASTE sequences provide similar image quality and tissue contrast in depicting the foetal brain, whereas the STIR sequence is the superior sequence in imaging the body. The FISP sequence has the lowest visual quality and tissue contrast.

Development of an instrument to assess trauma radiograph interpretation performance

Michael Neep [1]; Thomas Steffens [1]; Victoria Riley [2]; Patrick Eastgate [3]; Steven McPhail [1]

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Background The assessment of technical skills during training and practice can be considered to be a form of quality assurance. The purpose of this investigation was to develop a valid and reliable instrument to assess trauma radiograph interpretation performance suitable for use among health professionals. Method Stage 1 examined 14159 consecutive adult appendicular and axial examinations from an Australian hospital emergency department over a 12 month period to quantify a typical anatomical region case-mix of trauma radiographs. A sample of radiographic cases representative of affected anatomical regions was then developed into the Image Interpretation Test (IIT). Stage 2 involved prospective investigations of the IIT's reliability (inter-rater, intra-rater, internal consistency) and validity (content and concurrent) among 41 radiographers.

Results The final IIT included 60 radiographic examinations. The median (interquartile range) clinical experience of participants was 5 (2-10) years. Case scores were internally consistent1 (Cronbach's alpha=0.90). Favourable inter-rater reliability2 (kappa>0.70 for 58/60 cases, Intra-class Correlation Coefficient3 (ICC)>0.99 for total score) and intra-rater reliability (kappa>0.90 for 60/60 cases, ICC>0.99 for total score) was observed. There was a positive association between radiographers' confidence in image interpretation and IIT score (coefficient=1.52, r-squared=0.60, p<0.001).

Conclusion The IIT developed during this investigation included a selection of radiographic cases consistent with anatomical regions represented in an adult trauma case-mix. Results from this study provide foundational evidence to support the reliability and validity of the IIT. The investigators conclude that it is possible to assess image interpretation performance of trauma radiographs with this selection of radiographic cases.

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3D CT based orthopaedic reconstructive software

David Liston

Sectra Ltd

Background With the increasing relevance of the use of CT data in orthopaedic trauma patients the reliance on flat 2 dimensional X-ray data is becoming less and less.

Purpose Advancement in the use of digital data for clinical diagnosis and planning has seen the development of increasingly more sophisticated platforms to allow physicians and clinicians better understanding of symptoms. 3D reconstructive software for the complex trauma patient better enables a viewing surgeon to understand the fracture patterns and manipulate them back into their correct alignment pre-operatively. This not only decreases operative time but can significantly reduce the workflow of data centric clinicians such as MSK radiologist. Over time the process has now evolved into fully manipulative fragments as well as output to 3D print fractures/ specific anatomical zones to give better understanding of each individual patient.

The relevance in teaching environments of such platforms should also be highlighted, and how 3D reconstructive tools are used to better educate trainees on surgical approaches, treatment pathways as well as implant choice.

Summary This presentation will highlight the usages in clinical environments as a tool to make rapid diagnostic decisions as well as visualise difficult orthopaedic procedures pre-operatively, and how utilising 3D CT based planning can reduce workload on other departments.

High index of suspicion aided with muskuloskeletal ultrasound can resolve complex midfoot and hindfoot problems, which can be otherwise sometimes labelled as 'non-specific footpain': Review of literature with pictorial review of differential diagnosis

Saayija Kumarachandran [1]; Ajay Chourasia [2]; Mahdi Saleh [1]; Muhammad Ali [1]; Aanchal Mehta [3]; Avantika Narasimhan [4]; Ajay Sahu [1]

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Introduction: The correct diagnosis of foot and ankle problems remains an enigma for clinicians due to complex anatomy and multiple clinical conditions. Conventional radiographs are only helpful in late features of the midfoot arthritis. Ultrasound is very sensitive in diagnosis of early Midfoot arthritis well before X-ray changes and can be managed by guided injections easily, if needed. MRI is better in demonstrating bone marrow edema and biomechanical causes but a clinical radiologist has the advantage of clinically assessing the patient during ultrasound, aided with scanning.

Methods: We have come across many causes of midfoot problems in our department, which can be diagnosed by Ultrasound with accuracy. Midfoot arthritis, navicular stress disease, chronic metatarsalgia, extensor tendinitis, tibialis posterior

insufficiency, plantar fasciitis, stress fracture, peroneal tendon problems, cavus or planovalgus deformity and tarsal coalition etc. Interestingly some of these patients were referred as forefoot problems e.g Mortons neuroma clinically, however it was eventually diagnosed that there pain was being referred from midfoot arthritis.

Result: We will demonstrate cases of midfoot arthritis from our institution, where radiographs could not demonstrate it and were reported normal despite sonographic abnormalities detected later.

Conclusion: Ultrasound is an excellent modality to target symptomatic sites for assessment of changes (dorsal osteophyte formation, effusion, hyperemia and synovitis), which helps in making early diagnosis and instituting treatment in form of guided injections to the the affected joint. Ultrasound by a MSK Radiologist can resolve these problems in the most cost effective and timely fashion.

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Do radiologists and radiographers need to know about osteoporosis?

Amit Gupta ; Sandra Wood ; Ne-Siang Chew ; Muthusamy Chandramohan ; Clare Groves

Bradford Teaching Hospitals NHS Foundation Trust

Background Osteoporotic fractures represent a potentially avoidable burden to both the patient and healthcare service. The estimated lifetime risk of fracture at the hip, lumbar spine or distal forearm is 30-40% in developed countries. With over 200,000 fractures occurring every year, the current financial cost to the NHS amounts to over £1.75 billion annually with the figure only set to rise in the future as the population ages As vertebral fractures increase the risk of subsequent fragility fractures by four to five fold, their recognition by the radiology team is crucial for the implementation of secondary prevention strategies. Detecting and treating vertebral fractures early can prevent further vertebral fractures, decrease patient morbidity and prevent future hip fractures. Prompt radiological intervention presents an opportunity to reduce the financial burden of osteoporosis to the NHS.

Purpose: The aim of this review is provide clinicians, radiologists and radiographers an overview of osteoporotic fractures, highlight the importance of detecting such fractures and describe the methods of how we at our institution have improved our detection rates of such fractures -- not just a local problem but a national one.

Summary: Brief background of osteoporotic fractures and key statistics, pictorial review of different osteoporotic fractures, classification of vertebral fractures, the use of DEXA scanning to identify such patients and describe the methods we have introduced to improve our detection rates.

Gout imaging with dual energy CT: Imaging protocol, post-processing techniques and its limitations

Wei Ling Chuang ; Bak Siew Wong

Singapore General Hospital

Background: Gouty arthritis is a common crystalline and inflammatory arthropathy and is characterized by hyperuricemia (serum urate level >6.8mg/dl), with deposition of monosodium urate (MSU) crystals in tissues, leading to inflammation and tissue damage.

Definitive diagnosis of gout requires positive finding of MS crystals from fine needle aspiration of the synovial joint fluid. It can be technically challenging and is not identified in up to 25% of acute gout cases, whether due to insufficient amount of fluid aspirated, the anatomical location or recurrence of acute inflammation.

Impact: Dual-energy CT imaging enables high-molecular-weight compounds to be separated from low-molecular-weight compounds, allowing the differentiation and characterisation of calcium and uric acid, allowing DECT to be a non-invasive option in the diagnosis of gout.

Content: The current scan techniques being used in our institution include a 128-slice Siemens Flash CT scanner installed in 2013. Unenhanced scans acquired as per department protocol with the coverage of the entire foot.

Post-processing includes axial soft, axial bone, coronal bone, and sagittal bone images of the foot. In addition, material color-coded images using specific attenuation characteristics are generated to aid the diagnosis of gout. It is important to identify post-processing artifacts such as nail bed or calluses to avoid false-positive results. Tendons can be clearly depicted on the color-coded images, aiding in the localisation of disease.

Conclusion: DECT provide a fast and non-invasive option for the diagnosis of gout. Good imaging technique and knowledge of post-processing artifacts are crucial to provide an accurate diagnosis.

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12G Proffered papers Wednesday 14.10-15.30

The use of eye tracking technology to assess radiographer interpretation of X-ray images

Laura McLaughlin [1]; Sonyia McFadden [1]; Ciara Hughes [1]; Jonathan McConnell [2]; Raymond Bond [1]

[1]Ulster University; [2]NHS Greater Glasgow and Clyde

Background: Studies have used eye tracking technology to assess radiographer ability to identify pulmonary lung nodules within chest images. This digital technology has provided an insight into cognitive processes during image interpretation. Within this study we use eye tracking technology to assess image interpretation skills on a variety of pathologies to determine differences in approach and search strategies.

Method: Eye tracking data was collected during participant interpretation of musculoskeletal and chest radiographic images while thinking aloud. A total of 312 image interpretations were collected from 21 students and 18 reporting radiographers.

Results: Reporting radiographers were more accurate (p≤0.001), confident (p≤0.001) and took a mean of 2.4s longer to decide on image features compared to students. Reporting radiographers had a greater mean fixation duration (p=0.01), mean fixation count (p=0.04) and mean visit count (p=0.04) within the areas of pathology compared to students. Students had a higher fixation frequency than reporting radiographers (p=0.03) for the area of pathologies. Eye tracking patterns, presented within heat maps, and recordings of participants thought processes were a good reflection of group expertise and search strategies.

Conclusion: The accuracy and confidence of each group could be reflected in the variability of their heat maps. A number of computed eye gaze metrics were statistically significant in discriminating between students and practitioners, that an algorithm could be used to automatically and non-intrusively classify radiographer performance. Heat maps, containing high fixation areas representing common areas of pathology presentation, may be a useful aid for undergraduate teaching of pathology recognition.

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Formulating and implementing a robust feasibility governance pathway for clinical research within the imaging department

Rachel Sutton ; Ruth Cope ; David Wells

University Hospitals of North Midlands NHS Trust

The research team has been in place within Imaging since 2013. In the beginning there were many challenges to the role, these included: no list of trials, no pathway to assess feasibility, no definite Radiology Lead for each trial, difficulties in identifying trial patients, no funding pathway and no ability to audit. An authorisation proforma was devised in order to implement the feasibility pathway. The proformas contain all the governance checks required to assess capacity and capability for research trials involving Imaging and are held on a secure server which is accessible to members of the Imaging department. They act as a quick reference guide for trials and can be useful as an audit trail. The feasibility pathway has allowed our department to understand its research activity and therefore future capacity for trials. Evidencing trial activity has led to an increase in CRN funding which has in turn allowed us to support more trials. The feasibility pathway aims to identify barriers early so that issues can be resolved quickly. When capacity has been a challenge we have devised innovative solutions. When there hasn't been any funding for imaging we have worked together alongside research teams to establish agreement over costs. We believe it has also speeded up the trial set up process which is beneficial to both patients and sponsors. It has raised the profile of research within Imaging and the Trust so that we stand out as a research led department not just a support service.

The views of radiology service managers concerning professionalism and the ability of newly qualified graduate radiographers to cope with working in contemporary clinical contexts

Charles Sloane ; Paul Miller

University of Cumbria

Background The findings reported in this poster emerge from a broader project which mapped the views of radiology service managers in the UK concerning the 'fitness for purpose' of diagnostic radiography graduates.

Method In line with the conventional methods of Straussian Grounded Theory, N=20 Radiology Department leads in the United Kingdom, working within NHS Trusts (N=19) and independent provision (N=1), were interviewed. All interviews were semi-structured, conducted and recorded by telephone and transcribed verbatim.

Results A major theme emerging from the data concerned the ability of graduates to cope and with demands of working in the modern NHS. Conflicts related to motivation, role expectations and the graduate's ability to maintain their professional responsibilities were highlighted as issues which impacted upon their roles. Concerns were also raised into the ability of graduates to communicate effectively and to be cognisant of the potential consequences of poor communication upon efficient working and complaints.

Conclusion There was widespread dissatisfaction with the capability of graduates to fulfil key functions within their wider role beyond the technical aspects of clinical imaging. Issues related to the capabilities and expectations of the current generation of students applying for radiography programmes could stem from wider socioeconomic changes in society and the marketisation of education. This has implications for education providers in relation the design of curricula and programme delivery. It is argued that different approaches are now required which align professional and service requirements with the values of a new generation of students.

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Evaluation of interprofessional learning workshop involving radiographers, vascular surgeons and theatre staff

Brooke Reeve

Royal Free Hospital London

Aim To create quarterly inter-professional learning workshops, helping to undertake complex vascular procedures in theatre.

Content To describe the workshop set up, pictures and future development plans. Provided an opportunity for Radiographers and the Vascular theatre team, to understand each other's roles within a theatre setting. Gave an insight into what is expected from each team and how procedures will be carried out. Allowed Radiographers to learn the new theatre equipment in a 'controlled' setting, and become competent in the equipment with an Apps specialist on site. Provided Radiographers with a booklet on equipment and how to obtain 'Gold Standard Images' on the new theatre equipment. Relevance All Radiography Bands had the opportunity to attend the workshop. This inter-professional workshop was found to be relevant to their CPD, allowing an understanding of what's expected before attending a case.

Outcomes Both Vascular and Radiography teams found the workshop to be detailed and a high learning experience of a vascular theatre case. Both professionals experienced inter-professional working, understood each other's roles and what challenges arise during a case.

Discussion Radiographers rated the workshop and learning booklet to be high quality. Staff provided feedback that would help structure the next workshop. Both professionals where able to discuss throughout the session, how each team could help aid one another. During the workshop there was an opportunity to take on the other role giving insight on each other's role during a case.

Pulmonary artery hypertension - making the diagnosis

Rose Panton ; Adam Wallis ; Paula McParland

Portsmouth Hospitals NHS Trust

Background: Pulmonary artery hypertension (PAH) is characterised by mean pulmonary pressures of >25mmHg and a progressive re-modelling of the distal pulmonary arteries. The result is elevated pulmonary vascular resistance and subsequently, right ventricular failure. In normality pulmonary pressures at rest are typically <14mmHg, rising to 30mmHg during exercise with increased vascular resistance. Sub-types of PAH (including CTEPH) and their distinguishing imaging features will be demonstrated.

Relevance of the topic to diagnostic imaging: Timely and accurate diagnostic imaging has a crucial role in identifying and monitoring patients with PAH. Chronic thrombo-embolic pulmonary hypertension (CTEPH) is an important cause of severe pulmonary hypertension and is associated with significant morbidity and mortality.

Purpose: (1). To increase recognition of this important condition using diagnostic imaging. Specifically to: (a) highlight the characteristic radiological features and associated sequelae of PAH on CT imaging (b) highlight the imaging features specific to PAH sub-types (c) highlight typical ECHO findings seen in PAH (2). To describe the typical radiological features of CTEPH and highlight its importance as a cause of PAH.

Application to practice: It is hoped that by increasing radiological recognition of this condition it will guide informed clinical practice and optimise patient management.

Summary of content: The presentation will outline the typical radiological findings of pulmonary artery hypertension to inform accurate clinical diagnosis and early recognition of the disease.

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CT sinus and facial bones reporting by radiographers

Paul Lockwood

Canterbury Christ Church University

Background The aim of this study was to compare the observer performance of a cohort of radiographer's in reporting Computed Tomography (CT) sinus and facial bones investigations against a reference standard and alternative comparator of summary data from peer reviewed literature.

Purpose: The aim of this presentation is to enable conference participants to review results from a cohort of radiographers (n=6) results of an examination bank (n=25 cases using radiologists as reference standards) after completion of part-time training programme. A literature search was performed to identify an additional alternative comparison reference standard from studies reporting observer performance data in CT sinus and facial bones investigations of both trauma and sinus pathology (target conditions). The intended learning outcomes are: 1. Describe the process of assessing radiographer's ability using a range, and variety of statistical methods and reference standards. 2. Begin to evaluate the level of reporting radiographer competence in CT Sinus and facial bone reporting. 3. To start to reflect afterwards of the various advanced practice roles available for radiographers to support service delivery

Conclusion. The data analyses used to measure observer performance and determine differences between the cohort and the reference standards, used statistical assessment models including accuracy, sensitivity, specificity, Kappa (k), summary receiver operating characteristic curves with estimated area under the curve (AUC).

Constructing the "ideal" first-post sonographer: Mapping the views of ultrasound department leads in the UK

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Background The findings reported in this presentation emerge from a broader project investigating the future of Ultrasound education in the UK. Specifically addressed herein is the way in which the employers of prospective first-post sonographers assembled the attributes and aptitudes that would constitute an "ideal" person for such a role.

Method In line with the conventional methods of Straussian Grounded Theory, N=20 Ultrasound Department leads in the North West of England, working within NHS Trusts (N=17) and independent provision (N=3), were interviewed. All interviews were semi-structured, conducted and recorded by telephone and transcribed verbatim.

Results Participants cited "acquired" capacities such as advanced communication skills, good time management and the ability to work autonomously as essential in a first post-sonographer. They also argued that certain "inherent" personality traits should be sought out as part of a selection process; these attributes included patience, amicability, empathy, caring and a tendency towards perfectionism. Although academic aptitude was deemed important, the ability to be non-judgmental was deemed more so.

Conclusion In discussing the ideal attributes of a workplace sonographer, it became clear that the participants had a clear sense of which were desirable and undesirable. However, and in a more novel vein, it was equally clear that they also held strong and relatively consistent views on which kinds of personal attribute were static (i.e. immanent qualities of a prospective employee) and which were malleable (i.e. could be altered/improved with on-the-job training). This, it is contended, has significant import for educators and trainees alike