



P152 Review of the IAEA international conference on radiation protection in medicine
(Vienna, December 2017)

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The International Conference on Radiation Protection in Medicine: Achieving Change in Practice, organised by the International Atomic Energy Agency (IAEA) and co-sponsored by the World Health Organization and Pan American Health Organization, was held at the Vienna International Centre, 11-15 December 2017. This was five years after the landmark 2012 conference in Bonn, from which had emerged the Bonn Call-for-Action which identifies 10 priority actions to improve radiation protection in medicine.

The purpose of the 2017 Conference was to review actions taken and developments since the 2012 Bonn conference, especially focusing on actions taken by all relevant parties in line with the Bonn Call-for-Action. This will enable review of the overall approach to implementation of these actions and harmonization of activities between international organizations and other stakeholders, as well as allowing stakeholders to look ahead at new developments impacting on radiation protection in medicine.

Whilst the medical benefits of the use of ionizing radiation in medicine are unquestionable, there is growing evidence of unintended and unnecessary use of radiation in medicine. The conference dealt with justification and optimization in medical exposure; safety in medical use of ionizing radiation; and radiation protection of medical staff and public when ionizing radiation is used for diagnosis, intervention, therapy or research.

The 2017 conference was attended by 534 participants from 97 countries. Invited papers from authorities in the field were supplemented by approximately 200 contributed papers and 80 posters. This presentation will outline the structure of the 2017 Conference, and offer a summary of key points.

IMAGING TECHNOLOGIES & INFORMATICS

P153 An investigation into the impact of aging on the performance of LCD 2.4 MP colour display monitor when visualising low contrast detail using a CDRAD phantom

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Background: To Investigate the influence of deterioration of 2.4MP LCD colour display monitor luminance as a result of the long-term use on its performance in visualising low contrast details with different image quality. **Method:** A 2.4 MP LCD colour display monitor was set at three different maximum luminance values (250, 140, and 116 cd/m²) to simulate the monitor in initial use, after 1 year and after 4.6 years. This was based on the monitor being used 24/7. Six CDRAD images were generated using adults chest radiography protocols with different levels of image quality. The images were assessed on the monitor by four observers in three different sessions with the three different levels of luminance to investigate its influence on image scoring.

Results: Data analysis was conducted via repeated measures of variance (ANOVA). The overall ANOVA has shown that there is no significant difference ($p=0.30$) between the three ages (the three levels of luminance) of the monitor. Furthermore, the pairwise comparisons between the mean scores of monitor in initial use with that of the other two ages have shown that there is no significant difference among them $p=1.00$ and $p=1.00$ respectively.

Conclusion: The study shows that the monitor aging has no significant influence on its performance for detection of low contrast details and the monitor can be used for clinical practice without needing to be replaced.

P154 An investigation of the influence of image viewing parameter settings on the performance of 5 MP monochrome liquid crystal display (LCD) monitor in visualising low contrast-detail

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Background: To investigate the relation between the observer performance for low contrast-detail detectability and the image viewing settings (magnification, window setting) for a wide range of image quality on a 5 MP monochrome LCD monitor.

Method: Six images of CDRAD phantom were generated, using adults chest radiography protocols with different image quality. Five observers evaluated the images on a 5 MP monochrome LCD monitor. The images were assessed in four different ways: firstly, the observers were not free in adjusting the contrast, intensity, and magnification of the image; secondly, only the magnification was allowed to be adjusted; thirdly, only the contrast and intensity were allowed to be adjusted; finally, the observers were free to adjust the contrast, intensity and magnification of the image.

Results: Data analysis was conducted via repeated measures of variance (ANOVA). For the images with high quality, using magnification only, windowing only and using both magnification and windowing have a significant difference on improvement of image scoring $p=0.001$, $p=0.002$ and $p=0.004$ respectively. Furthermore, it was found that image viewing manipulation has a negative influence on image scoring for the ones characterised by low quality.



Conclusion: The study demonstrates that adopting both magnification and windowing is of a significant impact on improving image scoring; employing windowing solely has the second highest impact. Hence, this study recommends the utilisation of image viewing manipulation only with the images that are of high image quality, while it should be avoided with the images that are of low quality.

P155 Promoting patient engagement through sharing diagnostic radiological images

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Introduction: Advancing technologies offer novel opportunities for sharing radiological imaging data with patients^[1,2]. Products such as Sectra's 'Share with anyone'^[2] allow patients to access their own radiological imaging from home. However, little work explores the potential benefits and risks of such practices^[3].

Methods: A questionnaire was designed to measure respondent attitudes towards benefits and risks of image sharing utilising Likert scale type responses and a free text option. The questionnaire was distributed at a clinical imaging conference. Data were analysed using descriptive statistics.

Results: 121 responses were received. The majority (81.2%, n=95) of respondents agreed that sharing images with patients was a good idea. Respondents indicated overall agreement with several factors which can contribute to patient engagement^[4,5,6] including:

- Understanding - understanding information shared with them (87.6%, n=106)
- Communication - talking with their clinician (76.03%, n=92) and working in partnership (85.13%, n=103)
- Adherence - following their care plan (57.85%, n=70) and managing their own health (53.72%, n=65).

Several risks were also identified. These were primarily concerned with:

- Images being difficult for patients to interpret (36.36%, n=45)
- The potential for causing patient anxiety (27.28%, n=33).

Conclusion: Respondents confirmed that sharing images with patients may promote engagement, but there are risks inherent to this process. There is a need, therefore, for further work in:

- Clarification of how identified benefits and risks can be effectively managed
- Patients' perspectives surrounding this process.

1. Imperial College Healthcare NHS Trust. How it works. Available at <https://www.careinformationexchange-nwl.nhs.uk/> (accessed on 07 November 2017)

2. Sectra. Share and collaborate. Available at <https://sectra.com/medical/solutionarea/share-and-collaborate/> (accessed on 07 November 2017)

3. Cox, WAS, Cavenagh, P. & Bello, F. (2017) The diagnostic radiological image - identifying the benefits from the literature - Poster Presentation. UKRC/O Congress, 12 - 14 June 2017. Manchester Central Convention Complex.

4. Adams, RJ. (2010) Improving health outcomes with better patient understanding and education, Risk Manag Healthc Policy. 2010; **3**, 61-72.

5. Thompson, L & McCabe, R. (2012) The effect of clinician-patient alliance and communication on treatment adherence in mental health care: a systematic review, BMC Psychiatry, **12**:87

6. Coulter, A. (2012) Patient engagement - what works?, Journal of Ambulatory Care Management, **35**(2)

P156 Clinical imaging experts' perspectives on the benefits and risks of sharing diagnostic radiological images with patients

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Introduction: Advancing technologies offer novel opportunities to share with patients their diagnostic radiological images (Imperial College Healthcare NHS Trust 2017). This sharing may occur within the clinical environment under the supervision of a clinician, or may involve remote, unsupervised access for patients (Sectra 2017). However, the benefits and risks of such practices have not been widely explored (Cox, Cavenagh & Bello 2017).

Methods: A questionnaire was designed to measure respondent attitudes towards benefits and risks of image sharing utilising Likert scale type responses and a free text option. The questionnaire was distributed to clinical imaging experts. Data were analysed using descriptive statistics.

Results: 121 responses were received. The majority (81.2%, n=95) of respondents agreed that sharing images with patients was 'a good idea'. Respondents indicated overall agreement with several factors considered to contribute benefit (Adams 2010; Thompson & McCabe 2012; Coulter 2012) including:

- Understanding - understanding information shared with them (87.6%, n=106)
- Communication - talking with their clinician (76.03%, n=92) and working in partnership (85.13%, n=103)
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Several risks were also identified. These were primarily concerned with:

- Images being difficult for patients to interpret (36.36%, n=45)
- The potential for causing patient anxiety (27.28%, n=33).

Conclusion: Respondents confirmed that sharing images with patients may provide benefits, but there are risks inherent to this process. There is a need, therefore, for further work seeking:

- Clarification of how identified benefits and risks can be effectively managed
- Patients' perspectives surrounding.



1. Adams, RJ. (2010) Improving health outcomes with better patient understanding and education, *Risk Manag Healthc Policy*, 3: 61–72.
2. Coulter, A. (2012) Patient engagement – what works?, *Journal of Ambulatory Care Management*, 35(2)
3. Cox, WAS, Cavenagh, P. & Bello, F. (2017) The diagnostic radiological image - identifying the benefits from the literature – Poster Presentation. UKRC/O Congress, 12 - 14 June 2017. Manchester Central Convention Complex.
4. Imperial College Healthcare NHS Trust. How it works. Available at <https://www.careinformationexchange-nwl.nhs.uk/> (accessed on 07 November 2017)
5. Sectra. Share and collaborate. Available at <https://sectra.com/medical/solutionarea/share-and-collaborate/> (accessed on 07 November 2017)
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P157 Patient privacy and consent in radiology networks

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Radiology sharing networks are now the norm in the UK yet they are all based on simple RIS/PACS regional deployments. This means that access to the information is handled through the RIS and PACS applications - implicit consent to share the patients' information is assumed. But is this right? It is certain convenient for clinicians and makes deployment for suppliers simpler. Surely though the patients' rights to control who can see their images and other radiology documents should be in the control of the patient. GDPR will shine a spotlight on this. This presentation will discuss the current norm and compare that to an open-standards controlled Vendor Neutral Network approach - where privacy and consent controls are baked into the solution.

P158 West Midlands regional image sharing platform

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Summary: Implementation of a 17 Trust Regional Image Sharing Platform (RISP) to support direct patient care and research.

Method: Working collaboratively across 17 West Midlands NHS Trusts we procured and implemented a federated image sharing solution. RISP uses a smart HL7 message-driven automatic pull-based workflow or a manual direct referral push workflow to ensure that all of a patient's regional imaging and reports are available specifically to Trusts involved in their direct clinical care. Data was securely transferred between Trusts using an implementation of Dynamic Multi-point VPN. Good Information Governance was ensured with regionally agreed processes and responsibilities for sharing and a 17 Trust Data Sharing Agreement executed in counterparts to form one agreement. Collaborative regional networks of IT, IG and PACS leads were built to ensure a successful implementation. The Regional Image Sharing Platform was overseen and governed by a regional User Group.

Results:

- Clinicians have instant visibility of their patient's full regional imaging history and reports
- Clinicians can retrieve the relevant imaging from other Trusts themselves
- The solution was implemented at 17 Trusts in 17 months
- The solution also allowed the 100,000 Genomes research project to automatically collect imaging for 7000 consented participants
- Resulting new regional networks and IT infrastructure form strong foundation for future collaboration and regional programmes.

Conclusion: This project has enabled secure clinician to clinician sharing of imaging and reports between 17 Trusts, targeted specifically at the patients for whom the Trusts were actively delivering shared clinical care.

P159 MRI of the lumbar spine: paraspinal muscle asymmetry in a healthy volunteer population

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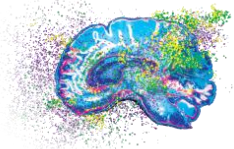
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Introduction: The lumbar paraspinal muscles are critical in providing spine stability, maintaining proper posture and assisting trunk movement. Paraspinal muscle asymmetry has been regarded as a potential indicator of localized spinal pathology and lower back pain (LBP). The current study aimed to examine the degree of cross-sectional area (CSA) asymmetry in a group of asymptomatic individuals.

Method: 103 women (Mean \pm SD Age 42 \pm 10y, height 165.6 \pm 6.2cm, and weight 72.2 \pm 14.0kg) were recruited from the general population reporting no LBP during the prior year and no previous spinal fractures. All participants underwent MRI examination and had T2-weighted axial images collected for the L3-L4 level. CSA of the left and right psoas (Ps), multifidus (Mu) and erector spinae muscle (Es) were calculated using ImageJ. Paired t-tests were undertaken to assess differences between left and right values for individual muscles and the total (Ps+Mu+Es).

Results: No significant differences between left and right areas were found for Es (Left 13.55 \pm 2.79cm², Right 13.41 \pm 2.74cm², p=0.261) or Mu (Left 4.90 \pm 1.31cm², Right 4.78 \pm 1.26cm², p=0.132). However, significant differences were found for Ps (left 8.73 \pm 1.78cm², right 8.53 \pm 1.92cm², p=0.048) and total muscle area (left 27.18 \pm 4.50cm², right 26.72 \pm 4.46cm², p=0.007).

Conclusion: In this healthy female population a left-right asymmetry was found for the psoas and total muscle area. This suggests that a degree of muscle asymmetry may be a normal phenomenon and not related to specific pathology. However,



further research is required to assess the potential importance of the magnitude of asymmetry and to examine the effect in a larger population with a greater age span.

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P160 Impact of fixed tube current (FTC) and automatic tube current modulation (ATCM) objective and subjective evaluation of image quality in CT examinations of the abdomen

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Purpose: To compare signal to noise ratio (SNR) objective and relative visual gradient analysis (VGA) subjective image quality between FTC and ATCM techniques modes when undertaking abdominal CT. **Materials and Methods:** A series of acquisitions using FTC and ATCM were performed using a Toshiba Aquilion 16 CT scanner of an adult abdominal anthropomorphic phantom (PH-5). Tube current was varied as follows: FTC: 100, 200, 250, 300 and 400mA; ATCM: low dose+, low dose, standard, quality and high quality; Pitch factors - 0.688, 0.938 & 1.438. SNR was calculated for 5 abdominal organs (liver, spleen, pancreas and left and right kidney). Relative VGA five abdominal axial images performed by observer.

Results: Mean SNR and relative VGA scores for both ATCM and FTC demonstrated no statistical significant difference, except when 100mA/low dose + and 200/low dose SNR values was higher for the FTC than ATCM and 0.938 pitch factor for the kidneys ($P=0.002$). However, 300 mA/quality and pitch of 1.438 was SNR value higher for the ATCM than FTC liver, spleen and pancreas ($P = 0.035$). This was similar for relative VGA scores higher for the ATCM than FTC on 300mA/quality and pitch of 1.438 for images 1, 2 and 3 ($p<0.05$).

Conclusion: Phantom results demonstrated higher image quality ATCM than FTC using 300 mA/quality and pitch factors >1 upper and middle abdominal slices. However, higher SNR values FTC than ATCM tube current > 200mA and pitch factors =0.938 lower abdominal slices. This method can be used to compare image quality for abdominal CT within clinical practice.

P161 Analysis of epileptogenic changes detected in the PET/CT, electrophysiological and MRI studies and their correlation with post-surgical outcomes

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Aims:

1. Compare and correlate the amount of epileptogenic foci found in EEG and PET/CT.
2. Determine most common localizations of epilepsy focal points in both functional and structural imaging methods.
3. Determine the success rate of surgery in the operated patients when the focal points of epilepsy coincided in all three imaging methods.
4. Verify the concordance between the location of epileptogenic focal points found in EEG and PET/CT studies.

Methods: We studied a group of 35 patients with clinically proven refractory epilepsy. All patients underwent an MRI scan with epilepsy protocol, Fluorodeoxyglucose-18-PET scan, and an EEG at least 1 hour prior to a PET/CT. Statistical data was analyzed with the SPSS 23.0 program. Assessment of normality was verified by the Kolmogorov-Smirnov and Shapiro-Wilk tests. The Wilcoxon Sign Criteria were used to compare the two dependent samples. Concordance was evaluated by using Cohen's kappa^(k).

Results:

1. According to Wilcoxon signed ranks test we can make assertion that there is a statistically significant difference between the number of epileptogenic foci found in PET/CT and EEG studies (Sig. 0.021<0.05).
2. Most common localization for epileptogenic activity in all three imaging methods was Right Temporal lobe (39.6-43.1%).
3. 10/14 patients who underwent surgery demonstrated excellent postsurgical outcomes, with 0 epileptic seizures not less than 1 year post operation; 3/14 patients had 1-2 seizures after surgery and 1/14 patient had same or more epileptic seizures.
4. Measure of Agreement Kappa value 0.637; Asymptotic Standardized Error^a 0.096; Approximate T^b 6.253; Approximate Significance $p<0.005$.

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P162 Using surface guided radiotherapy to improve the quality of care for lymphoma patients

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Background: Guy's and St Thomas' (GSTT) NHS Trust covers a population of 1.67 million. In 2014, two AlignRT systems were purchased to implement a deep inspiration breath hold (DIBH) technique for left sided breast patients to reduce cardiac toxicity. AlignRT is a patient motion management system that allows detects sub-millimetre differences in the patient surface compared to a reference surface and thus allows surface guided radiotherapy (SGRT). The GSTT lymphoma team wanted mediastinal lymphoma patients to benefit from the advantages of DIBH enabling a reduction of target volume and heart overlap, and irradiated lung tissue volume. The introduction of DIBH in 2015 assisted in the development of the butterfly lymphoma technique, now routine clinical practice. Once DIBH became routine in the delivery of mediastinal radiotherapy for lymphoma patients, the use of AlignRT for the set-up of these patients was investigated with the aim of reducing concomitant imaging dose for this group whose young age and good prognosis make long term side effects a concern.

Method: A comparison was made of the translation and rotation displacements calculated by the AlignRT system compared to that calculated by the Varian TrueBeam imaging system for every fraction of DIBH lymphoma patients.

Results: Early results indicate that the use of AlignRT to set-up mediastinal lymphoma patients allows a reduction in imaging frequency and hence concomitant dose.

Conclusion: AlignRT is already a vital part of the DIBH service at GSTT and is anticipated to become an integral part of patient set-up to reduce concomitant imaging dose.

P163 Infra-red thermal imaging: evaluation of the healthy lower limbs

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Lower limb ischemia is common in peripheral artery disease and diabetes. This study explores the use of Infra-red (IR) thermal imaging to assess upper to lower leg temperature in healthy volunteers (n=4) to consider a normal point of reference. A FLIR T650 IR thermal imaging camera was used in a temperature controlled environment. BMI was calculated from height and weight.

Phase 1; 12 single shot standing images acquired over several hours. Phase 2; 16 images with added thigh marker and foot positioner two days later. Reviewers measured the temperature in both legs from thigh to ankle. Assessments were made of intra and inter operator reliability using the root mean square standard deviation (RMSSD) and the root mean square coefficient of variation (RMSCV%). Both legs are the same temperature in healthy volunteers (+/-0.05 degrees), typically with a negative gradient from thigh to ankle and a warm 'spike' around the knee. Intra-operator RMSCV% (RMSSD) for Phase 1: 18.65% (0.74); Phase 2: 3.84% (0.28). Inter-operator RMSCV% (RMSSD) for Phase 1: 9.31% (0.38); Phase 2: 3.70% (0.24).

A moderate correlation is noted between temperature gradient and BMI (r=0.45). IR Thermal imaging of the lower limbs is a non-invasive technique that is relatively easy to perform, with positioning technique closely related to projection imaging, and ideally suited to the extended radiographer role. Use of the thermo-sensitive thigh marker combined with development and application of a foot template to aid positioning reduced measurement error and deliver increased reliability.

Gatt A et al (2014) Thermographic Patterns of the Upper and Lower Limbs:Baseline Data. International Journal of Vascular Medicine Volume 2015, 831369, <http://dx.doi.org/10.1155/2015/831369> Viktor V. et al (2017) Multimodal optical measurement for study of lower limb tissue viability in patients with diabetes mellitus, J. Biomed. Opt. 22(8), 085003 (2017), doi: 10.1117/1.JBO.22.8.085003.

P164 Optimisation of image processing algorithms for bed-side chest radiography; a comparison of two generations of AGFA MUSICA

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Background: Optimisation of chest radiography is a challenging task. Many studies focus on exposure parameters such as tube voltage, but in digital radiography image processing algorithms must also be considered. This study presents the results of an image quality investigation of the latest generation of AGFA MUSICA, compared with the previous version.

Method: Four expert image evaluators blindly and randomly graded chest radiographs that were re-processed with five different settings (MUSICA2, MUSICA3default, MUSICA3weak, MUSICA3+ and MUSICA3strong) against a reference on diagnostic reporting monitors. Underlying clinical exposures were standard practice (80-90 kVp, 2-3 mAs, with or without grid). A flexible continuous grading scale and linear mixed-effects models were used to establish statistical significance. 'Overall' quality and individual structures (lung, hilar, spine, heart and diaphragm) were assessed.

Results: It has been shown that both anatomy and processing settings are inter-dependent and statistically significant determinants of image quality. MUSICA3+ was found to give the best 'overall' image quality, along with structures in the less dense regions such as the lung and hilar. MUSICA3strong gave the highest scores in dense regions (diaphragm, ribs and spine), though in several cases the image evaluators indicated overall image noise was unacceptable. In most cases, MUSICA2 yielded the lowest scores.



Conclusion: Image processing algorithms are a fundamental part of the optimisation process, and must not be neglected. For bed-side chest radiography, it has been demonstrated that MUSICA3+ gives the best 'overall' quality, but changes to image processing should be considered if dense regions are of clinical interest.

P165 Identifying anatomical regions of pelvic X-rays using open-source texture analysis and machine learning software: A proof of concept study

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Background: The radiographic image texture of bone is influenced by density and trabecular pattern. Reporters generally assess texture qualitatively, but texture can also be assessed quantitatively. The open-source textural analysis software qMaZda (Szczyppinski et al., 2009) can calculate approximately 300 texture parameters. These large datasets generated make conventional statistical techniques unfeasible for determining which (if any) of these parameters are useful for differentiating bone structures. However, machine learning algorithms are ideally suited to identify and 'learn from' patterns and relationships within large datasets. Bone texture varies between individuals but some bony structures have characteristic trabecular patterns. This study aimed to determine whether a quantitative approach using open-source software is more accurate than reporters at identifying anatomical regions of pelvic radiographs based solely on their texture.

Method: 'Training' and 'test' datasets consisting of the textural parameters for 50 and 15 pelvic Rols respectively were created using images downloaded from PACS. A variety of machine learning algorithms were trialled on the training set using the open-source data mining software Weka (Frank et al., 2009). Accuracy was then evaluated on the test set and compared to the performance of 5 experienced reporters undertaking the same task.

Results: The 'Simple Logistic' algorithm identified the origins of the Rols of the test set with an accuracy of 93%. This compared to 73% for experienced reporters.

Conclusion: Open source textural analysis and machine learning software successfully identified anatomical regions within the pelvis. In future this approach could be used to identify pathological changes in bone.

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SERVICE INNOVATION AND OPTIMISATION

P166 Outsourcing CT scans

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Background: Many hospitals in the UK have introduced outsourcing of CT scans to supplement the demand for imaging required out-of-hours^[1]. However, there is sparse data on how this has affected the number of imaging investigations done out-of-hours. This study addresses this gap by investigating the impact of implementing outsourcing via 'Four Ways' at an UK district general hospital on the number of out-of-hour CT scans requested.

Method: This is a retrospective cross-sectional study. Data was collected on the number, type and indications of CT scans that were undertaken out-of-hours in January 2015, before the use of outsourcing, and compared to data from January 2016 and January 2017. Data was collected using HSS CRIS and analysed using Excel.

Results: Following the introduction of outsourcing, the total number of Emergency Department CT scans that were vetted increased (74 in January 2015, 61 in January 2016 and 123 in January 2017). Furthermore, the total number of Inpatient CT scans vetted during outsourcing hours also increased (23 in January 2015, 18 in January 2016 and 46 in January 2017). This was despite the fact that the total number of CT scans during the non-outsourcing out-of-hour period remained stable from January 2016 and January 2017.

Conclusion: These results indicate that since the introduction of outsourcing, the number of CT scans vetted out-of-hours has increased. This study did not look at the reasons for why outsourcing increased the number of scans, and this will form the basis of future work in this area.

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