DOSE AWARENESS DAY

d001 Radiation awareness amongst junior doctors, re-audit.

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Background Recent literature suggests that junior doctors' knowledge of ionising radiation is inadequate. Advances in technology and availability have led to of these investigations being readily requested. Exposure is associated with adverse risks especially malignancy, therefore in accordance with IR(ME)R, clinicians should be aware of radiation doses and their legal responsibility as referrers, to insure no unnecessary exposures. The first audit cycle demonstrated limited knowledge. Understanding of the fundamentals of imaging techniques was limited, with >70% requesting more teaching. The action plan included teaching sessions focussing on radiation awareness and using i-Refer to request imaging responsibly.

Method A prospective study of all foundation doctors attending teaching at Royal Oldham Hospital was conducted. A questionnaire regarding knowledge of radiation doses, ALARA and guidelines was circulated to all foundation 1 doctors.

Results Overall, results of the re-audit were very promising. Of the 25 responses received 96% agreed that CT TAP had the highest radiation dose, 72% correctly estimated the risk of inducing a malignancy (compared to 43% and 49% from first cycle), and 72% correctly estimated the relative dose of radiation compared to 0% form the first cycle. 95% and 98% understood IR(ME)R regulations and how to use i-refer to request responsibly, a dramatic improvement from 1% and 0% respectively from the cycle one.

Conclusion Structured and dedicated teaching sessions has shown to improve the knowledge of the junior doctors; this has the potential to help to reduce inappropriate imaging requests and unnecessary radiation exposures.

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d002 Derriford Hospital foundation doctors' knowledge of ionising radiation legislation and exposure

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Introduction Studies have revealed a lack of appreciation among referrers regarding ionising radiation exposure.[1] Furthermore, foundation doctors are commonly being asked by seniors to request radiology without fully understanding the clinical indications. Referrers have a legal obligation to comply with IR(ME)R (2000).[2] Many trusts bundle radiation training into `induction e-learning`, which may get overlooked by new trainees. This audit assesses foundation trainees` knowledge of radiation and suggests changes to employers/trusts learning provision.

Method

Target

1. 100% of foundation doctors should have knowledge towards radiation legislation.
2. 90% of foundation doctors should have appropriate knowledge of common/important radiation doses.[3]

Data Collection

•Questionnaire distributed to foundation doctors in PHNT.

Initiation of Change

•Teaching to foundation doctors on IRMER and iRefer.

Re-audit Data Collection

Questionnaire re-distributed to foundation doctors after intervention.

Results There were 24 responses to the first questionnaire. 12 were aware of legislation regarding radiation; 9 were able to name IR(ME)R. None were aware of referral guidelines. 21 admitted being asked to request radiology from seniors without full understanding. 17 felt that they did not have adequate teaching regarding referrals.

Following a teaching intervention, there were 23 responses to the re-audit questionnaire. 23 were aware of government legislation; 22 named IR(ME)R. 23 were aware of iRefer. There was significant improvement in knowledge of common plain film and CT ionising radiation doses. 3 stated they haven`t received adequate radiology referral teaching.

Conclusion Induction mandatory e-learning alone is not sufficient in ensuring adequate junior doctor knowledge of radiation legislation. Additional workshops significantly improve understanding of ionising radiation and appropriate referral, which is essential for patient safety within referring teams.

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d003 **Dose audit in plain radiography for paediatric imaging: a multi-centre study**

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Background: There are currently no National Paediatric Diagnostic Reference Levels (DRLs) for plain radiography paediatric imaging studies in the UK. A multi-centre study was performed to establish and compare Local DRLs between three NHS hospitals.

Methods: Data from 3 hospitals was collected for n=62,167 paediatric patients (<17 years old). Data was collected from the Radiology Information Service (RIS) for two sites and a Dose Management System (DMS) for the other. Dose Area Product (DAP) values were analysed for each age group (0,1,5,10 and 15 year olds) using SPSS v.22 for the most frequent examinations (>10 studies per age group). Exposure parameters including kV and mAs were also analysed where available.

Results: From the data obtained from RIS 29% did not include a unit for the DAP value; this were excluded from the final analysis. As expected this was not an issue with data obtained from the DMS. In each age group the median DAP varied from 1.4 to 7.1 cGycm2 for chest; 2.9-8.0 cGycm2 for wrist; 3.7-6.2 cGycm2 for ankle; 2.3-5.1 cGycm2 for knee and 3.1-10.1 cGycm2 for elbow.

Conclusions: The DMS not only provided the data in a more time efficient manner but it was of a superior quality when compared to that obtained from the RIS. National DRLs will be easier to establish across all radiology examinations as more sites across the NHS adopt DMSs. This data will now be compared to values published in literature. Although a mixture of Computed Radiography (CR) and Digital Radiography (DR) systems and vendors are operated across the three sites this audit has demonstrated a need for optimisation and harmonisation.

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d004 **Establishing a comprehensive and automated imaging dose registry for radiotherapy**

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Background: Radiotherapy centres are encouraged to actively manage concomitant imaging doses(2). An imaging dose registry has been developed to comprehensively and automatically capture both treatment and pre-treatment radiotherapy imaging exposures.

Methods: The registry is orientated around a Conquest DICOM archive of Radiation Dose Structured Report (RDSR) objects. Conquest forwards the objects to the open-source OpenREM system(1). which parses and stores the relevant dose information. A script extracts patient height and weight from the ARIA oncology management system (OMS) and stores these in OpenREM. A new data-warehousing layer presents the OpenREM data in a denormalised form suitable for exploration by data analytics tools. RDSR objects are automatically sent to the dose registry by the radiotherapy CT scanner and a script runs daily that extracts linac treatment exposure information from the ARIA OMS and generates RDSR objects which are forwarded to the registry. This includes information about kV and MV planar imaging and kV CBCT scans.

Results: Operators consider the registry the definitive record of imaging exposures and regularly consult it as part of technique audit and development. It is also used during multi-disciplinary peer review to consider whether imaging practices remain clinically appropriate. Opportunities for optimising CBCT protocols have been identified by detecting via the registry where significant dose modulation has been performed by the CT scanner during pre-treatment imaging. Pre-treatment exposures were consistent with local and national DRLs. **Conclusion**: The effectiveness of strategies for radiotherapy imaging optimisation can be explored by considering dose information alongside image evaluation.

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d005 **Comparison of a size-adjusted versus a standard-size approach for dosimetric calculations**

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Background Effective dose (E) is currently used as the only common dosimetric index between modalities, until organ doses are available. Even though it is meant for populations, several tools use phantoms of various sizes to evaluate E for different body habitus. This study investigates the differences between standard-size and size-adjusted dosimetry for chest radiography.

Method A set of 233 adult chest posterior-anterior examinations was used. The examination parameters and patient information were extracted from the dose management platform DOSE (Qaelum NV, Belgium). The E was estimated with two methodologies. First, calculated by DOSE, that uses a standard-size conversion factor. Secondly, simulations were executed with PCXMC (STUK, Finland), which scales its phantom to match patient's weight and height, using the corresponding examination parameters. This provided size-adjusted dose, which was compared to the standard-size results.

Results The patients' Body Mass Index (BMI) ranged from 13 to 44 (median 26). Differences in E (%D_E) between DOSE and PCXMC ranged from -22% to 90% (median 15%). The correlation between %D_E and BMI was r^2=0.73. Underestimations for the underweight and overestimations for the overweight and obese patients were observed. For 88% of the patients with normal BMI (18.5-25), %D_E was within ±15% and for 67% it was even within ±10%.

Conclusion A standard-size conversion factor towards effective dose works well for the normal size patients, but results in underestimations for the underweight and overestimations for the overweight and obese patients. These dose differences could be a trigger for a more personalized approach in dosimetry.

Martin, C. J. (2007) Effective dose: how should it be applied to medical exposures? The British Journal of Radiology, 80, 639-647 Yanch, J. C.; Behrman, R. H.; Hendricks, M. J. & McCall, J. H. (2009) Increased Radiation Dose to Overweight and Obese Patients from Radiographic Examinations. Radiology, 252, 128-139

d006 **Effective dose and effective risk of projection radiography procedures in obese patients compared with normal-weight patients.**

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[2]Musgrove Park Hospital; [3]University of Exeter

Background: The radiation dose to obese patients in projection radiography is not well documented as for computed tomography and interventional radiography. This study aimed to estimate the effective dose and the effective risk of projection radiography procedures conducted for obese patients with a comparison to normal weight patients.

Materials and methods: Dose of area product (DAP) from four projection radiography procedures; abdomen, lumbar spine, chest and pelvis, that were conducted for obese patients, have been used along with DAP figures from normal patients based on the national diagnostic reference level 2010 review, to estimate the absorbed dose and effective dose for obese and normal weight patients using Monte Carlo software, PCXMC 2. The effective risk was estimated, for males and females from 20 years age and above, based on the organ absorbed dose and the cancer risk figures from the report of the health protection agency.

Result: Obese patients in this cohort are receiving higher effective doses in the four studied procedures compared to the normal weight patients. The effective dose increases percentage in obese patients compared to normal adult ranged between 25% for the chest to 160% for abdomen imaging. The lifetime cancer risk is increased for obese patients, with increases up to 152% especially in the abdomen and lumbar spine radiograph.

Conclusion: Obese patients are receiving high effective doses compared to normal weight patients and hence more cancer cases among obese patients to occur as a result of ionising radiation doses relating to projection radiography examinations.

d007 **Nottingham University Hospitals. Standardising PA chest exposures via DoseWatch**

Nicholas Wong ; Elliott Simpson

Nottingham University Hospital

Showing how Nottingham University Hospital radiographers worked together with their Medical Physics Team on the dose optimisation of PA chest X-rays. DoseWatch is a dose monitoring programme which pulls detailed data directly from compatible X-ray equipment for each exposure. This is part of the Imaging Excellence Programme. We have set up medical exposures committee which meets monthly. These meetings discuss the obstacles which have become apparent with the implication and the management of the DoseWatch programme and how to overcome them. The first step for the PA chest examination was to standardise the exposures across both sites using the data from DoseWatch programme. Our medical physics team were able to search the DoseWatch programme using the exam codes entered into CRIS (e.g. XCHES). We then found that the exam code would be used for several local codes depending on the X-ray equipment (e.g. chest, XR chest, XCHES). The data showed that the rooms which were used for PA chests (one on each site) used different exposure parameters. One favouring 90kvp (no grid) the other 125kvp (with grid). Exploring the average DAP of the rooms shows that the dose to the patients is largely the same, and well below NRDLs

d008 **Exploring patient dose optimisation in Computed Tomography (CT) scanning**

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Background: There are concerns about radiation dose to patients from CT due to its increased use and its larger contribution to radiation exposure than other imaging modalities, this makes the optimisation of CT protocols paramount[1]. This study explored optimisation of patient dose during CT scanning by UK Radiographers. Objectives included investigating knowledge of CT parameters, identifying educational needs and examining collaborative working.

Method: Ethical approval was granted for this mixed method cross-sectional study through survey methodology using an adapted existing questionnaire. Participants were recruited with the support of Society of Radiographers via a link to the

participant information leaflet. The questionnaire contained quantitative and qualitative questions, 40 protocol questions could be scored and compared with the previous study[2].

Results: UK radiographers fared slightly better when the questions on exposure parameters were scored and compared to previously published data from a European cohort, with a mean score of 30.93/40 compared to 28.00/40 from the previous study. 98% of respondents felt that further education on optimisation of CT parameters would be beneficial. Through thematic analysis four main themes were identified indicating how additional education could be delivered, these were; 'further education to Masters' level', 'regular continuing professional CT focused updates', 'training from manufacturers/application specialists' and 'standardised training at undergraduate level'. Only 9% of respondents indicated that a multi-disciplinary team set protocols.

Conclusions: UK radiographers have reasonable knowledge of exposure parameters but they feel that further training/education will empower them to optimise patient doses effectively. Collaborative working is required to fully optimise protocols.

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d009 **Optimisation of paediatric CT dose and image quality**

Rebecca Gillen [1]; Nick Weir [2]; Mark Worrall [3]

[2]NHS Lothian; [3]NHS Tayside

Background CT is in general a relatively high dose imaging modality and, since younger patients are more radiosensitive, it is especially important to fully optimise paediatric CT protocols. The primary aim of this project was to assess the suitability of imaging protocols on a new CT scanner at the Royal Hospital for Sick Children (RHSC) compared to the CT scanner currently in clinical use. We also reviewed the imaging protocols to identify any aspects which could potentially be optimised to improve image quality and/or reduce radiation dose.

Method Head and chest scans were performed on three anthropomorphic phantoms (CIRS ATOM dosimetry phantoms) representing a 1 year old, a 5 year old and a 10 year old. The phantoms were scanned on both CT scanners installed at RHSC; the Siemens Sensation 64 which is in current clinical use, and the GE Discovery 670 which was installed more recently. The radiation dose associated with scanning the different sizes of phantom was recorded in terms of dose-length product (DLP). Image quality was assessed in terms of the Signal to Noise Ratio (SNR) in regions of interest. Imaging protocol settings were also compared for different age ranges and between the two scanners. In order to evaluate the reliability of using the phantoms to predict patient doses, a retrospective patient dose audit using data from 2016 was also carried out on the Siemens Sensation 64.

Results Phantom data demonstrated that paediatric head and chest scans on the GE Discovery 670 provided

1. Doses from Computed Tomography (CT) Examinations in the UK – 2011 Review, PHE-CRCE-013 (2014), P C Shrimpton, M C Hillier, S Meeson and S J Golding 2. Radiation Risks from Medical X-ray Examinations as a Function of the Age and Sex of the Patient, HPA-CRCE-028 (2011) BF Wall, R Haylock, JTM Jansen, MC Hillier, D Hart and PC Shrimpton 3. National survey of doses from CT in the UK: 2003, British Journal of Radiology, Vol 79 (2006) P C Shrimpton, M C Hillier, M A Lewis and M Dunn 4. Benchmarking paediatric CT practices throughout Scotland - Presentation given at the IPEM Optimisation in Paediatric Imaging Conference, 2016, M Worrall

d010 **Reducing administered activity in myocardial perfusion SPECT by 40% using LEGP collimators and resolution recovery (RR)**

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Background In 2016, our department performed 1199 myocardial perfusion SPECT (MPS) studies with median administered activity of 346 MBq, resulting in a radiation dose (stress + rest) of 5.2 mSv. This clinical evaluation follows our multi-vendor phantom study, which indicated patient dose can be significantly reduced by moving from LEHR to LEGP collimators, in combination with RR.

Methodology 45 MPS scans were performed on a GE Infinia with LEHR then LEGP collimators. Patients received tetrofosmin using our BMI-based protocol. Counts in the myocardium were matched between LEHR and LEGP images. Summed scores were extracted from a normal database comparison using Corridor 4DM. Functional data (EDV, ESV and LVEF) were obtained using Cedars Sinai QGS.

Results Image quality was comparable for each collimator. No significant differences were observed for the summed scores. On average EDV, ESV and LVEF were 16%, 26% and -3.1 percentage points different ($P < 0.01$) in the LEGP images, respectively. The LVEF difference showed an inverse relation with the ESV. This is likely to be due to differences in pixel in size.

Conclusion Use of LEGP collimators and RR is a simple and highly accessible method for attaining significant radiation dose reductions for MPS, which will facilitate a widespread reduction to population radiation dose. This enables a 40% reduction in administered activity in the LEGP images, leading to a radiation dose for a two-day stress-rest protocol of between 3 and 4 mSv. Furthermore the reduced Tc-99m usage will increase resilience against anticipated cost increases of radioisotope supply.

d011 **Effect of tube angulation on peak skin dose during interventional procedures**

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Background Interventional procedures involve the risk of excess use of radiation. Peak Skin Dose (PSD) is the quantity of concern as it is directly linked to skin injuries. This study focusses on quantifying the reduction in PSD when changing the tube primary and secondary angle during the procedure.

Method The study was performed on 1588 cardiac procedures from nine interventional rooms (3x Philips AlluraXPer, 6x Siemens Axiom Artis), in four hospitals of two different countries. For the data analysis and PSD calculation, the dose management platform DOSE (Qaelum NV, Belgium) was used. DOSE calculates the dose distribution on the patient's skin and performs a complete angle and table analysis, allowing for the computation of different angle combinations for each procedure.

Results By using different angles in 50% of the irradiation events, the physician can reduce PSD even by 50% compared to Dose at Reference Point (DoseRP). This trend was observed in almost all devices. It was also noticed that in several cases the tube angles remain constant during the whole procedure. For them, as expected, the ratio of PSD to DoseRP is close to unity.

Conclusion A significant reduction of PSD is observed when changing properly the tube angles, to avoid constant irradiation of the same area. Unquestionably, this is not always feasible and moreover, other parameters also influence PSD. By using an advanced dose management system, the operating physician can identify techniques that require corrective actions to ensure patient safety, especially when high skin doses could be expected.

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d012 **Reducing radiation the lens of the eye in routine CT head imaging- re-audit**

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Background CT head examinations may result in significant and unnecessary irradiation to the lens of the eye, a highly radio-sensitive tissue; thus increasing the likelihood of accelerated cataract formation. Standard CT head examinations expose the lens to approximately 25-103mGy. The International Commission on Radiological Protection estimates opacity formation with doses as low as 0.5Gy. With CT examinations readily available and patients often having multiple exposures over a lifetime, the need for radiation awareness and safe practice is paramount. First cycle demonstrated lens exclusion in only 38% of studies in the under 65s, where mobility issues or confusion/ dementia are likely to be less prevalent. The commonest cause for lens inclusion was mal-positioning; therefore a poster demonstrating effective positioning techniques to avoid the lens was placed in the radiology department.

Re- audit method A retrospective trust wide audit of all CT head scans was undertaken over a one week period in September 2016. CT scans were viewed in sagittal section to best visualise lens inclusion.

Results A total of 328 scans were analysed. 154 were under the age of 65, 55% of studies in this group excluded the lens of the eye (38% first cycle). Demonstrating a 17% decrease in lens inclusion in the under 65s following introduction of the poster.

Conclusion This is a modest improvement which has demonstrated the need for continued training, as well as highlighting the importance of improving image acquisition to reduce unnecessary radiation to the eye and potential cataract formation with multiple exposures.

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d013 **Evaluation of absorbed dose and protocols during brain computed tomography scans in a Nigerian tertiary hospital**

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Computed tomography (CT) scan of the brain is the commonest CT examination performed and had been recognized to deliver a very high radiation dose to the patients. This study was aimed at evaluating the radiation dose from routine brain CT scan and to compare the dose from the protocols for brain CT. The ex-post-facto design was adopted. All the records of brain CT scan from September 2011 to August 2015, acquired with a 16 slice CT machine (Phillips Brilliance Medical System, MX8000) in the Radiology Department of University of Maiduguri Teaching Hospital (UMTH) were evaluated. Ethical approval was obtained from the Ethical Committee of UMTH. The weighted CT dose index (CTDIW), volume CT dose index (CTDIVOL) and dose length product (DLP) values were recorded for each of the examination. Results showed that the two main protocols used were axial

and helical scan modes. The mean CTDIvol and DLP values were 76.6 mGy and 1285.8 mGy*cm for axial and 103 mGy and 1903 mGy*cm for helical scan modes respectively. There was a significant difference ($p < 0.05$) between the CTDIvol and DLP values of axial and helical scan modes. Conclusion: the study found higher radiation dose in helical than axial scan modes. This study, therefore, recommends the use of axial scan mode for routine brain CT scan, to reduce radiation dose, except where speed is desirable such as in unconscious patients, uncooperative patients and when automatic injector pump is to be used.

d014 **Worldwide patterns and trends in Diagnostic Reference Levels (DRL) for common adult Computed Tomography (CT) examinations**

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Background: In the last two decades, there has been extensive interest in DRL and various publications to set up institutional and national DRL. In this poster, we will look at DRL articles that feature three most common adult computed tomography (CT) examinations; head, chest and abdomen pelvis and observe if the CT DRL values decrease with time as a result of advancement in technology.

Method: An online search for articles on CT DRLs through the University of Sydney library search engine was conducted. Search terms such as "diagnostic reference levels" and "computed tomography" were used. Relevant articles were collected and analysed.

Results: Eighteen articles representing 18 different countries were collected and analysed. The two indicators of CT DRL, Computed Tomography Dose Index (CTDI) and Dose Length Product (DLP) on the head, chest, and abdomen pelvis were tabulated. The results did not indicate a downward trend of radiation dose to patient with time, other than CT head.

Conclusion: While advancement of CT imaging has been rampant in the last three decades, CT DRL values over time in the different countries do not reflect a reduction in radiation dose. The average weight of the different populations does not seem to be a major factor that affects CT DRL. The availability of technology and CT radiographers practice may have played more influencing roles.

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