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Purchasing and Supply Agency

Centre for Evidence-based Purchasing

Diagnostic imaging update

Imaging developments at the Radiological Society of North America (RSNA) conference, 2007

CEP 07030

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Informing procurement - Encouraging innovation

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Introduction

The Radiological Society of North America (RSNA) annual conference and exhibition, held from 25th to 30th November 2007, was themed ‘Connecting Radiology’. The NHS PASA Centre for Evidence-based Purchasing (CEP) imaging work programme currently has 15 ongoing projects, encompassing innovations in: computed tomography (CT), magnetic resonance imaging (MRI), radiography, fluoroscopy, mammography and picture archiving and communication systems (PACS). Information gathered at RSNA 2007 will be used to support these CEP projects.

This news report gives a synopsis of emerging developments at RSNA 2007, in the context of current national issues in imaging and focussing on the key themes of innovation and value.

In the week following RSNA 2007, two key strategies for cancer and stroke were published by the Department of Health (DH). Other national initiatives of ongoing concern in imaging are the 18 week wait referral to treatment time (RTT) target and the National Programme for Information Technology (NPfIT).

Cancer Reform Strategy

The Cancer Reform Strategy [1] was published on 3rd December 2007. Supported by an investment of £370million by 2010, key elements of this strategy include faster treatment, extended screening and extended services for the increasing numbers of people surviving cancer. The strategy describes a five year plan to deliver a world-class cancer service for NHS patients in England.

Planned actions for earlier diagnosis and treatment include extending the Breast Cancer Screening Programme by 2012 to all women aged between 47 and 73 and investing £100million in new digital mammography equipment. Also featured in the strategy is a move to national surveillance of all women at high risk from familial history of breast cancer. This national surveillance will be taken up by the NHS Breast Screening Programme (NHSBSP) in 2009 and will include access to MRI scanning for women with familial history of breast cancer, as recommended by the National Institute of Health and Clinical Excellence (NICE) in October 2006 [2]. The main motivation for the recommended use of MR rather than conventional X-ray mammography is the typically lower age range (20 years and upwards) of women to be screened for familial history concerns. MR does not use ionising radiation and therefore does not have the associated increased risk of cancer induction, which is important when considering a younger population, who would otherwise face increased lifetime exposure to ionising radiation through conventional X-ray mammography.

Planned actions for improving the experience of cancer patients and those living with cancer include a £200 million investment in new equipment and staff to increase the capacity of radiotherapy services over the next three years. Also planned is an extension to current waiting time standards, such that by 2010, the 31 day standard (from decision to treat to the start of first cancer treatment) will cover all subsequent cancer treatments, not just the first. This includes access to radiotherapy.

The current CEP work programme includes projects in both digital mammography and image guided radiotherapy (IGRT) [3].

National Stroke Strategy

The National Stroke Strategy [4] was published on 5th December 2007. This is a 10 year plan which aims to raise public awareness of stroke and transient ischaemic attack (TIA) symptoms and improve their speed of diagnosis through 24/7 access to

brain imaging, to allow for immediate delivery of appropriate drugs. One key message from the stroke strategy is that “Time is brain”, with a specific recommendation that high-risk TIA patients need to be assessed by an expert and, where possible, given a magnetic resonance (MR) imaging brain scan within 24 hours of onset of symptoms. Work is ongoing at DH to develop a guide to stroke imaging and NICE is developing clinical guidelines on the diagnosis and acute management of stroke and TIA, with expected publication date of July 2008 [5].

CEP will soon publish an evidence review of diffusion magnetic resonance (MR) and competing imaging technologies for the diagnosis of stroke and TIA, with work ongoing for a buyers’ guide to diffusion MR technologies.

18 week wait

Delivering an 18 week patient pathway from GP referral to start of treatment continues to be a key objective for the NHS [6], with target for completion of 2008. Imaging is one of four national projects focussing on specialities which face a particular challenge to delivery of the 18 week RTT target. This target may be achieved by changes in service delivery, (extended working hours, utilising spare capacity and independent sector contracts) rather than any centralised capital equipment procurement. Technological innovations at RSNA which enable improved patient pathways and workflows are therefore of particular interest.

National Programme for IT

The NPfIT [7] is intended to create a coherent IT infrastructure across the NHS. As of 1st April 2007, accountability for the delivery of the NPfIT transferred from NHS Connecting for Health (CfH) to Strategic Health Authorities (SHAs) as part of the NPfIT Local Ownership Programme (NLOP). CfH therefore recommend that purchasers seek advice from their local SHA / NPfIT regarding procurement of IT software and connectivity to any LSP delivered picture archiving and communication systems (PACS).

The NPfIT PACS provision enables imaging departments to network and archive large digital image datasets. This opens opportunities for service expansion in teleradiology through the adoption of PACS peripherals / accessories.

Our NHS Our future: NHS next stage review

An interim report from the NHS next stage review, led by Lord Ara Darzi, was published in October 2007 [8]. This sets out a 10 year vision for the NHS, following a three month consultation with patients, staff and the public and is presented as a strategic tool for local and national health service commissioners to lead change and reform in the NHS. The interim report highlights the need for an effective NHS, to

improve primary care access to diagnostic services, including brain imaging for diagnosis of stroke and TIA. It also raises the issue of England lagging behind other countries in treating heart attack patients with primary angioplasty. The establishment of a Health Innovation Council (HIC) is proposed, to act as a 'guardian of innovation' and to help overcome any barriers to DH and the NHS taking up innovation. A final report from the review is expected in June 2008, to coincide with the 60th anniversary of the NHS.

Imaging for cancer at RSNA 2007

With the publication of the DH Cancer Reform Strategy [1] and indications of a £100 million investment to be made in digital mammography equipment, it is anticipated that there will be particular NHS interest in equipment selection of these technologies to come.

Imaging for breast cancer screening. In digital mammography, the advanced application of tomosynthesis for three-dimensional (3D) imaging of the breast continues to be developed by many manufacturers. Other advances include the use of novel X-ray tube target and beam filter combinations to provide harder beam qualities, which offer advantages both in dose reduction and improved image quality on digital mammography systems. Advances in detector technology for mammography at RSNA were aimed at improved image quality and faster operation, allowing faster patient throughput.

CEP is currently undertaking a project to consider the cost-effectiveness of computed radiography (CR) for mammography versus full field digital mammography (FFDM) in both breast screening and symptomatic assessment. This will be published as part of a CEP buyers' guide to digital mammography.

Similar to the NICE clinical guideline on use of breast MR for familial history women in the UK [2], the American Cancer Society (ACS) guidelines (March 2007) [9] also recommend the use of MRI for some women at increased risk of breast cancer. RSNA 2007 placed great emphasis on improving clinician education of breast MRI. In addition, manufacturers presented new dedicated solutions for MR breast imaging. GE Healthcare presented BREASE, a breast MR spectroscopy package that can improve the radiologist's ability to characterize lesions and monitor response to therapy and the Vanguard Breast patient table for its 1.5 Tesla (T) MR systems, which allows dedicated breast imaging and biopsy intervention. Philips Medical Systems offered a dedicated breast imaging and biopsy table for its 1.5T and 3T MR systems. Aurora Imaging Technology presented a 1.5T MR system designed specifically for breast imaging, with an elliptical, homogenous field of view providing coverage of both breasts for optimised fat suppression.

Imaging for cancer detection and therapy. In digital radiography, dual energy subtraction has been in clinical use for only a few years. The technique allows for improved discrimination between tumours and cysts in the clinical image. Dual energy scanning in CT is a recent advance being promoted by three of the four main CT manufacturers, although each uses a different approach. Siemens and GE have adopted different dual exposure techniques, where two images at different tube potentials are acquired in rapid succession. Philips have followed a single exposure and dual detector approach, where the top layer of the detector is optimised to detect lower energy x-rays and the bottom layer, the high energy ones. With the dual

detector method, the information is acquired simultaneously, theoretically eliminating the need for image registration and minimising motion artefacts (eg in the cardiac cycle), but with a reduced energy discrimination and image quality compared to the dual exposure approach.

Dual energy subtraction in CT offers other clinical benefits, including improved differentiation of calcified plaque and contrast media. This may improve image quality and speed up the time of diagnosis in CT angiography studies and thereby present added value to those considering investing in the technology in the NHS.

In November 2007, CEP published an evaluation report on dual energy subtraction for chest radiography (CEP 07023).

At RSNA 2006, the annual oration in radiation oncology was titled 'Looking beyond anatomic based treatment in radiation oncology' [10], which addressed the merging fields of high quality diagnostic imaging (e.g. CT, MR) for accurate localisation of tumours, with functional imaging (e.g. positron emission tomography -PET, ultrasound) for cancer staging and re-planning of therapies, whilst sparing healthy tissue. There was much talk again at RSNA 2007 about image fusion systems to enhance diagnosis, planning control and treatment. 'Theronostics' became the phrase to describe the merging fields of diagnostics and cancer therapies. Fusion systems make use of the advantages of each modality to complement each other. In PET-CT, the PET scan detects the metabolic signal of growing cancer cells and is highly sensitive, whilst the CT scan provides a detailed picture of the internal anatomy that reveals the location, size and shape of abnormal cancerous growths. An alternative fusion concept delivers real-time control of ultrasound with the high spatial resolution of CT or MR to offer a non-invasive method of visualising different aspects of a disease. Fusion imaging of the brain has been around for some time, but it is now available for other areas of the body. One of the main issues to be resolved is the alignment of anatomical landmarks and scaling the images from different technologies, such that reasonable anatomical registration and hence visualisation can be achieved.

Most PACS vendors now include 3D and similar tools within their PACS products, to perform tasks such as 3D reconstruction from CT or MR and for image fusion, e.g. for PET-CT. Whilst integrated PET-CT and PET-MR scanners are now available or coming to the market, there remains the option for those operating NHS services with separate PET and CT scanners to fuse the CT (or MR) images with those from their PET system through adoption of PACS tools. This offers a significantly lower cost and less disruptive route to establishing a PET-CT service. There are several third party products available to perform these tasks and these can integrate well with existing PACS products.

Fusion imaging may also lead to different display device requirements, both in terms of their physical size and the display resolution. One company at RSNA was offering a 6 megapixel (MP) colour display and another a 4 MP greyscale display, each of which could be used as a single high-resolution display or as a 'pair' of more standard resolution displays (a 3 MP pair and a 2 MP pair respectively). This ability to reconfigure how the displays are used gives more flexibility in their use for displaying images from different modalities or, particularly, from combinations of modalities in fusion imaging. Examples were seen at RSNA 2007 of flat-panel display devices that used light emitting diodes (LEDs) as the backlight technology, in place of current conventional fluorescent tubes. LED has several advantages over fluorescent tubes, in particular the potential for increased brightness and contrast, improved colour fidelity in colour displays, a longer operating life and reduced environmental impact in manufacture and disposal, since LEDs, unlike fluorescent tubes, do not contain mercury.

Radiation dose in imaging and risks of cancer induction. Ionising radiation in imaging offers the benefit of effective diagnosis of medical conditions, but such benefits must always be considered against the potential risks of inducing cancer and other secondary effects. Highest risks are associated with paediatric exposures, high radiation dose imaging procedures and screening programmes in a presumed healthy population.

The diagnostic potential of CT scanning is undisputed; however, there is an ever increasing concern over the radiation doses delivered from CT examinations. As more scanners become available and new diagnostic areas open up to CT, more patients are being referred for CT examinations. In addition, the new scanners have potential to scan longer lengths of patients and at higher tube currents. There have been a number of peer-reviewed papers published in recent years highlighting the radiation risks of CT scanning. The most recent of these was published in the New England Journal of Medicine [11] during RSNA and led to a front page article in the American daily newspaper, USA Today, entitled: 'Unnecessary CT scans exposing patients to excessive radiation'. Although the findings of this study are contentious, radiation doses must both legally and ethically be kept 'as low as reasonably practicable'; a cornerstone of the UK Ionising Radiations Regulations 1999 [12].

One of the highest dose techniques in CT scanning has been that of coronary CT angiography (CCTA). This technique is increasingly used in place of conventional coronary angiography due to its non-invasive nature, although, because of the high associated doses, there has been some caution in its adoption. Data from these studies is reconstructed using retrospective electrocardiogram (ECG)-gating, which requires scanning at low pitches, giving rise to high patient doses. Typically, effective doses from this procedure are in the order of 10 - 20 mSv, which represent 5 to 10 times the natural background radiation dose received by every person in the UK each year. More recently, methods for performing CCTA with prospective ECG-gating have become available. This technique is said to reduce doses from CCTA

examinations by around 80%, resulting in effective dose values of 2 - 4 mSv, or approximately the same as the annual natural background radiation dose in the UK. GE and Philips propose performing prospectively gated CCTA studies with axial scans. On Toshiba's newest 320 slice Aquilion One scanner, launched at the conference, a CCTA exam can theoretically be performed in a single prospectively gated rotation, which is claimed to reduce doses even further.

Another dose reduction technique launched at this year's event was that of the 'adaptive collimation' concept. Helical scanning has many clinical benefits; however, it results in increased doses due to unnecessary irradiation at either end of the irradiated volume, so-called 'over-beaming'. This 'wasted dose' is particularly significant for short scan lengths. Siemens and Philips have now developed collimators which open and close asymmetrically during the course of the helical scan, so reducing the amount of unnecessary irradiation at the scan extremities. The extent of dose saving is dependent on the length of scan and the table feed. Dose savings of up to 25% can be obtained for short scan lengths at low table feeds.

In the scientific sessions, work was presented on optimisation of tube kilovoltage (kV) used in CT scanning protocols. It was shown that in many cases, particularly in contrast studies, improved contrast to noise ratios for the same dose can be obtained at lower kV settings than are used conventionally. In the past, use of lower kVs was limited to children, due to tube current limitations. It is now practical to use lower kVs more generally due to the higher power capabilities of modern CT scanners.

These developments are a selection of the dose reduction approaches being investigated and implemented on the latest CT scanners. Their use maintains the excellent diagnostic capabilities of CT, whilst minimising the radiation risk to the patient.

Imaging for stroke at RSNA 2007

Stroke is the third leading cause of death in the industrialised world, yet early diagnosis and treatment of patients with suspected stroke can deliver significant improvements in prognosis and reductions in long-term debilitating effects. The administration of thrombolytic drugs, such as tissue plasminogen reactivator (tPA) can renew blood flow to areas affected by ischemia if administered within a suitable time window. The first important factor in the diagnosis of suspected stroke is the ruling out of haemorrhage, since thrombolytic drugs are contra-indicated in this situation. The second stage of patient assessment, if the stroke is found to be due to a thrombus, is to establish whether the tissue in the ischaemic region is still viable. In the presence of viable tissue, often referred to as 'penumbra', there will be benefit gained from renewing the blood flow by the injection of tPA. Patients with non-viable tissue should be excluded from this treatment, as haemorrhage occurs in approximately 15% of cases.

The presence of penumbra may be assessed with brain CT perfusion imaging by injecting iodinated contrast and scanning the same volume repeatedly over a period of time. From this data, blood volume, blood flow and mean transit time maps are obtained and the presence of ischaemia and tissue viability can be assessed. The increased coverage on the newest scanners shown at RSNA 2007 enables the perfusion of a greater brain volume to be assessed. Toshiba can cover an entire brain in a single 16 cm rotation on the Aquilion One scanner. On the GE LightSpeed VCT XT, 8 cm of brain length can be covered using their 'volume shuttle' technology. In a similar manner, Philips can achieve an 8 cm coverage in 'jog scan' mode on their on their Brilliance 64 scanner. On the Philips 256 slice Brilliance iCT scanner, launched at RSNA 2007, 8 cm coverage will be achievable with a single rotation. Siemens have taken the approach of using a 'helical shuttle scan' where the scanner performs repeated short helical scans in opposite directions over the volume of interest. On the Siemens AS+, a length of 10 cm of brain can be covered whilst still achieving an adequate temporal resolution.

On most multi-slice CT scanners, a full stroke assessment is performed as three separate examinations. The first study is a non-enhanced brain scan, to determine if the stroke is due to thrombus or haemorrhage, and also to locate its position in the brain. This is followed by a contrast-enhanced angiography scan, which provides additional information on the vasculature. Finally, the perfusion brain scan determines the presence of viable tissue. The advantage of Toshiba's Aquilion One scanner in stroke assessment is that this 3 stage procedure can be performed in a single examination, thereby saving valuable time. Additional information may also be obtained by studying the venous and arterial flow of contrast through the vessels. The capabilities of dynamic volume scanning open up many possibilities for functional imaging in a diagnostic imaging area that was previously limited mainly to anatomical information.

With regard to the debate regarding use of MR versus CT for stroke and TIA assessment, the recent DH Stroke Strategy [4] delivers the following view:

> "High-quality imaging of the brain and blood vessels is a key part of a successful stroke service. Currently, computed tomography (CT) scans are sufficient to determine whether a stroke is due to a clot or a bleed, but the higher spatial resolution of magnetic resonance imaging (MRI) is better for determining whether the diagnosis for TIA is correct and how large any infarction may be. Both MRI and CT imaging will continue to have a role in the immediate term, but it is inevitable that advances will be made and therefore imaging for both stroke and TIA needs to be kept under review. It is a rapidly changing field and any definitive answer will soon be out of date. The Department of Health (DH) will be developing a stroke and TIA imaging guide

to assist local decision-makers and to give further opportunity for the options to be discussed."

Improving workflows and cost-effective solutions in imaging

Demonstrating that issues of innovation and value are as important in the US as they are in the UK, the RSNA meeting included a special symposium on quality improvement for the health services sector. In light of the rising costs and technological complexity of equipment, the symposium underlined the great potential of streamlining and improving radiology on the basis of clinical prediction rules and evidence-based guidelines. A number of resources were listed in the symposium, such as the guidelines of the Agency for Healthcare Research and Quality (AHRQ) [13] and the appropriateness criteria of the American College of Radiology (ACR) [14].

In MR, Siemens Medical Solutions showcased two new MRI systems: MAGNETOM Essenza 1.5T and MAGNETOM Verio 3T. The MAGNETOM Essenza is offered as a low-cost purchasing and installation MRI system and is configured so that it is always ready for scanning, thereby reducing scan preparation times. The MAGNETOM Verio 3T features a patient bore diameter of 70 cm, the largest of 3T systems, which can alleviate concerns of claustrophobia, allow for obese patients and support space-intensive examinations, such as interventional and paediatric MRI. Installation costs of the MAGNETOM Verio 3T can also be decreased compared to other 3T MRI systems on account of the system's smaller magnetic field footprint and lighter weight.

Philips Medical Systems presented the latest version of its Smart Exam application platform, which can increase patient throughput and examination reliability by automating planning, scanning and processing. Smart Exam has been expanded from knee and brain imaging to include shoulder and spine applications.

Toshiba demonstrated enhancements to its Vantage Atlas 1.5T MRI system, which features a 'patient-friendly' bore of 71cm diameter and 140cm length. The Vantage Atlas 1.5T system allows for a large clinical field of view and includes contrast-free MR Angiography applications, which can significantly reduce hospital costs on contrast agents. More importantly, such contrast-free MRA applications reduce the exposure of patients to health risks associated with gadolinium, the contrast ingredient used for MRA exams, which has been directly linked to nephrogenic systemic fibrosis (NSF), a sometimes fatal disease that occurs in patients with severe renal insufficiency.

Paramed Medical Systems launched a new MROpen 0.7T MRI system based on novel superconductive technology. The unique U-shape of the scanner alleviates

patient claustrophobia and allows for a range of weight-bearing spine MRI examinations.

Many incremental improvements were seen in diagnostic radiology at RSNA 2007, offering benefits in shortening patient pathways by improved utilisation of resources and / or allowing for a higher level of patient care. All of the manufacturers are developing or already have a common front end format to all of their own equipment operating systems. This should result in a reduction in the time required to train staff on new equipment, with transferable skills from one modality to another within the same manufacturer offering.

All of the companies were promoting improved workflow by integrating their IT systems. Once a patient has been added to a facility's patient administration system (PAS), the necessary information will be available to all networked imaging modalities, thus saving time and resources in patient data entry. Manufacturers are also improving the workflow, when setting up a radiography system to undertake an examination, by streamlining the data entry and examination selection processes. These two improvements should result in a reduction in operator interaction time and result in possible improved productivity of the systems.

Several manufacturers now display the review image on the tube head generator control. This should be useful when a repeat image is required due to positioning error. The operator can review the image whilst repositioning the patient, thus ensuring the correct position at the repeat exposure and minimising chances of any further radiation exposure to the patient.

CT-like images can be produced on most angiography systems now offered in the UK. These can be viewed during the angiography procedure and compared to prior diagnostic CT images for the same patient. The benefits of this are relieving the ever-increasing demand on CT services, whilst permitting much faster confirmation of the outcome of the angiography procedure. This on-table confirmation means that any further intervention can be undertaken during the same slot, or the patient can be safely returned to the ward without the need to be re-scanned by CT services. 3D imaging is also now being adopted in surgical theatres, using mobile image intensifiers with navigation systems to help guide surgeons to the region requiring treatment. This has led to reduced operating times and improved patient outcomes. The reduced operation time also helps to reduce any risks associated with the anaesthetics required during the operation.

In PACS, 3D tools are becoming important to the end user due to the increase in data being presented from imaging modalities. For example, with CT studies potentially generating many more images than a radiologist could feasibly look at singly, creating a 3D image from the image dataset allows the radiologist to view all available information in a reasonable time. Making the necessary tools available at

standard PACS workstations can potentially be cheaper than purchasing specialist workstations. Making these tools available throughout an institution (as opposed to having a few specialist workstations in a few areas) can reduce the time taken to produce a diagnostic report. 3D reconstruction has long been recognised as a powerful diagnostic tool, but it is now been used to aid in communication of that diagnosis. A few well chosen 3D images sent to a clinician can convey far more than several pages of a written report. This should result in faster communication and speedier treatment where required. With the trend to include data from sources beyond radiology in a PACS (particularly in cardiology) comes the need to access and present these data to system users in a coherent fashion. Systems are now being made available that can query multiple image data repositories and present the results to users as a single worklist that can be filtered by modality or source. Storage dedicated to particular modalities can thus be integrated into a single system, utilising an existing PACS and so saving on the costs of purchasing additional systems. PACS vendors are now also demonstrating the ability to retrieve data from multiple sites, giving the ability to improve workflow by having radiologists from one site report on images taken at another site. Radiology reporting is one of the most time-consuming elements of any diagnostic imaging service.

Tools to aid radiologist reporting and improve workflow were another feature of RSNA 2007. Yottalook [15] is a free web search engine designed to return search results that are most relevant to radiologists. It uses indexing technology from Google filtered by a proprietary relevance algorithm. Such targeting of results from web searches can help radiologists during reporting by providing images and information relevant to the studies that they are reviewing. RadLex [16] is a source of radiology terms designed to unify terminology used in radiological reporting. This is of particular benefit when used with Digital Imaging Communications in Medicine (DICOM) structured reporting and eases the task of searching for examinations based on a particular diagnosis or anatomy by encouraging the use of standard terms. RadLex is sponsored by the RSNA and is freely available to download from the internet.

Acknowledgements

Report contributors

Ioannis Delakis. Magnetic resonance imaging national evaluation team (MagNET), Imperial College, London.

Donald Emerton. Kings Centre for the Assessment of Radiological Equipment (KCARE). Kings College Hospital, London.

Maria Lewis. Imaging Performance Assessment of CT scanners (ImPACT), St. George's Hospital, London.

Jonathan Turner. Picture archiving and communication systems national evaluation team (PACSnet), St. George's Hospital, London.

References

1. Cancer Reform Strategy
   http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_081006

2. National Institute for Health and Clinical Excellence. Familial breast cancer clinical guideline CG41 (partial update of CG14)
   http://www.nice.org.uk/guidance/index.jsp?action=byID&o=10994

3. The CEP work programme
   http://www.pasa.nhs.uk/PASAWeb/NHSprocurement/CEP/Workprogramme.htm

4. National Stroke Strategy
   http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_081062

5. National Institute for Health and Clinical Excellence. The diagnosis and acute management of stroke and transient ischaemic attacks (in progress)
   http://www.nice.org.uk/guidance/index.jsp?action=byID&o=11646

6. 18 week wait initiative http://www.18weeks.nhs.uk

7. National Programme for IT http://www.connectingforhealth.nhs.uk

8. Our NHS Our future: NHS next stage review
   http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/dh_079077

9. American Cancer Society Guidelines for Breast Screening with MRI as an Adjunct to Mammography, CA Cancer J Clin 2007;57:75-89.
   http://caonline.amcancersoc.org/cgi/content/full/57/2/75 #

10. RSNA 2006 press release for annual oration topics
    http://www.rsna.org/Media/rsna/upload/Honored_Lecturers06.pdf

11. Computed Tomography - An Increasing Source of Radiation Exposure. DJ Brenner and EJ Hall, New England Journal of Medicine, Nov 2007, Number 22, Volume 357:2277-2284
    http://content.nejm.org/cgi/content/short/357/22/2277?query=TOC

References

12. The Ionising Radiations Regulations 1999 (Statutory Instrument 1999 No. 3232) http://www.opsi.gov.uk/si/si1999/19993232.htm#8

13. US Agency for Healthcare Research and Quality http://www.ahrq.gov

14. American College of Radiology Appropriateness Criteria http://www.acr.org/SecondaryMainMenuCategories/quality_safety/app_criteria.aspx

15. Yottalook radiology web search engine http://www.yottalook.com

16. Radlex lexicon for uniform indexing and retrieval of radiology information resources http://www.rsna.org/radlex

Appendix: CEP imaging reports 2007

CEP 07003. Evaluation report: Eizo Radiforce G33-N 3MP greyscale flat panel liquid crystal display (LCD) (Aug 07) **Full report** and **Executive summary**

CEP 07007. Evaluation report: MedStamp Communicator secure data transmission solution (Nov 07) **Full report** and **Executive summary**

CEP 07011. **Economic report:** Cost effectiveness of direct digital radiography versus computed radiography for chest examinations (Aug 07)

CEP 07015. Evaluation report: Medtronic PoleStar® iMRI Navigation System - portable magnetic resonance imaging system for neurosurgery (Oct 07) **Full report** and **Executive summary**

CEP 07023. Evaluation report: Dual energy subtraction for chest radiography (Nov 07) **Full report** and **Executive summary**

About CEP

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Centre for Evidence-based Purchasing
Room 152C
Skipton House
80 London Road
SE1 6HL

Tel: 020 7972 6080
Fax: 020 7975 5795
Email: cep@pasa.nhs.uk
www.pasa.nhs.uk/cep