IMAGING
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Hybrid Imaging in Europe **Who will do it ?**

Prof. Iain McCall

Editor-in-Chief
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Dear readers,

This edition focuses primarily on the topic of hybrid imaging. This merits particular attention as it goes through somewhat of a revolution just presently, following the collaboration of both the European Association of Nuclear Medicine (EANM) and European Society of Radiology (ESR) in solving the question of not only who will perform what aspects of hybrid imaging and nuclear medicine in the future, but more importantly, how will we train young professionals and students so that they can arrive at a point of specialised knowledge in the field.

Previous efforts by these societies have taken steps on the road to divining who is performing what types of studies in the field, and in what numbers, with the goal of streamlining and improving efficiency in training for multimodality imaging and facilitating the performance and interpretation of combined cross-sectional imaging. Eventually, it is to be hoped that a database will be created that serves the EANM and the ESR jointly for the future benefit of both specialties.

Augmenting this coverage of current efforts in the field regarding professional organisation, is an excellent and incisive paper from expert, Prof. Gustav von Schulthess, who shares with us his ideas for choosing and investing in hybrid imaging technology in a clinical environment. Given the investigation of novel modalities such as PET/MR, this article is certainly timely and informative in assisting those wondering what will make the most clinically and financially effective purchase at the moment. As well as this, we report on an innovative project funded by the European Commission that aims to merge the dual imaging modalities of PET and MR in one unit. Supported by Philips Healthcare, this initiative should shed light in time to come on ways in which PET/MR could see the light of day. Coordinated and contributed to by President of the EANM, and Editorial Board Member here at IMAGING Management, Prof. Wolfram Knapp, this cover story aims at deciphering the future of the specialty.

Finally, I would like to draw your attention to a healthcare economics based paper written by Jane Adam, who writes on behalf of the National Institute for Health & Excellence (NICE) on how they are divining the cost effectiveness and value for money of certain medical therapies and particularly, within the field of radiology. A consultant radiologist herself, Dr. Adam provides certain useful algorithms for assessing the effectiveness of one treatment over another. She also makes the important point that cost-effectiveness analysis is something radiology managers need more and more to know about and implement, as the spotlight falls on the utility of high cost radiology services.

I greatly hope you will enjoy reading the contents of the journal. If you wish to send your opinions and feedback regarding any of the articles within, please do so by emailing our Managing Editor at editorial@imagingmanagement.org

CONTENT

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Hybrid imaging technology continues to develop apace: but is the medical profession keeping up? This cover story reviews the results of a questionnaire on who is actually performing nuclear medicine; nuclear medicine professionals or radiologists, and proposes a way forward for a new and altered cooperative curriculum being proposed jointly by the EANM and ESR. The section finishes with an indepth look at new advances in hybrid imaging, such as the evolving uses of PET/MR and multimodality imaging in radiotherapy.

38 COST MANAGEMENT

Dr. Jane Adam is a highly experienced consultant radiologist working with the UK's National Institute for Health & Excellence (NICE). In this article, she draws on her professional experiences to share with us how, at a national level, an agency such as NICE is working to ensure that healthcare spending is carried out in a responsible and controlled manner to combat rising demand, spiraling healthcare costs and the growing requirements from patients for access to novel therapies. This article will tell you what methods they are using to assess value for money in terms of where funding should be allocated, and all about applying them to radiology.

Country Focus

Canada

In Every Issue

This edition's IMAGING Leaders profiles Prof. Oliver Speck, President of the European Society for Magnetic Resonance in Medicine & Biology. Here, he talks about the future of MRI, with regards to efforts to safeguard the continued clinical and research use of this valuable technology in Europe, and its more novel applications.

This article provides a review of what guidelines are in the context of contrast enhanced imaging exams, discusses what GBCAs are, how they are used and reviews health guidelines on Nephrogenic Systemic Fibrosis (NSF) in order to better understand how to manage this newly recognised risk. Part two, which appears in our next edition, provides an incisive overview of the various guidelines that were independently produced by the various regulating bodies, and highlights some key differences between them.

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MORE INFORMATION

For further information on *IT @ Networking Awards 2010* please:

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IT @ Networking Awards 2010 is organised by the European Association of Healthcare IT Managers and the European Association of Hospital Managers, supported by Excellent Event and EMC Consulting Group.

EUROPEAN COMMISSION ANNOUNCES DIGITAL AGENDA FOR EUROPE

Maximising Potential for Economic Growth a Priority

The European Commission has announced a new action plan to tackle the debilitating impact of the financial crisis, which it says in a new document, has "wiped out years of economic and social progress and exposed structural weaknesses in Europe's economy". To achieve a sustainable future, the recently launched Digital Agenda action plan outlines key areas of deficiency in Europe's ability to deliver electronic services within its borders, including online healthcare delivery. It makes proposals for actions that need to be taken urgently to get Europe on track for smart, sustainable and inclusive growth. Its proposals aim to set the scene for longer-term transformations that the increasingly digital economy and society will bring about.

Europe 2020 Strategy

The European Commission launched the Europe 2020 Strategy to exit the crisis and prepare the EU economy for the challenges of the next decade, in March this year. Europe 2020 sets out a vision to achieve high levels of employment, a low carbon economy, productivity and social cohesion, to be implemented through concrete actions at EU and national levels. This battle for growth and jobs requires ownership at a top political level and mobilisation from all actors across Europe.

The Digital Agenda for Europe is one of the seven flagship initiatives of the Europe 2020 Strategy, set out to define the key role that the use of Information and Communication Technologies (ICT) will have to play if Europe wants to succeed in its ambitions for 2020.

» INFO BOX

The overall aim of the Digital Agenda is to deliver sustainable economic and social benefits from a digital single market based on fast and ultra fast internet and interoperable applications.

Maximise Potential of ICT

The objective of this agenda is to chart a course to maximise the social and economic potential of ICT, most notably the Internet, a vital medium of economic and societal activity: for doing business, working, playing, communicating and expressing ourselves freely. Successful delivery of this agenda will spur innovation, economic growth and improvements in daily life for both citizens and businesses. Wider deployment and more effective use of digital technologies will thus enable Europe to address its key challenges and will provide Europeans with a better quality of life through, for example, better healthcare, safer and more efficient transport solutions, cleaner environment, new media opportunities and easier access to public services and cultural content.

> "The ICT sector is directly responsible for five percent of European GDP, with a market value of 660 billion euros annually"

The ICT sector is directly responsible for five percent of European GDP, with a market value of 660 billion euros annually, but it contributes far more to overall productivity growth (20 percent directly from the ICT sector and 30 percent from ICT investments). This is because of the high levels of dynamism and innovation inherent in the sector, and the enabling role the sector plays in changing how other sectors do business.

This flow of activity requires a business environment that fosters investments and entrepreneurship. But while the transformational power of ICT is clear, serious challenges must also be confronted in order to harness it. Although a digital way of life is emerging for many European citizens, on the basis of technology which declares its "worldwide", borderless reach, they cannot accept that a single market designed before the Internet is marred by privacy and security concerns, by insufficient Internet access, insufficient usability, by lack of relevant skills or by lack of accessibility for all.

Seven Key Areas to Tackle

Based on consultation with stakeholders and on insights contained in both the Granada Declaration and the European Parliament Resolution, the Commission has identified the seven most significant obstacles. On their own or in combination, these obstacles seriously undermine efforts to exploit ICT, making clear the need for a comprehensive and united policy response at the European level. They show that Europe is lagging behind its industrial partners.

Fragmented digital markets

Europe is still a patchwork of national online markets, and Europeans are prevented by solvable problems from enjoying the benefits of a digital single market. Commercial and cultural content and services need to flow across borders; this should be achieved by eliminating regulatory barriers and facilitating electronic

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payments and invoicing, dispute resolution and customer trust. More can and must be done under the current regulatory framework to weave a single market in the telecoms sector.

Lack of interoperability
Europe does not yet reap the maximum benefit from interoperability. Weaknesses in standard-setting, public procurement and coordination between public authorities prevent digital services and devices used by Europeans from working together as well as they should. The Digital Agenda can only take off if its different parts and applications are interoperable and based on standards and open platforms.

Rising cybercrime and risk of low trust in networks
Europeans will not engage in ever more sophisticated online activities, unless they feel that they, or their children, can fully rely upon their networks. Europe must therefore address the rise of new forms of crime - "cybercrime" - ranging from child abuse to identity theft and cyber-attacks, and develop responsive mechanisms. In parallel, the multiplication of databases and new technologies allowing remote control of individuals raise new challenges to the protection of Europeans' fundamental rights to personal data and privacy. The Internet has now become such a critical information infrastructure for individuals as much as for the European economy at large, that our IT systems and networks must be made resilient and secure to all sort of new threats.

Lack of investment in networks
More needs to be done to ensure the roll-out and take-up of broadband for all, at increasing speeds, through both fixed and wireless technologies, and to facilitate investment in the new very fast open and competitive Internet networks that will be the arteries of a future economy. Our action needs to be focused on providing the right incentives to stimulate private investment, complemented by carefully targeted public investments, without re-monopolising our networks, as well as improving spectrum allocation.

Insufficient research and innovation efforts
Europe continues to under-invest, fragment its efforts, under-use the creativity of SMEs and fail to convert the intellectual advantage of research into the competitive advantage of market-based innovations. We need to build on the talent of our researchers to deliver an innovation ecosystem where European based ICT companies of all sizes can develop world-class products that will generate demand. We therefore need to address the suboptimal character of current research and innovation efforts by leveraging more private investment, better coordinating and pooling of resources, 'lighter and faster' access of digital SMEs to Union research funds, joint research infrastructures and innovation clusters and the development of standards and open platforms for new applications and services.

Lack of digital literacy and skills
Europe is suffering from a growing professional ICT skills shortage and a digital literacy deficit. These failings are excluding many citizens from the digital society and economy and are holding back the large multiplier effect of ICT take-up to productivity growth. This requires a coordinated reaction, with Member States and other stakeholders at its centre.

Missed opportunities in addressing societal challenges
By harnessing the full potential of ICT, Europe could much better address some of its most acute societal challenges: climate change and other pressures on our environment, an ageing population and rising health costs, developing more efficient public services and integrating people with disabilities, digitising Europe's cultural heritage and making it available to this and future generations, etc.

Sustained Commitment Required

The Digital Agenda for Europe frames its key actions around the need to systematically tackle these seven problem areas. The Commission will remain vigilant for the emergence of additional obstacles and will react accordingly. The Digital Agenda will require a sustained level of commitment at both EU and Member State levels (including at regional level). It cannot succeed without a major contribution by other stakeholders, including young "digital natives" who have much to teach us. This Agenda is a snapshot of actual and foreseeable problems and opportunities, and will evolve in the light of experience and of the rapid changes in technology and society.

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ASSOCIATION NEWS

MIR Announces Programme Details for Annual Congress

Fresh programme details have been announced concerning the scientific programme of the Management in Radiology (MIR) Annual Scientific Meeting, which takes place this year in Mallorca, Spain, from October 14 - 15, 2010. The congress covers topics relevant to those leading departments interested in management, healthcare economics and administrative issues. Highlights of the programme, which can be found in full on the MIR website (see below) include:

- Image compression issues: "How long should we keep our images?";
- "The management decision I most regret and why": series of short presentations with audience debate;
- How to improve process optimisation in an imaging department;
- Renewing doctors' licence to practice: "How do we know if we are good enough?";
- The European Commission guideline on clinical audit: How will it affect departments?;
- Management of radiation protection in fluoroscopy-guided imaging: responsibilities of the department chairman, the radiologist and the radiographer;
- Update on the legal issues of teleradiology;
- Quality aspects and auditing of teleradiology, and

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- Management of Radiation Protection
- Teleradiology

Further information available on **www.mir-online.org**

MIR is a subcommittee of ESR

- The position of the European Society of Radiology on teleradiology.

Further information is available at:
www.mir-online.org, www.myesr.org

24th CARS Congress Update

CARS 2010, the 24th International Congress & Exhibition of Computer Assisted Radiology & Surgery, took place successfully in Geneva from June 23 - 26. Continuing with the CARS tradition, the congress opened with a clinical day that emphasised clinically-driven presentations relating to minimally invasive interventions. This was followed by three days of presentations and discussions on methods tools and applications of CARS technologies in clinical diagnosis and therapy. Altogether, 453 lecture and poster presentations were selected from around 600 submissions received from 41 countries, highlighting the continued interest from the scientific community in areas covered by the congress. Further information on next year's congress will appear in our next edition.

Further information is available at:
www.cars-int.org

Register Now for CIRSE 2010

CIRSE invites you to attend its annual meeting and postgraduate course, billed as the "world's top platform for specialists in all minimally invasive image-guided procedures". The programme has been designed around seven main themes:

- Vascular Interventions;
- Transcatheter Embolisation;
- Non-Vascular Interventions;
- Interventional Oncology;
- Neuro Interventions;
- Clinical Practice Development, and
- Imaging.

The concept of main topics running parallel to avoid overlap has been further expanded, adding neuro-interventions as the seventh topic in addition to transcatheter embolisation, non-vascular interventions, interventional oncology, vascular interventions, clinical practice and imaging. Another novelty at CIRSE 2010 will be a series of workshops organised in cooperation with the European Federation of Radiographer Societies. With this initiative, CIRSE is trying to establish closer ties with the allies who help provide optimal patient care on a daily basis.

Further information is available at
www.cirse.org

ECRI Institute Expands CT Dose Guidelines

ECRI Institute
The Discipline of Science. The Integrity of Independence.

Practical recommendations for striking the delicate balance between too much and not enough radiation are presented in a new guidance article, "CT Radiation Dose: Understanding and Controlling the Risks©," released by ECRI Institute (www.ecri.org), an independent, nonprofit organisation that researches the best approaches to improving patient care. This comprehensive Health Devices© article expands on the recommendations about controlling CT radiation dose published in ECRI Institute's 2010 Top 10 Technology Hazards list.

> "At this year's Connectathon, a total of 2,250 interoperability tests were carried out"

The article includes a section on dose-reduction technologies — and how much dose savings they each achieve. For example, it includes the advantages and limitations of axial cardiac scanning, iterative reconstruction, specific-organ dose reduction, adaptive post-processing software, and other technologies. Also included is a CT Dose Primer section, which explains factors that can be re-programmed in any CT system to reduce dose.

Further information is available at:
www.ecri.org

Tenth IHE Europe Connectathon a Success

IHE

The 10th annual European Connectathon, a well-known testing platform, held from 12 - 16 April in France was particularly successful this year. One of the most important results observed was that several IHE profiles were endorsed for national programmes in several countries where IHE national initiatives are active. IHE-Europe has proven throughout the last decade that the methodology used has showed good and effective results, mainly through their annual testing platform tackling interoperability in a pragmatic and concrete way.

At this year's Connectathon, a total of 2,250 interoperability tests were carried out and of these 1,950 passed. 80 profiles and 94 systems were tested in five domains (radiology, cardiology, IT infrastructure, laboratory and patient care coordination) by 66 companies bringing together over 250 engineers. For the first time, the Connectathon was entirely managed by Gazelle, the test management tool developed by IHE (http://gazelle.ihe.net/).

This annual event also offered opportunities for other important activities to take place, such as meetings on international DICOM standards and e-pharmacy but was also an opportunity to learn more through the workshops on EU-funded projects such as epSOS, HITCH and Smart Personal Health Systems.

Besides industry and users, a number of prestigious participants attended, such as national and European institutions including DG Information Society. The 2011 Connectathon will be held at Leopolda Storica in Pisa from April 11 to 15 - details will be reported in IMAGING Management.

Further information is available at:
www.ihe-europe.net

CORPORATE UPDATE

Sectra Provides Digital Mammography to ACT Health

Sectra has been awarded a contract to install a dedicated breast imaging PACS and three MicroDose mammography units for use in the Australian Capital Territory (ACT).

The new integrated mammography solution will provide radiologists with the ability to access digital images and information. This way, the screening and reading centres in Canberra will be able to exchange data and share workload in a secure way. In the Australian Capital Territory, BreastScreen ACT and South East New South Wales offers free screening services to asymptomatic women in the targeted age group of 50 - 69 years of age, under the programme run by BreastScreen Australia. In 2005 - 2006, over 1.5 million Australian women participated in the BreastScreen Australia programme.

Frost & Sullivan Presents Carestream Health With Award

Frost & Sullivan has presented Carestream Health with the 2010 European Digital Radiography New Product Innovation Award. Specifically, the award recognises development of the CARESTREAM DRX-1 System, a wireless cassette sized detector that is compatible with existing equipment to provide a cost effective and rapid upgrade path to digital radiography.

For the award Frost & Sullivan benchmarked Carestream Health against its competitors using five key criteria, with the citation for each stating the following:

Innovative Element of the Product; Leverage Leading Edge Technologies in Product; Value Added Features/Benefits; Increased Customer ROI, and Customer Acquisition/Penetration Potential.

Philips Announces First Mobile 3T with Multitransmit

Philips Electronics has announced the world's first Mobile 3.0T MRI system with MultiTransmit - the Achieva 3.0T TX Mobile MRI. The mobile system brings advanced MRI diagnostic capabilities to patients who previously may not have had access otherwise. Additionally, the Achieva 3.0T TX Mobile MRI will be the first 3.0T MRI system in Europe with MultiTransmit. The medical charity COBALT, purchased the first system. One key product feature is that the Achieva 3.0T TX Mobile is fully transportable in a 48-foot trailer. Additionally, it has the same ease of use and set-up time as many 1.5T scanners, but with the higher resolution and clarity that was once only available in sophisticated research institutions. The mobile unit also includes active magnetic shielding, permitting the light-weight high field magnet to be transported in the trailer.

Breast Imaging Centre Selects Tomosynthesis to Increase Detection in Dense Breasts

Greater Clarity Improves Diagnostic Confidence

The Breast Imaging Centre at Hôpital Privé Jean Mermoz in Lyon, France, one of the largest private hospitals in the Lyon and Rhône-Alpes regions, is rated by LePoint magazine as the eighth best centre in France for the treatment of breast cancer. In 2003, the hospital reinforced its reputation as a centre for excellence by adding a digital mammography system integrated with a PACS to its armamentarium. Recently, the Centre announced the addition of a new cutting-edge technology – a Hologic breast tomosynthesis system – with the aim of increasing detection of abnormalities in exams on dense breasts and improving workflow in the department.

Selenia System Performance Best on the Market

Dr. Christophe Tourasse, head of the Breast Imaging Centre, believes cutting edge technologies such as tomosynthesis can be critical in the early identification and diagnosis of breast cancer. "Digital mammography is one of the best techniques for detecting breast cancer in women," explains Dr. Tourasse. "However, it is not completely effective for women with dense breast tissue."

Hôpital Privé Jean Mermoz is the fifth hospital in France to install a Hologic Selenia Dimensions tomosynthesis system.

"I chose Hologic's Selenia Dimensions because the Selenia system's performance in 2D imaging is one of the best, if not the best on the market," states Dr. Tourasse.

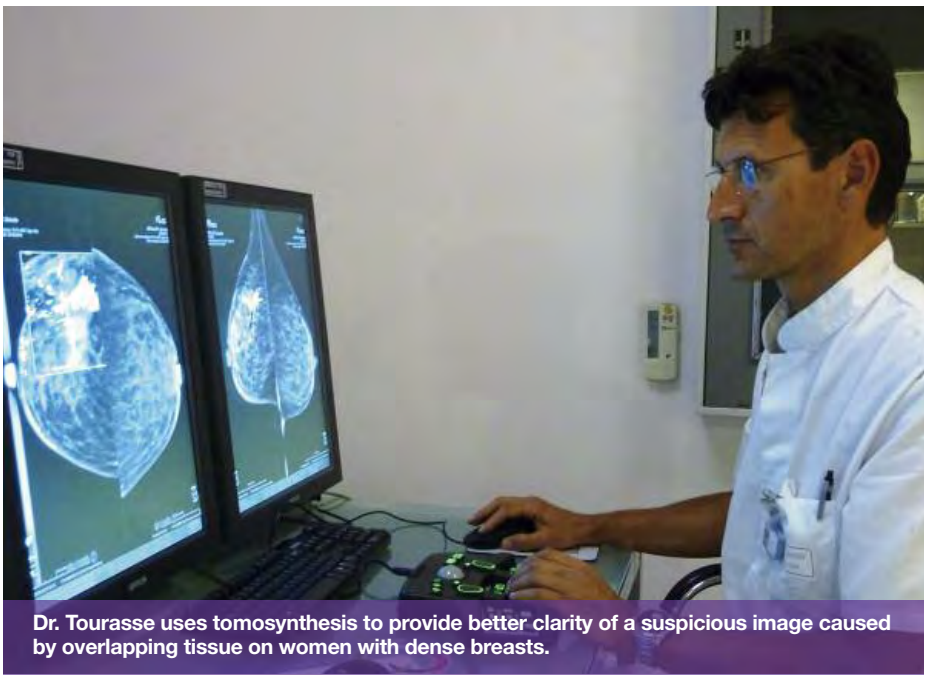
Breast tomosynthesis builds on the superior image quality of digital mammography by using computer algorithms and multiple digital images of the breast to create what is in essence a 3-D mammogram. Tomosynthesis enables doctors to see more by identifying abnormalities that may be hidden by dense or overlapping tissue.

A Valuable Tool for Routine Mammography Exams

Tomosynthesis has become an important tool for routine mammography examination in the Breast Imaging Centre. "Hologic's Selenia Dimensions system is very easy to use so we can include tomosynthesis in our workflow for routine mammography examinations," says Dr. Tourasse. "This was a key element in my decision to implement the Selenia Dimensions system. The patient doesn't notice any difference from a conventional mammogram, but the technology increases our diagnostic confidence. In addition, I have some cases where the cancer was not visible in conventional views and was diagnosed solely due to tomosynthesis."

"Tomosynthesis increases the radiologists' confidence that they are reading the image correctly."

"The ability to acquire two and three dimensional images during the same breast compression is the key feature of the system," states Dr. Tourasse. "The Selenia Dimensions system acquires images quickly, which enables us to use it as a routine evaluation tool. More importantly, it provides a correlation of planes between 2D and 3D, which is a key feature for identification of small lesions between 2D and 3D planes."



Dr. Tourasse uses tomosynthesis to provide better clarity of a suspicious image caused by overlapping tissue on women with dense breasts.

Greater Clarity Improves Confidence

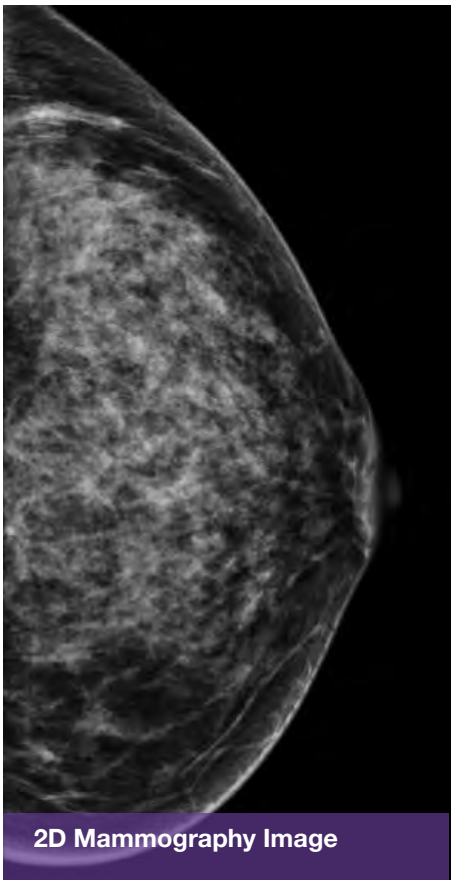
Dr. Tourasse uses tomosynthesis to provide better clarity of a suspicious image caused by overlapping tissue on women with dense breasts. Tomosynthesis increases the radiologists' confidence that they are reading the image correctly. "We can see the overlapping tissue when we go through tomosynthesis slices. It increases the specificity and allows us to take fewer spot views," says Dr. Tourasse.

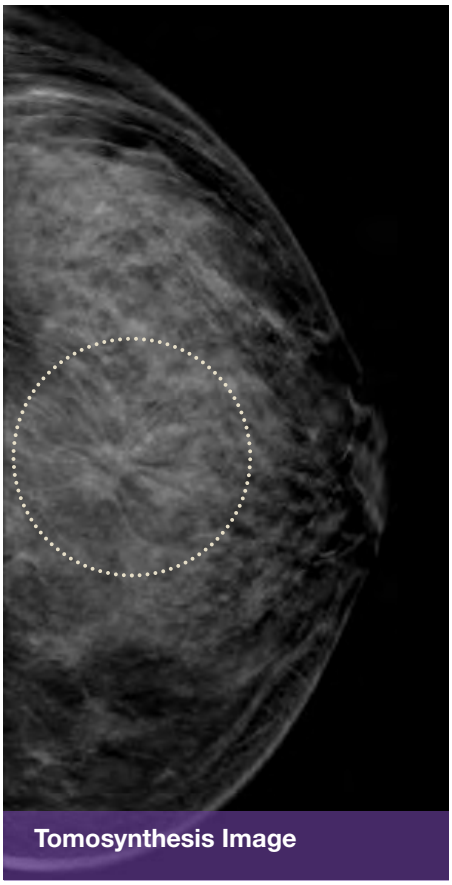
For a routine breast tomosynthesis exam, Dr. Tourasse uses the unique feature of combined 2D+3D for the CC view and 2D for the MLO. "Depending on the clinical indication, I also might do an extra tomosynthesis on a specific view to better visualise a suspicious area and have more clinical information."

"We are very interested in detecting masses, as these masses when cancerous, are linked to convergent architectural abnormalities much better seen in tomosynthesis. Tomosynthesis also helps detect microcalcifications in dense breasts, giving us a better idea of their spatial distribution. However, we continue to use magnified views to characterise the microcalcifications."

"During the past six months, the Center has used breast tomosynthesis on more than 5,000 patients."

Hôpital Privé Jean Mermoz performs about 10,000 mammograms annually. During the past six months, they have used breast tomosynthesis on more than 5,000 patients. Dr. Tourasse believes patients with BI-RADS® Category 3 mammographic density, heterogeneously dense breasts, can benefit the most from tomosynthesis screening mammograms. "For these patients, superimposed glandular structures create artifacts or false images that may mask a real cancer."





On the left is a 2D and on the right is a 3D (tomosynthesis) view of the same dense breast (density 3+). In the 2D view the lesion is very hard to see but in the 3D view, a large distortion in the middle of the image can be clearly seen. A biopsy confirmed the distortion was an Adenocarcinoma. With the Selenia Dimensions fusion mode, the 2D and 3D images are co-registered, allowing accurate comparison of the lesion in the two imaging modes and giving the radiologist more confidence in what he/she is seeing.

Tomosynthesis Useful in Difficult-to-Read Images

Dr. Tourasse adds that tomosynthesis helps explain images that are difficult to read, sometimes eliminating the need for a breast MRI or additional exams. "Anytime we take additional views, it interrupts our workflow. With tomosynthesis, we very rarely ask for additional views, so tomosynthesis helps us achieve a better workflow."

"Our focus on diagnosis and treatment sets our hospital apart," continues Dr. Tourasse. "The Breast Imaging Centre had been performing prone biopsies since the technology became available and has developed a close collaboration with several surgical teams. From the beginning we've seen the clinical benefits of vacuum assisted breast biopsy for diagnostic follow-up in addition to micro biopsy. Tomosynthesis gives us an exact localisation of a breast lesion and helps guide us when doing a breast ultrasound, specifically for lesions with weak echographic contrast. It also punctually helps us in preoperative localisation on not well seen lesions in 2D."

"Tomosynthesis gives us more confidence in our reading and that leads to a lower recall rate," concludes Dr. Tourasse. "In most cases, cancer not seen on 2D can be identified on a second reading with the help of the tomosynthesis."

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STATUS OF HYBRID IMAGING IN THE EU

Results of EANM & ESR Joint Questionnaire

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The European Association of Nuclear Medicine (EANM) performs a biennial survey using data from its national member societies to review current nuclear medicine procedures and technology installations in Europe.

2007 Survey Results

The previous survey in 2007 used data from 34 national societies, and showed that over 500 PET systems were installed, of which two-thirds were combined PET/CT devices (n = 339). By comparison, more than 5,000 gamma cameras were installed. Interestingly, there was almost one cyclotron per four PET or PET/CT devices. This relatively large number of cyclotrons, especially when compared with the U.S, reflects the fact that European nuclear medicine departments tend to be rather ambitious in making use of a variety of radiotracers, rather than restricting themselves to the use of FDG.

The number of PET procedures in 2007 totalled about 350,000; again two-thirds were PET/CT procedures (n = 226,000). This number accounts for about three percent of nuclear medicine procedures in vivo (excluding laboratory procedures). PET or PET/CT was completely reimbursed in 15 of the 27 countries that responded. In six countries, PET/CT was partially reimbursed.

Joint EANM/ESR Survey

A follow up survey was jointly initiated and undertaken by the EANM and the European Society of Radiology (ESR), as a first step towards improving training for multimodality imaging and facilitating the performance and interpretation of combined cross-sectional imaging. Specifically, the intention of this survey was to provide a database that would serve the aim of the EANM and the ESR to work together on an equal and constructive basis for the future benefit of both specialties. Both societies set out their positions and aspirations in a document published in 2007 ("White Paper of the European Association of Nuclear Medicine and European Society of Radiology on Multimodality Imaging").

To obtain the database, a questionnaire was sent to all individual members of the EANM and ESR. Up to 1,500 respondents from the ESR and 350 from the EANM represented 38 countries and drew the following conclusions:

- In two-thirds of departments the CT component is currently only used for anatomical landmarking and attenuation correction (low-dose CT);
- In only 20 percent of departments are most CT scans conducted as full diagnostic CT with or without contrast enhancement;
- Members of both societies expect that the proportion of diagnostic CT will increase in future (>50 percent of individual members);
- Members of the EANM reported use of a significantly higher variety of radiotracers, and
- A majority (>75 percent) of respondents from both societies declared themselves in favour of joint development of a training programme for hybrid imaging on a European level by the EANM and ESR and the respective UEMS sections.

The answers to the question on preferred training options (adjusted period of interdisciplinary training or integrated interdisciplinary training programme) were indeterminate, with a moderate preference of radiologists for integrated training. It is questionable whether the two options were sufficiently well defined to rely on the responses given.

Conclusions

Expectations that an increasing proportion of procedures will involve combination of PET and full diagnostic CT is driving the need for a qualification that will allow the performance and interpretation of both procedural components by a single specialist. It is in the interests of both nuclear medicine und radiology communities, to create a training programme that delivers the necessary skills in the respective complementary field. Thus, both societies have set up working groups composed of representatives of the societies and the respective UEMS sections to develop a curriculum that will serve both radiologists and nuclear medicine physicians who want to perform and interpret multimodality imaging. ■

CURRENT AND DESIRED QUALIFICATIONS IN HYBRID IMAGING

Special Competency Certification a Solution?

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The great majority of professionals in nuclear medicine and radiology expect that the number of diagnostic CT scans in hybrid imaging will increase. Then, CT expertise will be a necessary part of hybrid imaging in general. Joint interpretation of images by fully trained experts in nuclear medicine and radiology and consultation between the two specialists to combine the data into a final diagnosis has the advantage of providing a high-quality result. At a practical level, it would be desirable to have qualified experts in hybrid imaging who can cover both modalities, PET and CT. However, comprehensive training in both clinical radiology and nuclear medicine would extend the training programme to eight - ten years.

Integrated Training

The solution is to integrate one part of the complementary qualification (nuclear medicine for radiologists and diagnostic radiology for nuclear physicians) into the core specialisation, and to add adjusted complementary training in the other specialty. In total, two years of training in the complementary specialty obtained in a fully accredited department, should provide a broad foundation of knowledge in the second specialty, provided it is not confined to a single technique such as CT or PET or to a single clinical application.

It should be recommended that training in the second specialty includes about 18 months of cross-sectional imaging (CT and MRI for nuclear physicians, and PET and SPECT for radiologists); the remaining six months of training might then be dedicated to a variety of other diagnostic procedures. Clinical training should be paralleled by education in the physical principles of CT and MRI for nuclear physicians, and by education in radiopharmacy, radiotracer biokinetics and physical principles of SPECT and PET for radiologists. Training need not include therapeutic interventional radiology or radionuclide therapy.

Exceptions to Complementary Training

There is general consensus that a basic requirement for qualification in hybrid imaging is full specialisation in either nuclear medicine or radiology. Through the additional qualification in the second specialty as outlined above, the great majority of multimodal imaging procedures will be accessible, independent of the primary (core) specialisation. Some exceptions have to be considered, such as hybrid imaging in neurology, cardiology and thyroidology, and pre-therapeutic dosimetry in radionuclide therapy. Procedures in neurology and cardiology will require special training programmes.

The exact duration of training for multimodality imaging is necessarily subject to national regulations or even to local circumstances. The general time scale as outlined here is compatible with a model requiring a total of six years leading to a special competency certification for multimodality imaging. At the time of writing (January 2010), detailed specifications of the training syllabus are still under discussion between the European Association of Nuclear Medicine and the European Society of Radiology and their UEMS delegates. ■

Current Status: Who is Doing Hybrid Imaging?

Discussions are underway to develop European qualifications for the performance and interpretation of PET or PET/CT. In most countries, acquisition of skills in PET is part of nuclear medicine specialisation. In some countries, additional certificates are required to obtain reimbursement for PET/CT or PET studies. Preconditions for such certificates vary. In Germany, at least 1,000 PET studies must be documented. Currently, about 80 percent of diagnostic procedures using PET/CT are conducted with low-dose CT (non-diagnostic CT). The CT component of the hybrid systems is used for attenuation correction of the photons emitted by positron annihilation and for landmarking the anatomy of pathological foci. Therefore, about 40% of PET/CT procedures in Europe are performed and interpreted by physicians qualified in nuclear medicine only. In another 40 percent of procedures, the CT component (diagnostic or low-dose) is interpreted by fully-qualified radiologists. Only a small percentage of combined studies are performed and read by dual specialists in nuclear medicine and radiology.

INVESTING IN HYBRID IMAGING TECHNOLOGY

What are the Best Bets in a Clinical Environment?

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Choosing a hybrid system is like buying a new car. In both cases, customers ask:

1. Does it improve something for me?
2. Is its technology mature?
3. Is it cost-effective?
4. Is it easy to operate?
5. Is it more fun to drive?
6. Does it make me more attractive?

This article discusses investments in clinical hybrid imaging technology in general and PET-MR in particular, and examines the extent to which each option meets the six criteria listed above. It will focus on oncologic, neurologic, and cardiac imaging.

PET-CT a Mature Offering

PET-CT is useful in between 20 and 50 percent of oncology patients. Its almost simultaneous data acquisition is particularly useful in the abdomen, where patient repositioning between scans, bowel motion, and variable bladder filling can hamper fusion of data sets from separately acquired scans. PET-CT is infrequently used in brain imaging because software data fusion is easy and MRI is the mainstay. In cardiac imaging the advantages of PET over SPECT perfusion imaging are limited and software integration is adequate. PET-CT technology is mature and easy to operate, and its cost-effectiveness can be demonstrated (see further reading for more information).

The synergies of PET and CT in oncology were understood early. Not only is there an important clinical need for anatomic referencing of the metabolic images, but the speedily acquired CT data can also be used for attenuation correction of the PET images, thus obviating the slow PET attenuation correction systems. This has led to consistent semiquantitative PET images, which is important mainly in therapy monitoring. Technically, integration of PET and CT saves money in comparison with independent systems. A single operating console, table, and room are needed rather than two. As a PET scanner is considerably more expensive than a CT scanner and PET scanner use for attenuation scanning takes much longer than CT data acquisition, integration of PET and CT makes sense clinically and economically.

Thus the first four criteria outlined above are largely satisfied by the integration of PET and CT, with use of FDG (fluorodeoxyglucose) or other tracers of value in oncology. The "soft factors" five and six have some importance with regards to the choice of the PET and CT device in a PET-CT scanner. In oncology the use of a 64-slice CT hardly confers any advantage over a 16-slice or multislice CT with an even lower slice number. The type of detector crystal is used in PET scanners may also be more of a soft than a hard factor in oncologic PET as long as time of flight technology is used. Hence, emotionally induced over-investment definitely may influence the choice of the CT in PET-CT, but also some impact on the choice of the PET system.

Where is SPECT-CT?

SPECT-CT differs in important respects from PET-CT. It has a lower spatial resolution than PET and is relatively low cost compared with a state-of-the-art CT scanner. In addition, the need for attenuation correction is less established than in PET. This means that during SPECT data acquisition a CT scanner that is comparatively expensive is idle for long periods. The most clinically relevant SPECT exams are bone scanning and myocardial perfusion imaging. Anatomic referencing is not critical in a bone scan as it has an adequate anatomic reference in itself. Still, superimposed CT data are helpful for the distinction e.g. between degenerative and metastatic lesions, and thus SPECT-CT appears useful in this setting. In myocardial perfusion imaging, attenuation correction can be done by software fusion of CT data.

The problem of one system idling during data acquisition is exacerbated in cardiac patients undergoing SPECT-CT because CT coronary angiography has to be possible and this requires a 64-slice CT or better. In a high-throughput cardiac setting, integrating one of the new, very fast – but expensive – CZT cameras with a high-end CT scanner may make economic sense. In summary, SPECT-CT is not as successful in meeting criteria one to four, above, as PET-CT. The emotional factors five and six, are important because many nuclear medicine sites that do not have PET-CT will opt to display their power by purchasing a SPECT camera with a good CT scanner, an "overkill" in most settings.

PET-MR: Too Early to Tell?

The lack of clinical data makes a discussion of PET-MR largely speculative. To justify adding MR to PET we have to identify tasks for which PET-MR may be superior to PET-CT, which in turn requires identification of those areas where MR performs better than CT. MR is better than CT in the brain, the musculoskeletal system, some head and neck applications, the pelvis and liver disease. In the chest, CT excels and in the heart MR has yet to prove its clinical usefulness in a broad sense. In the brain, software fusion is very easy and so there the sole argument for integrated PET-MR imaging is simultaneous data acquisition, which can only be provided in fully integrated PET-MR systems.

While simultaneous data acquisition may be of benefit in resolving some research questions, it probably offers few advantages in a clinical setting. Rather than temporal simultaneity, pharmacokinetic simultaneity should be attained in a PET-MR examination. In other words, if one has an uptake time of 60 minutes or so for FDG and most other clinically useful tracers prior to PET imaging, the meaning of simultaneity becomes somewhat blurred. When does MR have to be acquired to reflect the physiological state of FDG uptake? In fact, FDG uptake reflects a physiological state extended over many minutes and so the question of temporal simultaneity becomes moot. With these considerations in mind, we are left with fully integrated clinical PET-MR applications in the neck, abdomen, pelvis, and musculoskeletal system. While there are technical developments in MR towards whole-body surveying scans, these can be done much more effectively with CT, so extended staging is still a domain of CT scanning. Hence, the first likely clinical applications are focal imaging of PET-MR with extended body PET surveys.

Technically we have to distinguish between fully integrated PET-MR systems, which can simultaneously acquire PET and MR data, and sequential systems deployed in one or two rooms and connected by a shuttle. A shuttle would be a table on which the patient can be transferred to the other imaging device without changes in body position. In fact, current PET-CT and SPECT-CT are one-room sequential systems where the system table serves as the shuttle. Full integration of PET-MR is very expensive as completely new PET detectors have to be developed. A whole-body fully integrated PET-MR system would likely cost over four million euros, and nobody currently disposes of any clinical data to argue in favour of or against buying such a system. The advantage of sequential systems connected by a shuttle is that the PET and MR scanners can be placed sufficiently far apart that today's photomultiplier PET detector technology still works. For this reason, the shuttle distances need to be two or more metres.

The advantage of single-room sequential PET-MR is that it requires only one – albeit large – room. A two-room system has the advantage that the systems can be run independently if needed and that the system can be operated in a "pipeline" mode: once the first patient enters the second scanner, the first scanner is free to receive the second patient and so on. All systems consisting of a PET and an MR scanner currently have the problem that there exists no proven solution for extracting attenuation correction data from MR scans. One has either to also incorporate a CT or to revert to the old PET source attenuation correction. Hence, a good starting system would be a two-room shuttle-linked PET-CT-MR system with the CT providing attenuation data or more. Another unsolved problem in PET-MR is how to deal with all the MR coil gimmickry when the patient enters the PET. It will cause additional attenuation artifacts, which have to be corrected for. Again, no mature technology is available to deal with this.

In light of these unresolved issues, points one to four above have to be answered as follows. We have few data to prove that PET-MR may be useful and the technology largely does not exist yet. Cost-effectiveness may be present for a two-room shuttle-connected PET-CT-MR system, as the system can be operated in the "pipeline" mode described above or independently. A single-room PET-MR system will be much less effective, and the fully integrated system – while efficient in the sense that data acquisition is simultaneous – will be extremely costly owing to the major re-engineering efforts needed. Ease of operation is not proven either for shuttle operation or for MR local coil handling. So the tremendous hype around PET-MR is likely due to the soft factors five and six defined at the outset. While PET-MR may be interesting, the "sex appeal" of such a system seems to completely outweigh reason at this point, and in the view of this author PET-MR should remain an academic endeavour until substantial clinical data exist that prove its utility over PET-CT in respect to defined clinical questions.

Conclusions

In summary, PET-CT is of proven utility and has many current clinical indications. SPECT-CT is clinically established, but today's system designs require high investments in technology that is idle for the most part and therefore not cost-effective. The shuttle system concept explained above for PET-MR could also be explored in SPECT-CT. PET-MR is currently surrounded by much hype and no data. Data will have to be acquired and carefully analysed

in comparison with PET-CT data. This task is best done in academic centres and so for the next few years the installation and use of such systems should be largely confined to academic centres.

Whether, where, and when PET-MR will see the light of day and be introduced into the wider clinical environment cannot be stated, nor is it possible to draw conclusions on the form that PET-MR would then take, i.e. fully integrated or shuttle integrated. Nevertheless, the soft factors cannot be ignored and may still lead buyers to adopt PET-MR technology much too early and without good clinical or financial arguments. If one radiological practice looks much "sexier" than another with a PET-MR, buying decisions will become irrational. Finally, it is important to note that equipment manufacturers love integrated imaging systems because they can always sell two for one; hence what may be soft factors for the buyers may be clear-cut financial factors for the vendors. ■

Further Reading

1. VON SCHULTHESS GK, BURGER C.
Integrating imaging modalities: what makes sense from a workflow perspective? Eur J Nucl Med Mol Imaging 2010 (accepted for publication).

THE HYPERIMAGE PROJECT

Investigating New Applications for PET/MR

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The EU-funded HYPERImage research project aims to merge the concurrent PET and MR imaging techniques, with the goal of opening new fields in therapy planning, guidance and response monitoring. PET/CT scanners allow functional information such as glucose uptake rates derived from an FDG-PET scan to be co-registered with anatomical features in the CT images. However, because of MRI's superior soft tissue imaging capabilities and its ability to provide additional functional information, such as blood perfusion measurements, a combined PET/MR scanner could potentially be of even greater benefit than PET/CT. In addition, MRI's ability to capture the motion of internal organs could be used to enhance both the resolution and sensitivity of the PET images. However, concurrent clinical PET/MR scanners do not currently exist due to inherent incompatibilities between conventional PET detectors (photomultiplier tubes) and the high magnetic field strengths encountered in MR machines.

Can PET & MR be Compatible?

Getting an experimental MR-compatible PET detector to work inside an MR system was a key first step in developing this technology. Development of a solid-state PET detector that is not affected by the high magnetic field of the MR-scanner or by reception of the MR signal involved eliminating magnetic materials, such as nickel in electronic component housings, and screening of the entire detector in a Faraday cage to prevent the introduction of RF noise into the MR signal.

One of the first challenges is to assess how well the motion capture capabilities of MR imaging can improve PET images. PET's reliance on low-level radioactive decay events means that PET images typically take ten to twenty minutes to acquire. As a result, any movement of the target tissue, e.g. due to cardiac motion, blurs the PET image, leading to a loss of resolution.

The project will therefore investigate how motion information extracted from the MR images can be fed into the PET reconstruction software to 'deblur' the PET images.

About the HYPERIMAGE Consortium

The HYPERImage consortium comprises three universities (King's College London, UK; Universität Heidelberg, Germany; and Universiteit Ghent - Institute for Broadband Technology, Belgium), three research foundations (Fundación Centro Nacional de Investigaciones Cardiovasculares, Spain; Fondazione Bruno Kessler, Italy; and The Netherlands Cancer Institute, the Netherlands), a university medical centre (Uniklinikum Hamburg-Eppendorf, Germany) and industrial partner Philips. Around five million euros of the project's funding is provided by the EU's 7th Framework Programme, with consortium partners collectively providing an additional 2.3 million euros. The project started in 2008 and will run for three years.

As an extension of this technique, it may also be possible to use the MR-derived motion information to dynamically correct for PET attenuation. In oncology applications, this motion compensation may allow more reliable imaging of much smaller tumours and those located in regions with a significant amount of movement.

Improved Pharmacokinetics

PET/MR imaging may also provide better pharmacokinetic measurements than currently possible. Pharmacokinetic investigations to identify tumour activity involve the measurement of how fast a tracer is perfusing into tumour tissue, how much is actively transported into tumour cells and how fast it is removed from the blood stream. This requires a perfusion measurement, most easily accomplished with MRI, and a tracer uptake measurement performed with PET. Combining the complementary strengths of MRI and PET may thus improve the accuracy of pharmacokinetic investigations.

Quantifying the pharmacokinetics of PET tracers more accurately may allow clinicians to monitor a tumour's response to therapy more accurately, allowing smaller changes to be detected. This should in turn allow clinicians to more quickly identify whether a patient is responding to a particular chemotherapy regimen. This could also reduce the costs of developing new chemotherapy agents because fewer patients may be needed in phase three randomised trials to determine if one agent is better than another.

In cardiology, the simultaneous capture of MR-derived functional information such as cardiac wall motion and PET-derived information such as myocardial perfusion could improve the diagnosis of myocardial infarction. Since these tests are normally performed during an artificially induced stress test, the reaction of the patient is also highly variable from day to day and hour to hour. Once again, simultaneous capture of MR and PET images could overcome this variability.

The Way Ahead

The HYPERImage team is now focusing on finding ways to integrate a scaled-up detector into the bore of a whole-body MRI scanner. Scaling the detector area to the required size is not the major issue, since the planar nature of solid-state photomultipliers means that they can be tiled together to create large detector surfaces. The greater challenge will be positioning this detector into the MR machine's excitation coils without disturbing the coils' normal functioning. The approach currently being adopted is to split the MR scanner's RF and gradient coils to create the required space. On the software side, the major challenge will be the development of algorithms to extract accurate motion vector fields from the MR data and feed them through to the statistical PET reconstruction and PET attenuation correction processes. ■

APPLICATIONS OF MOLECULAR IMAGING

Evaluating Therapy in Oncology

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Single-photon emission tomography (SPET) and positron emission tomography (PET) can be used to visualise molecular alterations in the living subject, allowing alterations in metabolic pathways to be seen, and facilitating early diagnosis and treatment of disease. FDG-PET has already been accepted as an essential tool in the staging and re-staging of many tumours. In this article, we summarise the role of molecular imaging in evaluating therapy in oncology.

PET-CT Increases Accuracy

FDG PET-CT is characterised by a high accuracy of neoplastic lesion detection. Along with diagnosis, staging, detection of relapse, restaging and follow-up, one of the main applications of PET-CT is the assessment of therapy response and treatment planning. In routine practice, structural and tumour volume changes are used to guide therapeutic strategies and to measure the disease-free and overall survival. However, tissue metabolism changes more rapidly than morphology, and changes in tumour FDG uptake may therefore predate alterations in volume.

A typical example is malignant lymphomas, in which anatomical imaging after the completion of therapy often reveals residual masses that could represent either persistent disease or fibrotic tissue. Early identification of patients with residual disease resistant to radio- or chemotherapy

can provide a basis for alternative treatment strategies and decrease the costs and side-effects of unsuccessful therapy. The metabolic imaging provided by FDG-PET offers functional tissue characterisation that is useful for assessing response to therapy. Accordingly, a number of studies have addressed the utility of FDG-PET for early response assessment during treatment of lymphomas.

Early Response Assessment

Patients with malignancies other than lymphoma can also benefit from early response assessment: appraisal of changes in tumour size by conventional imaging after several cycles of chemotherapy or radiotherapy can require a lot of time. Furthermore, response evaluation with morphological imaging methods does not correlate well with pathologic response, with changes at the cellular level or with tumour viability. In contrast, FDG-PET is able to detect cell behaviour and thus to identify potential residual tumour disease.

"Appraisal of changes in tumour size by conventional imaging after several cycles of chemotherapy or radiotherapy can require a lot of time."

The use of FDG-PET as a surrogate tool for monitoring therapy response offers better patient care by individualising treatment and avoiding ineffective chemotherapy. Various examples can be cited, including breast, lung and rectal cancer:

1. FDG-PET can predict response after a few cycles of standardised chemotherapy for metastatic breast cancer, and is also a valid method for prognostic stratification in patients with metastatic breast cancer treated with high-dose chemotherapy.
2. Patients with stage III or IV non-small cell lung cancer are usually treated with chemotherapy or chemotherapy plus radiation therapy, but conventional imaging sometimes cannot reliably distinguish necrotic tumour or fibrotic scar from residual tumour tissue. By contrast, FDG-PET allows evaluation of the pathologic response soon after radical radiotherapy or chemoradiotherapy. In addition, in comparison with CT scan findings, FDG-PET results show a significantly closer association with overall survival.
3. Management of locally advanced rectal cancer includes treatment with chemotherapy plus radiation therapy before surgery. Several works in the literature have underlined the importance of FDG-PET in assessing neo-adjuvant therapy response owing to its intrinsic capability to recognise early changes in the metabolic behaviour of tumours.

Assessment of Response to Targeted Therapies

Another interesting application of PET is assessment of response to targeted therapies. Although many agents have failed, some drugs such as bevacizumab, trastuzumab, cetuximab, gefitinib and erlotinib have already become part of the standard of care for common tumours including breast, colorectal, ovarian, lung and head and neck cancers. Furthermore, imatinib has shown unsurpassed efficacy in the less widespread, but aggressive, chronic myeloid leukaemia and gastrointestinal stromal tumours. Until now, no predictor of response to targeted therapy has been validated, but the selection of patients likely to benefit from tyrosine kinase inhibitors is mandatory, for clinical and economic reasons.

These new drugs, which are mostly antibodies, are very expensive and their effectiveness is limited to a percentage of patients. Molecular imaging is a novel and potentially valuable tool to identify patients who can benefit from these treatments and to evaluate the response to therapy in those patients selected for treatment. As already mentioned, PET is able to provide information about tumour metabolism, such as glucose consumption or proliferative activity, which can be used as an early predictor of therapy response. Moreover, some centres are trying to assess the in vivo distribution of these target molecules and the response or resistance to targeted agents using radiolabelled tyrosine kinase inhibitors or monoclonal antibodies.

PET Informs Decision-Making

Like other imaging exams, PET can be used to inform decision-making, e.g. whether a surgical approach is advisable, which intervention will be most appropriate and whether advanced therapies are feasible. In addition, molecular imaging could be employed to personalise therapy by guiding radiation therapy planning (the most significant example is intensity-modulated radiation therapy) and improving definition of tumour target volumes. Although CT remains the gold standard for depicting anatomy for the purpose of target volume definition and dose calculation, PET-CT could help with respect to the dose constraints for organs at risk, if the hypermetabolic component is smaller than the morphological appearance of the tumour, reducing the gross tumour volume. Further, PET

could permit the inclusion of FDG-avid, but non-enlarged, lymph nodes within the field of treatment or could modify TNM staging, resulting in a shift in treatment modality from curative to palliative.

Conclusions

In conclusion, PET is an exceptional non-invasive tool, which can provide qualitative and quantitative in vivo assessment of biological processes. PET-CT is currently a very accurate method for diagnosis, staging, post-treatment evaluation, restaging and follow-up of many tumours.

The impact of PET imaging on cancer therapy management is significant and many studies have considered its role in relation to radiotherapy, chemotherapy and appraisal of new drugs. Steady developments in cancer biology, radiochemistry and physics will provide rich soil for the further growth of molecular imaging. ■

MULTIMODALITY IMAGING FOR PRE-THERAPEUTIC MOLECULAR RADIOTHERAPY DOSIMETRY

The Key to Individualised Patient Care

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The treatment of cancer with radiopharmaceuticals is expanding rapidly, in terms of both the numbers of patients treated and the range of treatments offered (Carlsson et al. 2003). An increasing number of radiopharmaceuticals are now being introduced to the clinic and there is a strong potential for this modality to play a larger role in cancer management alongside surgery, external beam radiotherapy (EBRT) and chemotherapy. The ongoing development of new tumour targeting agents is complemented by recent advances in imaging technology and methodology, which facilitate quantitative assessment of image data and absorbed dose determination. This can provide the basis for a radical change in the manner in which molecular radiotherapy (MRT) is performed.

Whilst MRT is generally administered in a similar fashion to chemotherapy, with fixed or weight-based activities, the use of multimodality quantitative imaging for internal dosimetry offers the possibility for individualised treatment planning as is performed for EBRT. A key element in treatment planning is a pre-therapy assessment of the spatial and temporal distribution of uptake of a tracer administration of the radiopharmaceutical to be used for therapy, or of a surrogate. The advent of hybrid multimodality imaging (SPECT/CT and PET/CT), imparting corresponding functional and anatomical information, now makes accurate dosimetry-based treatment planning achievable.

Multimodality Imaging for Dosimetry

Pre- and peri-therapeutic dosimetry studies indicate that a wide range of absorbed doses are delivered to both normal organs and tumours. A high inter-patient variability is observed, thereby justifying a dosimetric approach to individualised patient care (Flux et al. 2009, Matthay et al. 2001). The methods required to implement pre-therapeutic dosimetry are broadly similar to those employed for peri-therapeutic dosimetry. Accurate dosimetry is reliant on multimodality imaging for visualisation, image quantification and absorbed dose calculation.

Visualisation and image quantification

Multimodality imaging enables the localisation of functional uptake in the context of corresponding anatomical information. This is a prerequisite for pre-therapeutic assessment of a potential therapy procedure. Initially, it is necessary to identify the sites and extension of disease to direct the therapeutic procedure itself. Volume definition and delineation, required for the calculation of mean absorbed doses, is challenging when applied to functional data owing to the relatively poor spatial resolution of SPECT/PET imaging with respect to CT or MRI. Multimodality imaging is also necessary to identify normal organs/tissues that may be irradiated by uptake in adjacent tumours. This may be the case, for example, if a tumour is located close to a

sensitive organ such as the spinal cord (see figure 1). Activity taken up in metastatic lung deposits will irradiate normal lung tissue, to an extent dependent on the size of the deposit and the radiation used.

Accurate image quantification is essential for the calculation of clinically useful absorbed doses. In the case of gamma-emitting radionuclides, planar scintigraphy or SPECT must be performed. Gamma cameras are not well designed for activity quantification and corrections must be implemented to produce accurate results, particularly in the case of high-energy emitters such as I-131, which is widely used for MRT. Image quantification is limited by several effects, including dead-time (caused by high activity imaging), photon attenuation and scatter and partial volume effect for small structures. It is possible to correct for all these effects, empirically or using specific developments (Ljungberg et al. 1994).

Most recent approaches consider the integration of correction algorithms during the reconstruction process (within the projector), and require anatomical information (most often CT) to be provided. However, the influence of SPECT or PET reconstruction algorithms on image quantification needs to be taken into account, as most modalities are optimised for provision of high contrast images without preserving the count rate (Divoli et al. 2007). Registered image data have commonly been obtained by fusing patient scans acquired separately from CT and from scintigraphy. A large body of literature has been produced to address the issue of image registration, which in the past often entailed the use of fiducial markers attached to the patient (Sjogreen et al. 1997, Papavasileiou et al. 2001). The advent of hybrid imaging, whereby registered anatomical and functional data can be acquired in one scanning session, has introduced a significant advance for quantitative imaging.

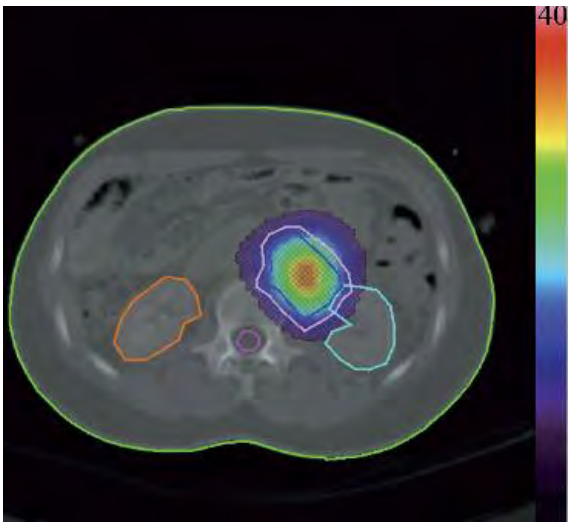


Figure 1: A parametric absorbed dose distribution superimposed onto a CT map, showing a maximum of 40 Gy. The 3D absorbed dose was determined from sequential SPECT scans. Outlines indicate the gross tumour volume, the planning target volume, the kidneys and the spinal cord as delineated on planning CT. The spread of absorbed dose outside of the target volume is due to the partial volume effect, so it is clear that the spinal cord is not being irradiated.

Absorbed dose calculations

Absorbed dose calculation relies on organ/tissue volume and density determination, as for a given cumulated activity (i.e. the total number of radioactive decays) the mean absorbed dose is inversely proportional to the mass of the volume of interest. Dose conversion factors (S values) can be obtained from anthropomorphic reference model tables (Stabin et al. 2005). These can, to a certain extent, be scaled to patient-specific organ masses obtained via multimodality imaging (Divoli et al. 2009). Patient-specific absorbed dose calculations can also be derived using multimodality imaging, where a combination of functional (activity) and anatomic (volume and density) parameters are used to model radiation transport and energy deposition via Monte-Carlo codes (Zaidi and Andreo 2003, Chiavassa et al. 2006) (see figure 2, p. 23).

> "Multimodality imaging enables the localisation of functional uptake in the context of corresponding anatomical information."

Current Issues

The implementation of treatment planning based on multimodality imaging and dosimetry presents a number of challenges. In practice, many centres are unable to accommodate the additional scans necessary for pre-therapeutic dosimetry and it is likely that the logistics of routine dosimetry based on multimodality imaging must be addressed on a Europe-wide scale. Scientifically, there are two major issues to be addressed. The first is the predictive accuracy with which pre-therapeutic dosimetry can be performed. In many cases it is impractical to use the therapeutic radionuclide for the pre-therapeutic tracer study, and a surrogate is used. A common example is the use of In-111 as a tracer for Y-90, particularly for the treatment of lymphoma with monoclonal antibodies (Chiesa et al. 2007, Cremonesi et al. 2006).

Similarly, there is an increase in the use of positron-emitting radioisotopes of the therapeutic radionuclide such as Y-86 (for Y-90) or I-124 (for I-131) as tracers (Pauwels et al. 2005, Sgouros et al. 2004). Bremsstrahlung imaging of Y-90 is feasible using SPECT/CT (Minarik et al. 2009, Fabbri et al. 2009). The predictive accuracy of these procedures depends not only on the reproducibility of patient biokinetics but also on the accuracy with which the image data can be quantified, since errors in-

herent in both the tracer and the therapy study will be compounded. Use of the therapeutic radiopharmaceutical as a tracer has the distinct advantage that differences between absorbed doses delivered therapeutically and those predicted are not due to different methods applied to image quantification or to the dose calculations themselves, but to differences in uptake and retention between the tracer and the therapy study, both of which can be calculated accurately (Flux et al. 2003). The second major issue to be studied is the possible extent to which a tracer study can affect the uptake of a radiopharmaceutical given for therapy as there is some evidence that sequential therapies may in some situations affect the biokinetics (Lassmann et al. 2004, Sisson et al. 2006).

Conclusion

An increasing number of radionuclides are available to treat the same disease. Neuroendocrine tumours may be treated with I-131 mIBG or with peptides labelled with Lu-177 or Y-90. Liver tumours and lymphomas may also be treated with either I-131 or with Y-90, and palliation of bone metastases has been achieved with Sr-89, Sm-153, P-32, Re-186, Re-188, Lu-177 and the alpha emitter Ra-223. For any given patient, the ideal radiopharmaceutical will depend on the level and distribution of functional uptake, the retention of the radiopharmaceutical, and the geometric extent and localisation of uptake with respect to normal organs. Pre-therapeutic multimodality imaging can now enable individualised treatment planning to a level of accuracy not previously considered achievable. In comparison with EBRT, only a small number of patients are treated with radiopharmaceuticals in individual cancer centres. Multi-centre, Europe-wide collaboration is necessary for the advancement of MRT using dosimetry based on multimodality imaging to determine dose-effect correlations. ■

Acknowledgements: The authors would like to acknowledge the participation of all EANM Dosimetry Committee members: K. Bacher, M. Bardiès, C. Chiesa, G.D. Flux, M. Konijnenberg, M. Lassmann, S.E. Strand, L. Strigari. G.F. would like to acknowledge NHS funding to the NIHR Biomedical Research Centre.

References are available on request to the Managing Editor at editorial@imagingmanagement.org

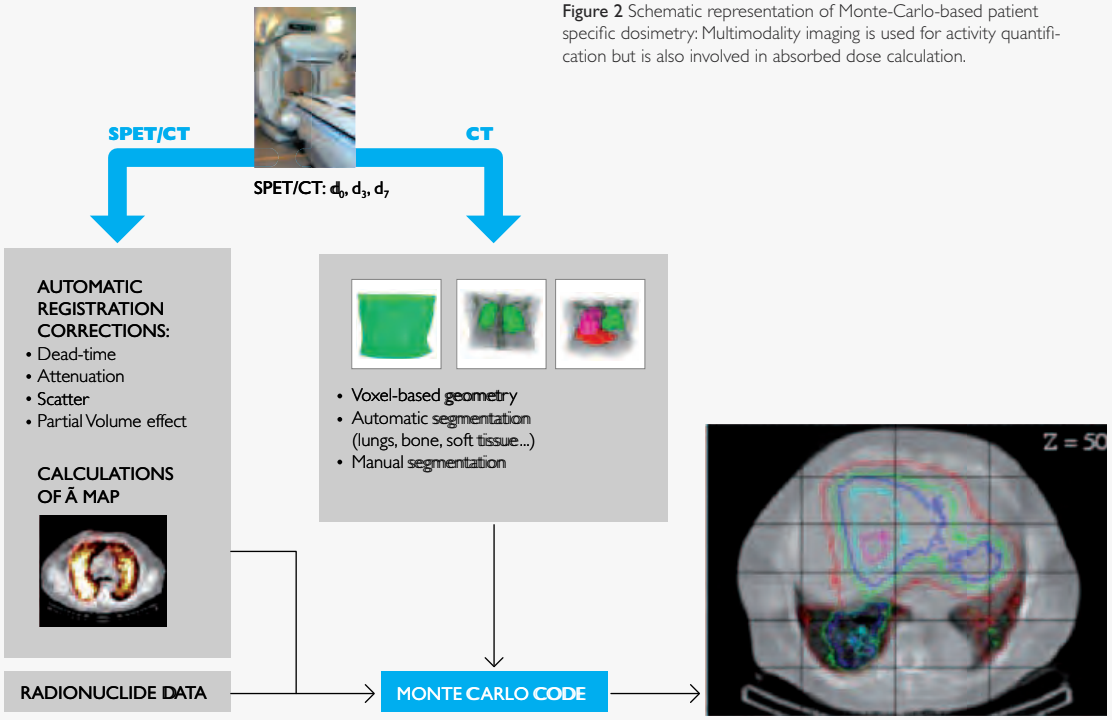


Figure 2 Schematic representation of Monte-Carlo-based patient specific dosimetry: Multimodality imaging is used for activity quantification but is also involved in absorbed dose calculation.

DIGITAL ANGIO

CHANGING THE WORLD OF X-RAY IMAGING

Outstanding advantages of the World's First Direct-conversion FPD, SHIMADZU *safire*, for Dual-application (Fluoroscopy&Radiography)

safire: Shimadzu Advanced Flat Imaging REceptor

Introduction

Doctor Roentgen, winner of the first Nobel Prize, discovered X-rays in 1895. In 1896, the following year, the son of Shimadzu Corporation's founder Genzo Shimadzu Jr. became the first person in Japan to succeed in capturing X-ray images. Based on X-ray technology accumulated over more than a century since the corporation was founded, Shimadzu continues to pursue the R&D for the most advanced technology in this field, providing high added value and reliability diagnostic imaging systems and solutions to advanced medical facilities. Our challenge to develop the world's first Direct-conversion flat panel detector(FPD) for both still images and moving images which nobody could provide still now is also the one that was made from such pioneer spirits and rich clinical and X-ray field experiences of ours.

If we look at the history of X-rays, we can see that the evolution of X-ray technology can be divided into two general areas: still images and fluoroscopic (moving) images. The development of still-image technology, of course, is tied to the history of film-screen systems. Even in this digital age, film imaging is used widely for radiography because of its high image quality. The history of fluoroscopy began with fluorescent screens. This was followed by the historical development of the I.I. ("image intensifier"), and now this technology is used widely in fluoroscopic tables and cardiac/angio systems in combination with CCD cameras and digital image processing systems.

The way that the history of X-rays is intertwined with that of detectors underlines the significance of developments in detector technology. In Shimadzu, we are well aware that progress in X-ray detector technology can lead to advances in the whole field of X-ray technology. To achieve the higher image quality than film, we spent a long time for researches and repeated clinical evaluations. It was really a big challenge and investment. We finally succeeded in launching the world's first Direct-conversion FPD for Dual-application(Fluoroscopy & Radiography) to the world.

X-ray Conversion Method for Moving-image

Fig. 1 shows the X-ray conversion method for moving- image FPD. With indirect-conversion FPD which is the majority in the current FPDs, X-rays are firstly converted to light by a CsI phosphor, and then this light is converted to electric signals by photodiodes. During this 2-stage conversion process, light is scattered and images are made from those scattered lights, making it impossible to achieve the image quality equal to or better than that obtained with film. This conversion process and phosphor material are almost same as that of I.I./CCD camera. So, the image quality is also expected to be the same as I.I./CCD. On the other hand, "Direct-conversion FPD" converts X-rays directly to electric signals. This method, while requiring an extremely high technical capability, is ideal for obtaining high-quality images.

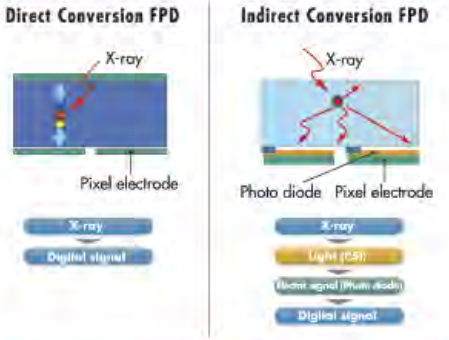


Fig. 1 X-ray Conversion Method for Moving-image FPD

Fig. 2 is a graph showing the modulation transfer function (MTF) for indirect-conversion FPD, direct- conversion FPD, film-screen, and the I.I. and CCD camera combination. The horizontal axis represents the spatial frequency and the vertical axis represents the transmission rate of image information. The closer the MTF is to 1.0, the more faithful the image is to the original. As *Fig. 3* clearly shows, direct-conversion

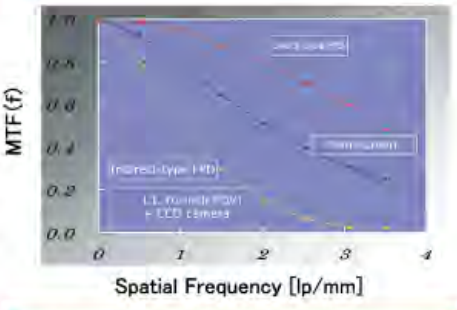


Fig. 2 Comparison of MTF Curve for Different X-ray Detectors

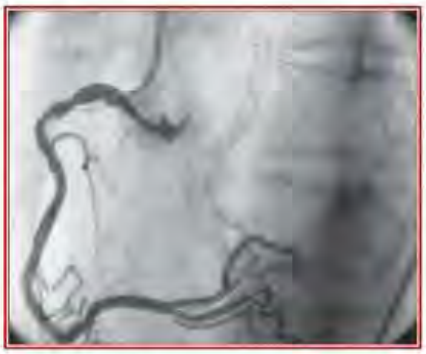


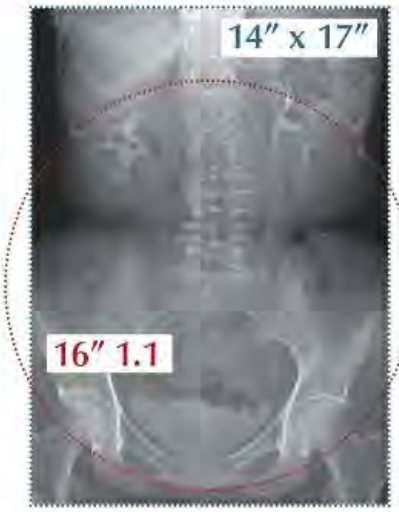
Fig. 3: Coronary Artery

FPD offer a spatial resolution that surpasses that of film-screen. On the other hand, indirect-conversion FPD offer only the same level of image quality as the I.I. and CCD camera combination.

Clinical images obtained by Shimadzu Direct-conversion FPD *safire* systems

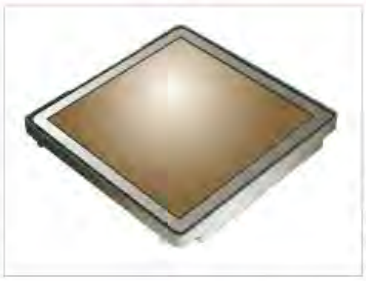
Fig. 3 shows a clinical image of the Right Coronary Artery obtained by our Cardiac/Angiographic system. A stent implant along with its structure is very clearly visualized, which were difficult to be observed with conventional I.I. or indirect FPD systems. *safire* will greatly help your safe and prompt interventional procedures, and it also means radiation exposure and injected contrast medium can be reduced consequently.

Fig. 4 shows a pulsed DSA image of the head. It is possible to clearly visualize the detailed structure of the head's vascular system with the contrast medium flowing from the arterial system to the venous system with time.



14" x 17" FOV by 17" x 17" FPD

Universal table system
SONIALVISION *safire*



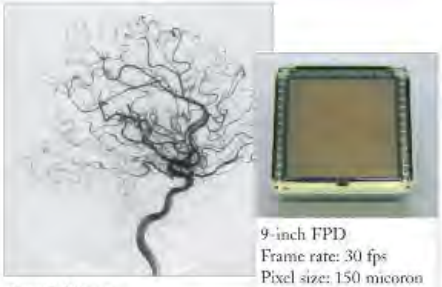
17" x 17" FOV
Fluoroscopy
& Radiography
Pixel size:
150 micron

Radiographic
System
RADSPEED
safire

Fig. 5

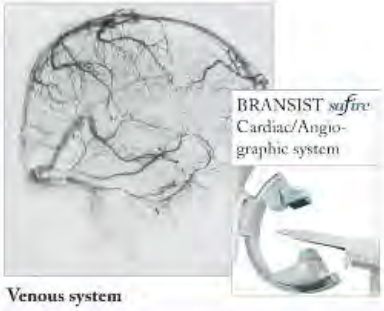
Fig. 5 shows a clinical image obtained by our 17"x17" *safire* which provides the world's largest Field Of View as of today.

It can cover even the whole colon, which could not be covered even by I.I. This FPD for both fluoroscopy & radiography is integrated in our universal solution RF table, SONIALVISION *safire* which has various advanced application capabilities such as Tomo-synthesis etc. Also the same FOV size FPD(for radiography) has been integrated in our General Radiographic System, RADSPEED *safire*.



9-inch FPD
Frame rate: 30 fps
Pixel size: 150 micoron

Arterial System



Venous system

Fig. 4

Summary

It is believed that direct-conversion FPD will revolutionize the world of medical imaging diagnosis, and it will be standardized in the next-generation. It will not only achieve the outstanding resolution clinical images, but offer the potential to reduce radiation and contrast injection, also increase safety, efficiency and clinical possibility in your examinations. ❍

Interview:

Zaans Medical Centre Installs Siemens Ysio

Reaps Workflow and Throughput Benefits

Interviewee
Mr. Gunes Sar
Project Leader
Equipment Purchasing/Unit Construction

Manager
Departments of Radiology, Vascular & Nuclear Medicine
Zaans Medical Centre
Zaandam, The Netherlands

Please tell us about the medical imaging department at the Zaans Medical Centre.

We perform in excess of 120,000 procedures per year at the Zaans Medical Centre imaging department. We have eight full-time radiologists working here, with an additional 45 radiographic technologists. We offer a complete range of imaging services, which is very easy to perform now that our department has installed the two Siemens Aristos FX-plus systems and one Siemens Ysio digital radiography (DR) system with a wireless detector and one fixed detector in the wall-mounted bucky. We also have the ortho package installed in all three of the machines.

We recognise an important area in the management of a medical imaging department is the efficient use of equipment and improved workflow. How has the Ysio made an impact compared to other DR/CR systems?

The changeover from analogue to digital radiography with the Siemens Ysio has had a great impact on our workflow. Working with the two ARISTOS FX-plus systems since 2008, we improved our throughput by up to three times with our x-ray procedures. Since the installation of the Ysio system in 2009, we have entered another dimension of speed and efficiency in DR procedures. As well as its ability to be installed specifically to our needs, the Siemens Ysio DR system also makes it possible to examine patients at the bedside, with a flawless picture quality that exceeds CR in sharpness and readability. This is better for the patient, because the specialist can now see the image within five seconds on the screen. For the radiographic technologists the Ysio has proved to be highly efficient, fast and with perfect quality, featuring new generation detectors. You can use the touchscreen pad on the Ysio if you want to adjust kV or mAs or other criteria. We used to have five analogue CR rooms - now we have three DR rooms, saving us space. Our workflow has improved with a factor of three, and throughput has also increased. Quick diagnostics for the patient, higher throughput, better workflows, and ease of use for radiographic technologists are benefits that all imaging department managers can appreciate.

> "In a nutshell, the patient can remain in his own bed with the Ysio - that's a quality improvement for the patient!"

How has the installation of the Ysio and the department's existing two Aristos FX Plus systems helped you to schedule your patients within the different rooms?

Using our RIS, we can plan the exam path for every patient in any of the three rooms. The Ysio enables the radiologist to remotely organise patients from the comfort of the Ysio room. The other huge benefit is the flexibility and versatility of the wireless detector. In a nutshell, the patient can remain in his own bed with the Ysio - that's a quality improvement for the patient!

What did you identify as the particular strengths of the Ysio as opposed to its other competitors when you were making your purchasing decision?

The main positive attributes that contributed to our decision to install the Ysio were:

- Wireless detector with high-quality x-ray images
- Very easy to use
- Touchscreen interface on the x-ray tube
- An automatic movement control is pre-installed - this is a big plus for the radiographic technologists

- A special ortho software is available from the vendor, so that we can do stitching procedures using our 3D multi-modality workstation
- The system is very fast in its movements and post-processing
- Some vendors still don't offer wireless detectors or promote the use of three detectors in the same room. By contrast, we only require two detectors with the Ysio and can perform every type of examination.
- It is a compact, fully automatic system, which can be installed even if there is a shortage of space in the department.

Has the installation of this system brought any other unexpected benefits?

Here I would particularly like to highlight the ergonomic features for the radiographic technologists, which are excellent. Everything is fully automated, and controlled by the technologist. Our dedicated DR room is large enough, leaving more space for bed patients or trauma trolleys.

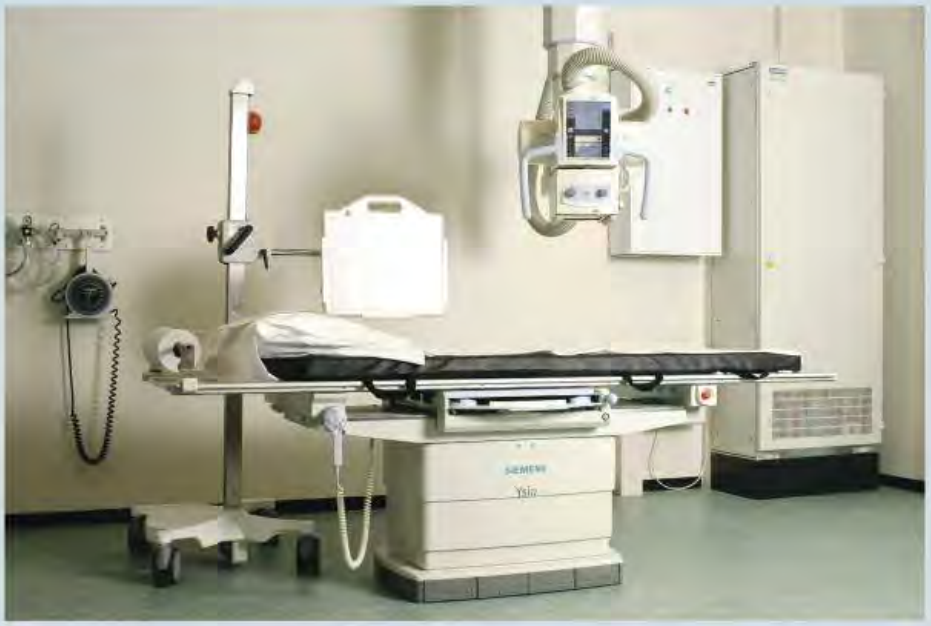
What two key benefits you would emphasise about the Ysio system if you were speaking to another imaging department manager looking to purchase a DR system?

The main two benefits I would emphasise to another imaging department manager are firstly that it is a very fast system that enhances your workflow, with a very good price-quality ratio. Secondly, the training of radiographic technologists on the Ysio is very fast and easy indeed, which saves a lot of time compared to other systems.

> "Since the installation of the Ysio system we have entered another dimension of speed and efficiency in DR procedures"

Do you plan to modernise the department further in the future, and if so, in what areas?

We are still busy modernising our medical imaging department. We purchased two Arcadis varic mobile c-arm systems for the OR and one SPECT-CT Symbia T6 for our nuclear department with another soon on the way. The newest machine that we have purchased is the Artis Zeego Multi-axis interventional system, which will be the first of its kind in a radiology department in the Netherlands. We are very proud that this has been made possible to acquire the Zeego, with its large display. We hope that this will be operational by October of this year.



For more information please visit www.siemens.com/ysio

Wireless DRX-Evolution Detector Brings Speed, Diagnostic Accuracy & Flexibility

The Radiologist's Perspective

Interviewee
Dr. Wolf-D. Wetzel
Senior Staff Physician
Radiology
Waldkrankenhaus Rudolf Elle GmbH
Eisenberg / Thuringia - Germany

Dr. Wolf Wetzel, Senior Staff Physician at the Department of Orthopaedics in the Waldkrankenhaus Rudolf in Thuringia, Germany, recently converted his department to digital radiography, with none of the often high costs of installing a complete digital suite, and all of the benefits for patients and radiologists in terms of speed, accuracy and comfort and convenience for the patient.

Background

The Department of Orthopaedics at the Waldkrankenhaus Eisenberg is well known both nationally and internationally, especially for its work on the subject of endoprosthetics. Says Wetzler, *"Our experts in artificial joint replacements have gained an outstanding reputation well beyond the state of Thuringia"*. The main focal points are endoprosthetics, spinal column surgery, hand and foot surgery, arthroscopy, sports trauma, casualty surgery, rheumatology, tumour surgery and paediatric orthopaedics. Together with the Departments of Internal Medicine, General and Visceral Surgery and Anaesthesiology the hospital offers comprehensive healthcare provision for all residents of the district of Saale-Holzland. Approximately 120,000 x-ray images are taken every year, and more than 60,000 patients are treated in the radiology department, which employs nine assistants/medical technical assistants and offers conventional x-ray, ultrasound and CT.

Dr. Wetzler made the decision to convert to DR with a solution that is customisable to fit his department's specific needs. The DRX-Evolution combines the world's first wireless cassette-sized DR detector, the Carestream DRX-1, with a versatile digital radiography system that uses modular components to allow design of a DR suite that meets workflow and budget demands. The possibility of creating a tailor-made digital radiology-solution that can flexibly be adjusted to the respective needs was crucial to the purchasing process. Dr. Wetzler states, *"DRX-Evolution is a completely new solution. Before that we were still working with analogue equipment. The system is therefore our first digital x-ray installation. Primarily we were interested in a two-detector system, and we also wanted it to be a modern, cable-free detector system"*.

Advantages of the System

The advantages of this system for Dr. Wetzler were clear: *"What appealed to me about DRX-Evolution was the possibility of taking lateral x-rays of patients with severe mobility restrictions, without having to turn them on their side. This is of the utmost importance to our department due to its focus on orthopaedics. In these cases the Evolution System is a huge facilitator, both for our employees and for our patients – we do not have to turn them on their side to take certain images of the spinal column, the knee or for other purposes"*.
But what are the advantages for the user, i.e. efficacy, productivity, costs? Dr. Wetzler is very clear on this: *"We are now in the happy position to have a system in place that meets our demands and is also very economical. And of course everything can be done a lot quicker due to the advantages of operating a digital system"*.

Unlimited Positioning Freedom

This is not the only benefit in converting to a digital x-ray system: the flexibility of cassette positioning offered by the DRX-Evolution is a

clear advantage. The speed of wireless DR enables the image to appear on the console in seconds, while the wireless detector eliminates the need to move patients around a fixed DR detector - simplifying even the most challenging views. Furthermore, the DRX-Evolution is designed to make even difficult exams go quickly and smoothly. Your technologists are able to:

1. Select the patient exam from the console worklist and hold the remote auto-position button, and the system automatically positions itself for the examination.
2. Remove the detector from the Bucky tray to the table for easy tabletop views.
3. Move the wall stand easily along side the table for cross-table views.
4. Control the entire system from the tube head touch screen.
5. Adjust technique, SID, filtration, view and much more without leaving the patient's side.

"We see patients suffering from problems with their musculoskeletal system every single day. In such cases the DRX-Evolution is a huge facilitator, both for our employees and for our patients – we do not have to turn them on their side to take certain images of the spinal column, the knee or for other purposes"

System Components:

- Gull Wing Wall Stand that extends, tilts, swings and glides to a full 6 axis of motion
- Easy positioning heavy duty 4-way float elevating table
- Intelligent OTC with touch screen
- Integrated Operator Console
- Choice of generators 65 or 80KW

Superior Customer Experience

Dr. Wetzler describes a superior experience as a client of Carestream Health, developer and manufacturer of the DRX Evolution. *"I would like to express great praise for the employees of Carestream who were involved in the preparation and the realisation of the installation. At our radiology department, space is somewhat limited and at the beginning it was not at all certain that the configuration I had in mind could be realised from a constructional point of view. A lot of planning was done in advance and the entire installation was carried out absolutely perfectly"*. He also remains impressed at the level of training offered, stating *"The training period (technical support, training of MRTAs at the device was particularly important to us. And I am happy to emphasise that the training of our employees was simply excellent. We now have a modern digital system in place that meets our requirements, and is a very economical system. And of course everything is accomplished a lot quicker. I am absolutely satisfied with the image quality"*.

About Carestream Health

Carestream Health is a worldwide provider of dental and medical imaging systems and healthcare IT solutions; molecular imaging systems for the life science research and drug discovery/development market segments; and x-ray film and digital x-ray products for the non-destructive testing market. For more information about the company's broad portfolio of products, solutions and services, please contact your Carestream Health representative or visit **www.carestreamhealth.com.**

Carestream

ECRI Institute
The Discipline of Science. The Integrity of Independence.

DIGITAL RADIOGRAPHY SYSTEMS

ECRI Institute, a non-profit organisation, dedicates itself to bringing the discipline of applied scientific research in healthcare to uncover the best approaches to improving patient care. As pioneers in this science for nearly 40 years, ECRI Institute marries experience and independence with the objectivity of evidence-based research.

ECRI Institute's focus is medical device technology, healthcare risk and quality management, and health technology assessment. It provides information services and technical assistance to more than 5,000 hospitals, healthcare organisations, ministries of health, government and planning agencies, voluntary sector organisations and accrediting agencies worldwide. Its databases (over 30), publications, information services and technical assistance services set the standard for the healthcare community.

More than 5,000 healthcare organisations worldwide rely on ECRI Institute's expertise in patient safety improvement, risk and quality management, healthcare processes, devices, procedures and drug technology. ECRI Institute is one of only a handful of organisations designated as both a Collaborating Centre of the World Health Organisation and an evidence-based practice centre by the US Agency for healthcare research and quality.

For more information, visit **www.ecri.org**

Contact
ECRI Institute Europe,
Weltech Centre Ridgeway,
Welwyn Garden City,
Herts AL7 2AA, United Kingdom
info@ecri.org.uk - www.ecri.org.uk

	ECRI Institute's Recommended Specifications	PHILIPS	PHILIPS	
MODEL	**Nontilting**	**BuckyDiagnost CS**	**BuckyDiagnost FS**	
WHERE MARKETED		Worldwide	Worldwide	
FDA CLEARANCE	Yes	Yes	Yes	
CE MARK (MDD)	Yes	Yes	Yes	
SYSTEM				
Film	Yes	Yes	Yes	
Digital	Optional	No	No	
Type		NA	NA	
BUCKY SYSTEM				
Type	Motorized	Automatic, manual	Automatic, manual	
Size, cm (in)	43 x 43 (17 x 17)	35 x 43 (14 x 17)	35 x 43 (14 x 17)	
AEC	3-field	Amplimat	Amplimat	
Grid ratios	10:1 or higher	12:1, 8:1	12:1, 8:1	
Lines/mm (in)	2.5 (100)	3.6 (90)	3.6 (90)	
Longitudinal travel, cm (in)	50 (20)	±20 (±7.8)	±20 (±7.8)	
DIGITAL SYSTEM				
Spatial resolution	>3 lp/mm	NA	NA	
Matrix, pixels	<150 microns	NA	NA	
Gray levels	4.096	NA	NA	
DICOM 3.0 compliant	Yes	NA	Yes	
RADIOGRAPHIC CAPABILITIES				
Bucky	Yes	Yes	Yes	
Cross table	Yes	Yes	Yes	
Horizontal	Yes	Yes	Yes	
Off table	Yes	Yes	Yes	
Upgradable for digital	Yes	Yes	Yes	
X-RAY GENERATORS				
Preferred units	80 kW	Optimus (50, 65, 80 kW) 3-phase or 30 kW single-phase	Optimus (50, 65, 80 kW) 3-phase or 30 kW single-phase	
X-RAY TUBES				
Preferred units		RO 1750, SRO 33/100, SRO 25/50, SRO 09/51	RO 1750, SRO 33/100, SRO 25/50, SRO 09/51	
TUBE SUSPENSION				
Model, suspension		CS 2-4	FS-S, FS-F, FS-C	
Model, collimator		Automatic or manual	Automatic or manual	
ACCESSORIES				
Compression bands	Yes	Optional	Optional	
Handgrips	Optional	Optional	Optional	
Head clamps	Optional	Optional	Optional	
Footrest	Optional	No	No	
Others		Optional lateral cassette holder	Optional lateral cassette holder; optional sinus cone	
POWER REQUIREMENTS	Standard	480 VAC, 3-phase; 50/60 Hz	480 VAC; 50/60 Hz; 3-phase	
PURCHASE INFORMATION				
Year first sold		1995	2003	
Number installed				
USA/worldwide		1,000/3,700+	60/200	
Fiscal year		Not specified	Not specified	
OTHER SPECIFICATIONS		None specified.	None specified.	
Last Updated		Feb-06	Feb-06	
Supplier Footnotes	<1>These recommendations are the opinions of ECRI's technology experts. ECRI assumes no liability for decisions made based on this data.			

PHILIPS	PHILIPS	PHILIPS	PHILIPS
Digital Diagnost Compact Multipurpose	**Digital Diagnost TH**	**Digital Diagnost VM**	**Digital Diagnost VR**
Worldwide	Worldwide	Worldwide	Worldwide
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
CsI scintillator with a-Si	CsI scintillator with a-Si	CsI scintillator with a-Si	CsI scintillator with a-Si
Digital detector	Digital detector	Digital detector	Digital detector
43 x 43 (17 x 17)	43 x 43 (17 x 17)	43 x 43 (17 x 17)	43 x 43 (17 x 17)
3-field chamber	5-field chamber	5-field chamber	5-field chamber
12:1, 8:1	12:1, 8:1	12:1, 8:1	12:1, 8:1
3.6 (90)	3.6 (90)	3.6 (90)	3.6 (90)
NA	46 (18.1)	Up to 374 (147.2)	NA
Up to 3.5 lp/mm	Up to 3.5 lp/mm	Up to 3.5 lp/mm	Up to 3.5 lp/mm
3000 x 3000	3000 x 3000	3000 x 3000	3000 x 3000
16,368 (14-bit)	16,368 (14-bit)	16,368 (14-bit)	16,368 (14-bit)
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
Yes	Yes	Yes	NA
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
Optimus, microprocessor-controlled high-frequency generator, 30 kW; optional 50, 65, 80 kW	Optimus, microprocessor-controlled high-frequency generator, 50 kW; optional 65, 80 kW	Optimus, microprocessor-controlled high-frequency generator, 50 kW; optional 65, 80 kW	Optimus, microprocessor-controlled high-frequency generator, 50 kW; optional 65, 80 kW
RO 1750, 150 kV with nominal focal spots 0.6/1.2 mm for 30/50 kW; high-speed tube SRO 33/100, 150 KV with nominal focal spots 0.6/1.2 mm for 65/80 kW	RO 1750, 150 kV with nominal focal spots 0.6/1.2 mm; optional high-speed tube SRO 33/100, 150 kV with nominal focal spots 0.6/1.2 mm; tubes with focal spot 0.6/1.0 mm or 0.3/1.0 mm	RO 1750, 150 KV with nominal focal spots 0.6/1.2 mm; optional high-speed tube SRO 33/100, 150 kV with nominal focal spots 0.6/1.2 mm; tubes with focal spot 0.6/1.0 mm or 0.3/1.0 mm	RO 1750, 150 kV with nominal focal spots 0.6/1.2 mm; optional high-speed tube SRO 33/100, 150 KV with nominal focal spots 0.6/1.2 mm; tubes with focal spot 0.6/1.0 mm or 0.3/1.0 mm
CS 2, CS 4 overhead	CS 2, CS 4 overhead	CS 2, CS 4 overhead	CS 2, CS 4 overhead; FS floor-based
Automatic	Automatic	Automatic	Automatic
No	Optional	No	Optional
No	Yes	No	Yes
No	Optional	No	No
No	No	No	No
Stretch grip	Optional lateral cassette holder	None specified	Stretch grip, babix holder
380-400, 415-480, 190-360 VAC; 50/60 Hz	380-400, 415-480, 190-360 VAC; 50/60 Hz	380-400, 415-480, 190-360 VAC; 50/60 Hz	380-400, 415-480, 190-360 VAC; 50/60 Hz
2005	1999	2004	2001
Not specified	Not specified	Not specified	Not specified
January to December	January to December	January to December	January to December
Barcode reader, fully integrated CR reader, handswitch.	Barcode reader, digital wall stand, fully integrated CR reader, image stitching, fully integrated second tube, variofocus (each size between small and large focal spot is selectable via APR).	Barcode reader, fully integrated CR reader, image stitching, variofocus (each size between small and large focal spot is selectable via APR).	Barcode reader, fully integrated CR reader, image stitching, variofocus (each size between small and large focal spot is selectable via APR).
Feb-06	Feb-06	Feb-06	Feb-06

Product Comparison Chart

	Ecri Institute's Recommended Specifications	Carestream HEALTH	Carestream HEALTH	
MODEL	**Nontilting**	**"DRX-Evolution System**	**"DRX-Evolution System**	
WHERE MARKETED		Worldwide	Worldwide	
FDA CLEARANCE	Yes	Yes	Yes	
CE MARK (MDD)	Yes	Yes	Yes	
SYSTEM				
Film	Yes	No	No	
Digital	Optional	Yes	Yes	
Type				
BUCKY SYSTEM				
Type	Motorized	Motorized, 5 axis of motion, optional floor rail	Configuration Dependant	
Size, cm (in)	43 x 43 (17 x 17)	43 x 43 (17 x 17)	43 x 43 (17 x 17)	
AEC	3-field	Yes, 5 chambers	Yes, 5 chambers	
Grid ratios	10:1 or higher	10:1, 12:1, 15:1 choice of 5 different grids	10:1, 12:1, 15:1 choice of 5 different grids	
Lines/mm (in)	2.5 (100)	80 Lines/cm (203 Lines/inch)	81 Lines/cm (203 Lines/inch)	
Longitudinal travel, cm (in)	50 (20)	180 cm	180 cm	
DIGITAL SYSTEM				
Spatial resolution	>3 lp/mm	3.6 cyc/mm	3.6 cyc/mm	
Matrix, pixels	<150 microns	2544 x 3056, 139µm Pixel	2545 x 3056, 139µm Pixel	
Gray levels	4.096	4096	4097	
DICOM 3.0 compliant	Yes	Yes	Yes	
RADIOGRAPHIC CAPABILITIES				
Bucky	Yes	Yes	Yes	
Cross table	Yes	Yes	Yes	
Horizontal	Yes	Yes	Yes	
Off table	Yes	Yes	Yes	
Upgradable for digital	Yes	na	na	
X-RAY GENERATORS				
Preferred units	80 kW	64 or 80 kW high frequency with digital feedback control circuitry	64 or 80 kW high frequency with digital feedback control circuitry	
X-RAY TUBES				
Preferred units		400,000 HU	400,000 HU	
TUBE SUSPENSION				
Model, suspension		Overhead mounted, fully motorized, manaul or auto movements	Overhead mounted, Semi motorized or manaul movements	
Model, collimator		Automatic	Automatic or Manual	
ACCESSORIES				
Compression bands	Yes	Depents on type of table	Depents on type of table	
Handgrips	Optional	Depents on type of table	Depents on type of table	
Head clamps	Optional			
Footrest	Optional			
Others				
POWER REQUIREMENTS	Standard			
PURCHASE INFORMATION				
Year first sold		2009	2010	
Number installed				
USA/worldwide		Worldwide	Worldwide	
Fiscal year		January to December		
OTHER SPECIFICATIONS		Wireless "Cassette sized" DR Detectors offers maximum positioning flexibility. Ability to move DR detectors betweem DRX Family products. Base system comes fully motorized with bidirectional tube and/or detctor tracking, bidirectional tube/detector centering, optional 128 user configurable auto-positioning linkable to RIS procedure codes for automated workflow. Wallstand base configuration with 5 axis of motion, motorized, floor rail optional. Kodak DirectView EVP+ software, DICOM Worklist Management, IHE Scheduled Workflow Software; HIS/RIS Connectivity, Dose Area Product Meter.	Wireless "Cassette sized" DR Detectors offers maximum positioning flexibility. Ability to move DR detectors betweem DRX Family products. This system is configurable to meet specific site demands. A motorized wallstand base configuration with 5 axis of motion and Auto tracking can be added to enhance productivity. Kodak DirectView EVP+ software, DICOM Worklist Management, IHE Scheduled Workflow Software; HIS/RIS Connectivity, Dose Area Product Meter.	
Last Updated		May-10		
Supplier Footnotes	<1>These recommendations are the opinions of ECRI's technology experts. ECRI assumes no liability for decisions made based on this data.			

	"DRX-Evolution System	Canon DR System CXDI-70C Wireless	Adora	D²RS
	Worldwide	Worldwide	Europe	Worldwide
	Yes	Yes	No	WIP
	Yes	pending	Yes	Yes
				Digital dynamic remote controlled table
	No	No	No	No
	Yes	Yes	Yes	Yes
		CsI and a-Si	CsI and a-Si	CsI
	Configuration Dependant	Filmless	Digital	Digital and fully motorized
	43 x 43 (17 x 17)	NA	35 x 43 (14 x 17)	For 35x43 cm Canon FPD
	Yes, 5 chambers	35 x 43 (14 x 17) Portable	5 field solid state	Yes
	10:1, 12:1, 15:1 choice of 5 different grids	8:1	10:1, 12:1	10:1
	82 Lines/cm (203 Lines/inch)	52 Lines/cm	40 lines/cm	40 lines/cm
	180 cm	NA	2000 cm (787 in)	From x-ray axis to x-ray axis: 135 cm
	3.6 cyc/mm	4 lp/mm	3,1 lp/mm	3,1 pl/mm
	2546 x 3056, 139µm Pixel	2800 x 3408	2208 x 2688	2208 x 2688
	4098	4.096	4.096	4096
	Yes	Yes	Yes	Yes
	Yes	Yes	Digital	Yes
	Yes	Yes	Yes	"Yes, dynamic and portable FPD
	Yes	Yes	Yes	*Depending on the configuration"
	Yes	Yes	Yes	Yes
	na	Yes (Retrofit)	NA	Yes, dynamic, portable and detachable FPD
				NA
	64 or 80 kW high frequency with digital feedback control circuitry	Any	65 kW CPI	65 or 80 kW
	400,000 HU	Any	A196 Varian	0.6/1.2 or 0.6/1.0; 400, 600, 700 or 1000 khu
	Overhead mounted, Semi motorized or manaul movements	Any	Adora	"Tube of the remote controlled table *Ceiling suspension in option"
	Automatic or Manual	Any	N300	Automatic collimation with filter selection
	Depents on type of table	None specified	Yes	Yes
	Depents on type of table	None specified	Yes	Yes
		None specified	None specified	NA
		None specified	NA	Yes
		Carrying handle	Mattress, Patient Hoist, Table Rotation, Paper Roll Holder	*Compression in option
		100, 120, 230, 240 VAC; 50/60 Hz	400 VAC, 240 VAC; 50/60 Hz	400 V ac +/- 10%, 3 phases, 50 Hz
	2010	2010	2008	2009
				20
	Worldwide	Worldwide		
		January to December	July to June	January to December
	Wireless "Cassette sized" DR Detectors offers maximum positioning flexibility. Ability to move DR detectors betweem DRX Family products. This system is configurable to meet specific site demands. Auto tracking and wall stand tilt and rotation can be added to enhance productivity. Kodak DirectView EVP+ software, DICOM Worklist Management, IHE Scheduled Workflow Software; HIS/RIS Connectivity, Dose Area Product Meter.	None specified.	None specified.	"The 3-in-1 solution: Radiography, Fluoroscopy and direct projections Auto-positioning Video camera *Automatic stitching in option"
			Jul-10	July 2010
			Adora RAD offers flexibility for any exam, and is fully autopositioned	

Product Comparison Chart

	Ecri Institute's Recommended Specifications	AGFA HealthCare	AGFA HealthCare	SIEMENS	SIEMENS	
MODEL	**Nontilting**	**AGFA DX-D 500**	**AGFA DX-D 300**	**Ysio**	**AXIOM Aristos FX Plus**	
WHERE MARKETED		Europe	Europe, US, Canada	Worldwide	Worldwide	
FDA CLEARANCE	Yes	No	Yes	Yes	Yes	
CE MARK (MDD)	Yes	Yes	Yes	Yes	Yes	
SYSTEM						
Film	Yes	Yes (optional CR)	Yes (optional CR)	Digital radiography system matching the requirements of the individual clinical workflow. Ceiling mounted X-ray tube, bucky wall stand, patient table, integrated flat detector and wireless mobile detector (wi-D).	Digital radiography system with 2 fully motorized, ceiling-mounted supports for X-ray tube and flat detector.	
Digital	Optional	Yes	Yes	Yes	Yes	
Type		DR	DR	For radiography	For radiography	
BUCKY SYSTEM						
Type	Motorized	Manual	Moterized	Integrated and/or wireless detector (wi-D)	Flat Detector	
Size, cm (in)	43 x 43 (17 x 17)	43 x 43 (17 x 17)	43 x 43 (17 x 17)	43 x 43 (17 x 17) / 35 x 43 (14 x17)	43 x 43 (17 x 17)	
AEC	3-field	3-field	3-field	3-field IONTOMAT	3-field IONTOMAT	
Grid ratios	10:1 or higher	15;1	08:01	15:1	15:1	
Lines/mm (in)	2.5 (100)	80 lines/cm	50 lines/cm	80 (203)	80 (203)	
Longitudinal travel, cm (in)	50 (20)	35 to 190 (Center to Center)	SID 100 to 180	346 (136)	346 (136), 260 (102) for the pocket sized room	
DIGITAL SYSTEM						
Spatial resolution	>3 lp/mm	3.6 lp/mm	3.6 lp/mm	3.4 lp/mm	3.5 lp/mm	
Matrix, pixels	<150 microns	3072 x 3072	3072 x 3072	3k x 3k (9 million pixels), 139 µm / wi-D: 2,3k x 3k, 144 µm	3k x 3k (9 million pixels), 143 µm	
Gray levels	4.096	16.384	16.384	16 bit	14 bit	
DICOM 3.0 compliant	Yes	Yes	Yes	Yes	Yes	
RADIOGRAPHIC CAPABILITIES						
Bucky	Yes	Yes	Yes	Yes	Yes	
Cross table	Yes	Yes	Yes	Yes	Yes	
Horizontal	Yes	Yes	Yes	Yes	Yes	
Off table	Yes	Yes	Yes	Yes	Yes	
Upgradable for digital	Yes	N/A	N/A	Digital radiography system	Digital radiography system	
X-RAY GENERATORS						
Preferred units	80 kW	80 kW	50, 64 or 80 kW	High frequency, 65 kW and 80 kW	High frequency, 50 kW or 80 kW	
X-RAY TUBES						
Preferred units		SV 150 / 40 / 80 C -100	Model E7252X (300 KHU)/ E7254FX (400 KHU) or E7869X (600 KHU)	"OPTILIX 150/30/50 HC-100 OPTITOP 150/40/80 HC-100"	"OPTILIX 150/30/50HC-100 OPTITOP 150/40/80HC-100"	
TUBE SUSPENSION						
Model, suspension		3D TOP Overhead Support	Fixed on U-arm	Ceiling mounted	Ceiling-mounted	
Model, collimator		Automatic (AL02)	Automatic	Manual and motorized, pre-set via organ programs	Manual and motorized, pre-set via organ programs	
ACCESSORIES						
Compression bands	Yes	Yes	No	Yes, optional	Yes, optional	
Handgrips	Optional	Yes	Yes	Yes	Yes	
Head clamps	Optional	Yes	No	Not applicable	Not applicable	
Footrest	Optional	Yes	No	Not applicable	Not applicable	
Others		Yes	Yes	"Standard: Wireless remote control (system depending), hand grips, CD/DVD recorder, patient stretch grip, cassette tray. **Option:** External hard disk for USB export, hand held control, patient positioning mattress, Ortho imaging, several trolleys, footswitch, accessory filters for collimator, additional compensation filters, filter holder, additional grids, different detector holder, different clip-on grids for wi-D, examination bed with integrated detector tray for wi-D, UPS for imaging system, three-field template, etc.	"Standard: Standing desk for control console, grid holder, three-field template. **Option:** Wireless remote control, Ortho imaging, Orthostepper, pocket-size room, patient positioning mattress, footswitch, accessory filters for collimator, barcode reader, external storage medium, different tabletops, filter holder, caremax integrated FD/LX, additional compensation filters, additional anti-scatter grids, etc."	
POWER REQUIREMENTS	Standard	400V 3 phase	380V or 480V 3 phase	3-phase, 400 V (440/480 V with additional transformer for generator)	3-phase, 400 V (440/480 V with additional transformer for generator)	
PURCHASE INFORMATION						
Year first sold		2009	2010	2008	2006	
Number installed		20 plus	10 plus	> 310	> 340	
USA/worldwide		Europe	Yes	> 70	> 30	
Fiscal year				October to September	October to September	
OTHER SPECIFICATIONS				Fast and convinient X-ray tube positioning via organ programs; intuitive user interface; Ortho imaging; power-assisted servo-movements; color touchscreen user interface MaxTouch; complete system operation with control of generator; system and imaging system integraded in one console; enhanced quality managment tools	Ortho imaging; DiamondView: multi-scale post-processing; complete system operation with control of generator, system and imaging system integraded in one console; MIMIC function; smart move; pocket size room option	
Last Updated				June 2010	June 2010	

SIEMENS	SIEMENS	SIEMENS	SIEMENS	SIEMENS
AXIOM Aristos VX Plus	**AXIOM MULTIX M**	**MULTIX Swing with mFD**	**AXIOM Vertix MD Trauma**	**AXIOM Luminos dRF**
Worldwide	Worldwide	Worldwide (except United States)	Worldwide	Worldwide
Yes	Yes	No	Yes	Yes
Yes	Yes	Yes	Yes	Yes
Digital radiography system with ceiling-mounted X-ray tube, tilting detector stand and optional patient trolley.	Digital radiography system with floor- or ceiling-mounted tube (system depending), patient table, mobile flat detector (mFD) and optional bucky wall stand.	Digital radiography system with floor-mounted x-ray tube, patient table, mobile flat detector (mFD) and optional bucky wall stand.	Digital radiography system designed and optimized specifically for traumatology and emergency care with ceiling-mounted stand.	The digital 2-in-1 solution for fluoroscopy and radiography.
Yes	Yes	Yes	Yes	Yes
For radiography	For radiography	For radiography	For radiography	For radiography and fluoroscopy
Flat Detector	Mobile flat detector (mFD)	Mobile flat detector (mFD)	Mobile flat detector (mFD)	Dynamic flat detector / optional wireless detector (wi-D)
43 x 43 (17 x 17)	35 x 43 (14 x 17)	35 x 43 (14 x 17)	35 x 43 (14 x 17)	43 x 43 (17 x 17) / 35 x 43 (14 x17)
3-field IONTOMAT	3-field IONTOMAT	3-field IONTOMAT	3-field IONTOMAT	5-field IONTOMAT
15:1	15:1	15:1	8:1	15:1
80 (203)	80 (203)	80 (203)	40 (102)	80 (203)
354 (139)	354 (139)	123 (48)	354 (139)	Image receptor movement max. 113 (45)
3.5 lp/mm	3.1 lp/mm	3.1 lp/mm	3.1 lp/mm	3.4 lp/mm
3k x 3k (9 million pixels), 143 µm	2688 x 2208 (5,9 million pixels), 160 µm	2688 x 2208 (5,9 million pixels), 160µm	2688 x 2208 (5.9 million pixels), 160 µm	2840 x 2880 pixels, 148 µm / wi-D: 2,3k x 3k, 144 µm
14 bit	12 bit	12 bit	12 bit	14 bit for DR
Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes, with integrated detector and wi-D
Yes with trolley	Yes	Yes	Yes	Yes, with wi-D
Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes
Digital radiography system	Digital radiography system and upgrade package for analog MULTIX PRO/TOP available	Digital radiography system	Digital radiography system	Digital radiography and fluoroscopy system
High frequency, 50 kW or 80 kW	High frequency, 55 kW, 65 kW and 80 kW	High frequency, 55 kW	High frequency, 55 kW and 80 kW	High frequency, 65 kW or 80 kW
OPTILIX 150/30/50HC-100 OPTITOP 150/40/80HC-100	OPTILIX 150/30/50 HC-100 OPTITOP 150/40/80 HC-100	OPTIPHOS 135/30/55R	OPTILIX 150/30/50 HC-100 OPTITOP 150/40/80 HC-100	OPTITOP 150/40/80 HC-100
Ceiling-mounted	Floor-mounted or ceiling-mounted (system depending)	Floor-mounted	Ceiling-mounted	Overtable tube position / optional ceiling-mounted tube
Manual and motorized	Manual and motorized	Manual	Manual	Manual and motorized, pre-set via organ programs
Not available	Yes, optional	Yes, optional	Not applicable	Yes, optional
Yes	Yes	Yes	Not applicable	Yes
Not applicable	Not applicable	Not applicable	Not applicable	Yes, optional
Not applicable	Not applicable	Not applicable	Not applicable	Yes, removeable
Standard: Standing desk for control console, grid holder, three-field template, axle for paper role holder. **Option:** Compensation filter for collimator, barcode reader, ortho package, several trolleys, filter holder, caremax integrated FD/LX, additional compensation filters, additional anti-scatter grids, etc.	"Standard: Lateral detector holder, cassette tray, three-field template, patient. **Option:** Collision protection, footswitches, hand switch, filter for collimator, tomo height light localizer, additional anti-scatter grids, additional compensation filters, remote controll, filter holder etc.	Standard: External manual release for exposure. **Option:** Lateral detector holder; patient positioning mattress; additional anti-scatter grids; several trolleys; cassette holders; etc.	"Standard: Hand switch; footswitch; filter for collimator; cassette tray. **Option:** Lateral detector holder; several trolleys; additional compensation filters; etc.	Standard: Footswitch, side hand rail, shoulder supports, head-end hand rail, protective foil for liquids, wall holder for grids. **Option:** Detector holders, patient mattress, additional compensation filters, filter holder, five-field template, additional anti-scatter grids etc.
3-phase, 400 V (440/480 V with additional transformer for generator)	3-phase, 400 V (440/480 V with additional transformer for generator)	3-phase, 400 V (440/480 V with additional transformer for generator)	3-phase, 400 V (440/480 V with additional transformer for generator)	3/N/PE 400/440/480 V
2007	2003	2007	2005	2007
> 340	> 620	> 20	> 40	> 420
> 10	> 310	NA	> 10	> 30
October to September	October to September	October to September	October to September	October to September
Ortho imaging; DiamondView: multi-scale post-processing; complete system operation with control of generator, system and imaging system integraded in one console	Ortho imaging; different system versions are available; upgrade package for conventional Multix Pro/Top systems	Weight capacity of up to 450 kg (990 lbs), excellent space savings with generator integrated into the patient table	Specially designed for environments such as the trauma room	Ysio option with ceiling-suspended tube, wireless detector (wi-D) and wall stand for virtually limitless projection flexibility
June 2010	June 2010	June 2010	June 2010	June 2010

SAFE USE OF MRI CONTRAST AGENTS

Part One: Usefulness of Gadolinium Versus Iodine-Based Contrast Agents

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Much attention has recently been focused on the safe use of gadolinium-based contrast agents (GBCAs) in MRI with regards to nephrogenic systemic fibrosis (NSF). In the wake of its discovery and subsequent investigation, many guidelines were created on the subject. Part one of this article reviews what guidelines are, what GBCAs are, and how GBCAs are used in comparison to iodine-based contrast agents (IBCAs).

What are Guidelines?

A guideline is any document that aims to streamline particular processes according to a set routine. Medical guidelines form part of clinical governance and can potentially be issued by any interested organisation (governmental, professional, institutional or private). Their objective is to standardise medical care, raise the quality of medical care, improve cost-effectiveness and to minimise risk. Guideline development is based on identification, summary and evaluation of the highest quality current evidence.

Some guideline groups have very specific methodologies (e.g. SIGN & NICE), to reliably obtain best evidence using specific literature search strategies and strict evaluation criteria. In other instances, the process by which the evidence informing a guideline has been obtained and evaluated is not explicit. Equally crucial is the methodology used to define the most important questions to be addressed such that evidence regarding all possible options and outcomes are identified.

Risk Benefit Ratios

In the area of GBCA use and NSF the regulatory authorities (EMEA and FDA) do not issue guidelines but rather provide information in the form of 'Questions & Answers' and regulate through product labeling, though the FDA has had 'Regulatory Alerts' inserted into many guidelines where the use of contrast enhanced MRI is discussed, for example many of the ACR Appropriateness Criteria (see the U.S. National Guideline Clearing House - www.guideline.gov). Safety is always a relative word and in diagnostic imaging the risks of an investigation for the individual patient must be balanced against their perceived potential for benefit. While MRI has none of the risks of exposure to ionising radiation associated with radiological techniques such as CT it entails other risks, particularly in relation to the strong magnetic fields employed. These risks are predictable and managed by strict operating procedures, training of all staff in MRI safety, the provision of information to patients prior to scanning and importantly, screening questionnaires. These are all designed to eliminate the possibility of patients potentially coming to harm, for example by ensuring that those with MRI incompatible implanted devices are not exposed to a magnetic field.

Contrast Agents in MRI

Another potential source of risk in radiological procedures are the adjunctive techniques that may be required to enhance scans. For example, conventional angiography and many CT studies employ injections of intravascular iodine-based contrast media (IBCM). However, through refinement in their chemistry, modern IBCM now have much lower incidences of minor and major reactions compared with those compounds used in years past. GBCAs frequently used in MRI use chelating agents to bind the potentially toxic gadolinium cation in a stable compound that can be injected intravascularly without toxicity for human MR imaging. This chelation binds the gadolinium in a stable form with low toxicity and these agents in general have similar pharmacokinetics to IBCM, being predominantly excreted unchanged in the urine by glomerular filtration. The exceptions are gadobenate dimelumine (Multihance), gadofosveset trisodium (Vasovist) and gadoxetic acid disodium (Primovist/Eovist) which also undergo approximately four, nine and 50 percent hepatobiliary excretion respectively.

Safety of GBCA Versus IBCM

GBCAs are associated with similar idiosyncratic and non-idiosyncratic adverse reactions as IBCM. However, the risks of these are orders of magnitude lower in terms of frequency of anaphylaxis and potential for nephropathy than the IBCM, partly through the much lower doses required for GBCA enhancement of MRI scans compared to the volumes of IBCM needed in CT and conventional angiography. For example, whilst commercial GBCAs are more nephrotoxic than IBCM

Continued on page 38

AUTHOR **GUIDELINES**

Content

IMAGING Management welcomes submissions from qualified, experienced professionals active in the imaging industry, related technology companies and medical healthcare professionals with an interest in imaging-related topics and themes. We are particularly interested in articles focusing on management or practice issues and therefore accept scientific papers with a clear connection to these areas. Articles must be written by independent authorities, and any sponsors for research named. Our editorial policy means that articles must present an unbiased view, and avoid 'promotional' or biased content from manufacturers.

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Structure

Article texts must contain:

- Names of authors with abbreviations for the highest academic degree;
- Affiliation: department and institution, city and country;
- Lead authors are requested to supply a portrait photo (see specifications below);
- One contact name for correspondence and an e-mail address which may be published with the article;
- Acknowledgements of any connections with a company or financial sponsor;
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- References or sources, if appropriate, as specified below.

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For further details or to request a copy of the 2010 editorial planner, with topics and focus areas included, please email **editorial@imagingmanagement.org**.

Thank you,
The IMAGING Management Editorial Team

Continued from page 36

in equimolar amounts, this has not been a significant clinical problem as they are used in much lower doses.

Individual case reports of GBCA induced nephropathy at clinical doses in patients with pre-existing renal insufficiency have been published. However, the patients involved had the same risk factors as for CIN with IBCM suggesting similar mechanisms of chemotoxicity rather than anything specific to the gadolinium itself. Rates of adverse events of GBCAs are even lower than for modern IBCM, for example, the rate of fatal, unpredictable idiosyncratic anaphylactic reactions with GBCA use is estimated at approximately 1:100,000 administrations compared to 1:40,000 for IBCM.

Studies Prove Usefulness of GBCAs

With MRI, the excellent soft tissue contrasts achievable compared to CT and other modalities led some to believe that exogenously administered contrast would be superfluous. However, research and deployment has validated the clinical usefulness of GBCAs from CNS imaging through to cancer imaging, myocardial perfusion and more. This has led to GBCA use becoming the 'standard of care' for a variety of MRI studies. In vascular imaging early non-contrast enhanced magnetic resonance angiography (MRA) techniques were often hampered (particularly in body imaging) by long acquisition times and artifacts. In this respect the advent of contrast enhanced MRA (CE-MRA) was a real advance as CE-MRA allows repeatable and dynamic non-invasive assessment of the vasculature on an outpatient basis without the need for exposure to ionising radiation and with contrast agents that are less nephrotoxic in the doses required than conventional iodine-based media. This requirement for relatively increased doses in CE-MRA has recently been reduced by advances in MRI hardware (such as dedicated array coils) and software (parallel imaging, time resolved/echo sharing etc.) that have been developed for vascular applications. In patients with renal disease contrast enhanced examinations have been quite widely used as part of the investigation of the cause of renal impairment, especially in evaluating for potentially correctable renal arterial disease.

In patients with more established renal failure then the diagnosis of the vascular complications of renal disease (such as lower limb ischaemia) is important and furthermore contrast enhanced MR venography (MRV) techniques have proven extremely useful for the assessment of the venous stenoses and thromboses occurring as complications of central venous access for haemodialysis. Indeed, CE-MRV provided exquisite detail of venous disease in these patients in a way difficult to achieve by more conventional means. ■

Part two of this series on contrast media will appear in the next edition of IMAGING Management.

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ASSESSING THE "COST VERSUS BENEFIT" OF RADIOLOGY

All nations aspire to obtaining the best value for money for their population, achieving the maximum heath gain for the money spent. Although a predominantly State-funded system like the NHS in the UK can look at these issues more readily than those with a mixed economy of healthcare, private insurers are also interested in value for money and are increasingly evaluating the evidence of benefit of treatments before funding them. All licensed drugs have trial evidence that they work within their licensed indications, otherwise they would not have been granted a marketing authorisation by bodies such as the European Medicines Agency. Nevertheless they do not necessarily have to work particularly well or sufficiently well to justify their cost compared with other available treatments.

As the provision of healthcare has become more complex and expensive, health economics has emerged as an increasingly important discipline. There are three main ways in which the value for money of a health intervention can be assessed, as outlined here.

Cost effectiveness analysis. This looks at the costs of achieving a defined benefit. Examples might be cost per life saved, life year gained, hospital admission avoided, 5mm drop in systolic blood pressure, or 1% drop in HbA1c etc. Here the outcome itself is known to be of benefit either in health or societal terms, or associated with a monetary value.

Cost utility analysis. This uses a universal measure of 'wellness' or 'illness' on a scale of 0-1, where 1 is perfect health and 0 is death. Everyone will be somewhere on that scale and can be described in terms of their 'utility' (interestingly, it is possible to be in a state less than 0 i.e. considered to be in a health state worse than death). Utility declines with age and illness. A cost utility analysis looks at the average

gain in utility against the cost of a treatment, allowing the success of any treatment for any condition to be judged using the same units. This is refined by the length of time for which the intervention works, to give a calculation of total health benefit gained as a result of the treatment. The unit is a quality adjusted life year (QALY) which is a year of perfect health. When the cost of the treatment is known, a cost per QALY can be calculated. This represents what would have to be spent on that intervention to 'buy' the equivalent of a rise of 1 in the utility scale, lasting for one year in the treated population. This is looked at in relative terms i.e. in comparison with treatments already available. So in essence, an intervention which gives a big rise in utility and lasts a long time compared with alternative treatments will generate many QALYs in the treated population and may be a good investment even if it is relatively expensive.

Cost minimisation analysis. This is simpler, and can be used when two treatments are equally beneficial. It evaluates which is the cheaper, taking all costs related to the treatment into account. These calculations can only be made on the basis of excellent evidence on the effectiveness of treatments, and the costs involved. Complex economic models are constructed to map the course of the disease in relation to the treatment(s) used, in order to calculate the value for money provided. This methodology is particularly widely used in the NHS in the UK by the National Institute for Health and Clinical Excellence (NICE) before being funded for use in the NHS.

Assessing the 'Value' of Radiology

These same principles can be applied to radiology. There are however several examples in relation to health screening, notably population screening for breast cancer, where similar analyses provided evidence that mammographic breast screening was a good investment in terms of cost versus benefit for the population in the selected age group.

Interventional procedures are also amenable to health economic evaluation, particularly comparing image guided intervention with open surgical techniques. It is is perhaps surprising, and probably not to radiology's benefit, that these analyses have not been widely undertaken because the generally lower cost of interventional radiology might well work to its advantage in several areas of practice. It can be done; for example NICE evaluated the use of ultrasound guided central venous line insertion compared with 'blind' placement. The analysis found ultrasound guidance to be cost effective in cost per QALY terms on the basis of the number of complications avoided and the medical time saved by fewer attempts being required.

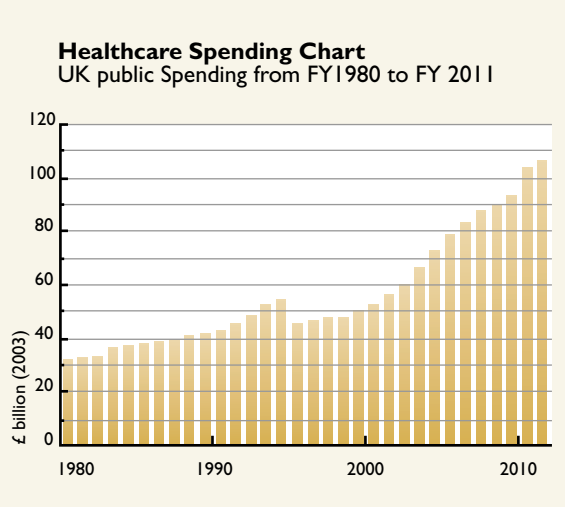

Fig. 1. UK healthcare spending in real terms (inflation-adjusted) (Source: Public Spending UK)

Evaluation of the health benefits of diagnostic radiology outside population screening is more problematic because here there is a more indirect relationship between the diagnostic test and the utility gain of the patient. It would however be perfectly possible in theory to calculate for example the cost per QALY of using MRI to diagnose acoustic neuroma. Equally, in the case where two different imaging methods could be used to make the same diagnosis, it would be possible to evaluate which provides the better value for money based on their sensitivity, specificity and cost. In circumstances where a second test is used to confirm the finding of a first, a calculation of the additional information/benefit gained relative to the cost of another investigation would give a measure of the incremental cost benefit of carrying out the second test.

The Future

As an expensive service, radiology will not be immune from scrutiny forever. In some cases, investigations are done for reassurance, for medico-legal reasons or to compensate for clinical uncertainty and might not be a good use of scarce resources. Cost effectiveness evidence for the appropriate and effective use of radiology resources may not be a bad thing.■

Further Reading

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2. "THE FIVE BIGGEST LIES IN THE HEALTHCARE DEBATE": Newsweek August 29th, 2009
3. www.emea.europa.eu
4. www.nice.org.uk
5. "THE CLINICAL EFFECTIVENESS AND COST EFFECTIVENESS OF ULTRASONIC LOCATING DEVICES FOR THE PLACEMENT OF CENTRAL VENOUS LINES" TA 49, 2002

Interviewee
Prof. Oliver Speck

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INTERVIEW WITH **PROF. OLIVER SPECK**

How did you choose experimental physics and what do you enjoy about it?

I have always been fascinated by technology. As a kid I took all my toys apart to see how they worked. Also, I enjoyed maths and physics at school. After school, when it was time to select a topic for my diploma thesis, I was very lucky to stumble across Prof. Jürgen Hennig, the physicist in charge of MRI at the University Freiburg. Without knowing about his prominent position and seminal contributions to the field, I started to work with MRI and only later fully appreciated the tremendous support and training I received in his lab. When the first 3T human MR systems were installed I travelled to Hershey (U.S.) and Rouffach (France) to work on them, even before the first 3T MRI was installed at the University in Freiburg. This continued with my move to Magdeburg in late 2006 where the first European 7T system was operational since 2005. In addition to the 7T human system, we have access to 1.5T and 3T human research systems as well as to a 4.7T small animal system and 9.4 and 14T high resolution spectrometers, operated by cooperating institutions in Magdeburg.

As President of the ESMRMB what are your main duties?

The presidential track of the ESMRMB schedules two years of president elect, two years of presidency, and two years of past president, thus ensuring continuity, distribution of the workload, and "training on the job". During each of these phases, a number of ex officio duties arise. Among the more important for the president are the representation of the society, responsibility for the society's business and executive board meetings, leading relations with other societies and fundraising.

Tell us about the ESMRMB's current activities and projects.

Our society is Europe's representative body of radiologists and medical physicists with an interest in MR, gathering over 1,000 members throughout Europe. The next annual meeting is in Leipzig on October 6 – 8, 2011. We are highly honoured that Prof. Richard Ernst, 1991 recipient of the Nobel Prize in Chemistry for his contributions to the development of methodology of high-resolution NMR spectroscopy, will deliver the inaugural Sir Peter Mansfield Lecture.

In addition, the ESMRMB has established a very successful educational programme with the School of MRI focusing on clinical MR, Lectures on MR targeting basic scientists and Hands-On MRI courses aimed at technicians and radiologists. The society is currently extending its clinical programme to beyond Europe with a European MRI Academy and ran two courses in the Middle East this year. Negotiations are underway with other societies and industry partners to ensure that less privileged areas, in particular Asia, receive adequate training in MR. Our society also joined the European Institute for Biomedical Imaging Research (EIBIR).

Is the ESMRMB involved in the Alliance for MRI?

The ESMRMB is a supporting member of the Alliance for MRI to help safeguard the future clinical and research use of MRI presently threatened by EU legislation to protect workers (EU Physical Agents 2004/40/EC EMF Directive). MRI has been used for over 25 years, imaging up to 500 million patients without evidence of harm to workers due to EMF exposure. The exposure limits in the current Directive have been proven to be detrimental to patient care, most notably restricting and

limiting the use of MRI in interventional applications and in imaging vulnerable patients and children where closer patient contact is required. Furthermore, new research and developments in MRI will be severely restricted as will routine cleaning and maintenance of MRI equipment.

The Alliance for MRI is thus of utmost importance to ensure there are no infringements to the use of MRI in Europe. Signals from the European Commission indicate that the revised Directive expected for this autumn will ensure a solution for MRI, via an exemption for MRI from the binding limit values. The medical field will remain within the scope of the Directive and workers and patients will be adequately protected.

Please tell us a bit about your current research projects.

Much of the work at 7T is related to the development of methods that allow the use of the system for neuroscience and clinical research. We can now provide a multitude of methods for such studies. One focus lies in high resolution neuroanatomic imaging and functional MRI. In addition, a number of research projects aim at the exploitation of the full potential of high field imaging. With spatial resolution as high as 200 micrometer, involuntary motion of subjects becomes a significant problem. We continue with the development of methods that detect subject motion with automatic update of the scan volume to follow any displacement or rotation. Other projects include the development of novel RF coils, methods for data correction, e.g. for geometric distortions, and applications in neuroscience.

Do you collaborate with the industry? Does the industry think ultra high field MR will become more usable in the future?

We are collaborating with industry in multiple ways. We develop and optimise methods jointly with the system vendor, and provide expertise to the company with the potential that some developments may be introduced in future products. In return, we get access to the system architecture and measurement sequence, source code, information about the system infrastructure and hardware, and within specific projects hardware to be tested. Other collaborations are within joint research projects. In one such project (called INUMAC), we are developing methods for ultra high field MR together with the University Freiburg, Siemens and Bruker.

> "Signals from the European Commission indicate that the revised Directive expected for this autumn will ensure a viable solution for MRI"

Although vendors first developed ultra-high field systems based on the demand from a few research centres, the situation is currently changing. About 40 7T systems are installed or to be delivered and the vendors are now developing the next generation systems that can be sited in a more standard hospital setting due the introduction of actively shielded magnets in this segment. This is a clear indication that industry counts on a wider proliferation of such systems for use in basic research and in the high-end segment of clinical research and diagnosis. Ultra-high field MR is expensive and rare. Economic factors alone will prevent it being a widely applied modality for the diagnosis of common pathologies. However, understanding a disease aided by such equipment would not just help the individual patient but a much broader population.

What are the goals of researching ultra-high-field MR in humans, as opposed to in animals?

The selection of human rather than animal MR is half choice and half fate. Apart from the fact that I learned MR on a human MR system, I am not generally against research involving animals, but neither am I eager to do animal experiments myself. I prefer research on human subjects for two reasons: They can end the experiment any time if they feel uncomfortable and the results can possibly be applied immediately to the diagnosis of disease. MR is an ideal modality for such research since it is safe and repeatable. I have never done any experiment on a subject that I would not be a volunteer for myself. Indeed, I have perhaps been in the 7T magnet more times than any other volunteer.

To our current knowledge, the health consequences at ultra-high field are not very different from lower magnetic field strength. However, the highest risk, as with any MR instrument, is carelessness in daily routine. Any magnetic object brought close to the magnet is very dangerous and all severe accidents in MR have been related to such objects that turned into projectiles close to the magnet. We therefore hold mandatory regular safety briefings with all staff and research partners that enter the magnet room.

The possibilities offered by fMRI of the brain are some of the most exciting within medical imaging — which of these areas most fascinates you and why?

Both brain imaging and the detection of brain function fascinate not only neuroscientists but also a broader audience. This can be seen at any public event we host. Regularly hundreds of visitors are "attracted" by the magnet and the possibilities in brain research. Personally, I am fascinated by the complexity in structure and function of the brain. Although I have a technical background and am more an interested layman than an expert in neuroscience, the abilities and sometimes limitations of our brains are astonishing. One could say that the human brain is the only entity in the universe (that we know) that tries to understand itself. This may raise the philosophical question of whether that may be possible at all. However, from what we know, e.g. about the processes involved in learning and memory, we may be able to design strategies and therapies in the treatment of dementia, one of the largest problems our ageing population is facing. ■

HEALTHCARE IN CANADA

Providing Universal, Accessible & Connected Health Services

Sources:

Health Canada
(www.hc-sc.gc.ca)

World Health Organisation
(www.who.int)

Compiled by:
Dervla Gleeson
Managing Editor

Canada's publicly funded healthcare system, known as medicare, consists of ten provincial and three territorial health insurance plans. It provides access to universal, comprehensive coverage for hospital and physician services administered and delivered by the provincial and territorial governments, free of charge.

The provincial and territorial governments have most of the responsibility for delivering health and other social services. The federal government is also responsible for some direct delivery of services for certain groups of people. Publicly funded healthcare is financed with general revenue raised through federal, provincial and territorial taxation, such as personal and corporate taxes, sales taxes, payroll levies and other revenue. Three provinces, British Columbia, Alberta and Ontario, charge healthcare premiums, but non-payment of a premium does not limit access to medically necessary services. The competitive advantage that publicly financed healthcare provides to Canadian business is significant. Public financing spreads the cost of providing health services equitably across the country. In addition, financing health insurance through the taxation system is cost-efficient because it does not require a separate collection process.

The Canada Health Act lists five basic principles, which state that healthcare plans must be available to all eligible residents of Canada; comprehensive in coverage; accessible without financial and other barriers; portable within the country and during travel abroad; and publicly administered. The federal government provides cash and tax transfers to the provinces and territories in support of health through the Canada Health Transfer. To support the costs of publicly funded services, including healthcare, the federal government also provides equalisation payments to less prosperous provinces and territorial financing to the territories.

Primary healthcare services often include prevention and treatment of common diseases and injuries; basic emergency services; referrals to and coordination with other levels of care, such as hospital and specialist care; primary mental healthcare; palliative and end-of-life care; health promotion; healthy child development; primary maternity care; and rehabilitation services.

Services provided at the first point of contact with the healthcare system are known as primary healthcare services and form the foundation of the healthcare system. In general, primary healthcare serves a dual function. First, it provides direct provision of first-contact healthcare services. Second, it coordinates patients' healthcare services to ensure continuity of care and ease of movement across the healthcare system when more specialised services are required.

A patient may be referred for specialised care known as 'secondary services' largely provided by hospitals funded via global budgets negotiated with the provincial and territorial ministries of health, or with a regional health authority or board. Referrals can be made by doctors, hospitals, community agencies, families and potential residents. Needs are assessed and services are coordinated to provide continuity of care and comprehensive care.■

EDUCATION OF RADIOLOGISTS

Author
Dr. Louise Samson

Chair
CAR Lifelong Learning Working Group

Within the radiology specialty, the training programme is structured in accordance with the standards dictated by the Royal College of Physicians and Surgeons of Canada (RCPSC). The programme consists of one year of general training in the various medical areas (surgery, paediatric, OB-GYN, etc.), followed by four years of training in imaging. Mandatory radiology training spans a number of radiology subspecialties including pulmonary, cardiac, neurological, abdominal, musculoskeletal, breast pathology, vascular and non-vascular interventional radiology and angioradiology, including conventional imaging, CT scanning, MRI and nuclear medicine. The applicable standards are available on the RCPSC website (www.rcpsc.medical.org). At the end of the training each candidate is invited to apply to the RCPSC certifying exam that consists of a written part, an objective structured clinical examination (OSCE), and an oral part.

Education Programmes

There are 17 faculties of medicine in Canada, 16 of which offer a residency programme in diagnostic radiology (some of these offer specialty programmes in paediatric radiology and neuroradiology as well). Each programme has to be accredited by the RCPSC in order to have the permission to train radiology residents. 13 of these are offered in English and three are in French. Although residents are encouraged

to be bilingual, only programmes within francophone universities in Québec require that its candidates be fluent in French. Thereafter, candidates wishing to practice in Québec must pass a fluency examination in basic French to obtain a license to practice in the province.

Radiology programmes easily fill their residency positions. This specialty is often much sought-after by medical school graduates. Those graduates wishing to apply for a position in a residency programme must register with the Canadian Residency Matching Service (CARMS) (www.carms.ca), which organises this process for all Canadian residency programs. From the outset of their training, residents are involved in clinical radiological work as well as interventions, and are supervised according to their level of autonomy.

All practicing radiologists should participate in maintenance of certification programmes, or in continuing professional development (CPD) initiatives. This requirement is linked to the license to practice in certain provinces. Radiologists who are fellows of the RCPSC can follow its programme, accumulating a minimum of 400 credits over a five-year period. Certain provinces offer similar programmes. Within this context, national organisations, universities and scientific associations regularly organise CPD activities in accordance with the standards developed by the RCPSC.

Employers do not have access to the specific results achieved by certified radiologists applying to work in hospitals, as these are confidential. However, candidate radiologists who apply must have passed the examination in order to obtain a license to practice. The "board eligible" notion as seen in the United States does not exist. However, there are specific requirements for foreign candidates who may, occasionally, obtain a restricted license to practice. These requirements are specified by the various provincial professional colleges. Hospitals and professional bodies may, however, require a physician's participation in a recognised CPD programme.

CanMEDS Training

All training programmes in Canada include a CanMEDS training component. CanMEDS refers to a description of the requirements for specialist physician roles which are specific to each specialty, including radiology. These roles include medical expertise, communication, collaboration, professionalism, management, health advocacy, and scholarship. The CanMEDS competencies specific to radiology are available for consultation on the RCPSC website (rcpsc.medical.org).

Radiology training requirements are also evolving in order to better address social needs. Not only is CanMEDS mandatory, but residents are encouraged more and more to train and collaborate with all healthcare professionals. In some provinces there is a mandatory 360 degree assessment of the radiologist in practice, and residents have to develop skills in practice audits and in the design of such assessments since this will be the norm in their practice.■

RADIOLOGY IN CANADA

Interview with CAR Association President Dr. E.A. Lyons

Interviewee
Dr. E.A. Lyons

Professor of Radiology, Obstetrics and Gynaecology and Anatomy
Officer of the Order of Canada
Former Head and Chairman Department of Radiology
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President
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Please share with us the highlights of your career in radiology.

As a first year medical student I participated in a B.Sc. in medicine research project using ultrasound to compare the pulsations of the third ventricle in the brain intracranial pressure. When a local neurosurgery resident introduced a clinical ultrasound service I worked as an on-call technologist. Three years later he left. I started in radiology as a first year resident and the ultrasound section chief. My third year of residency involved a year of research in obstetrical ultrasound in Glasgow. After, I returned to the University of Manitoba, completed the radiology residency and embarked on a practice of academic radiology with a primary focus on ultrasound.

In 1990 I assumed the position of professor and chairman of the department of radiology at the University of Manitoba and the Health Sciences Centre in Winnipeg. After a term of seven years as department head I moved back to spend my time in ultrasound seeing patients and expanding the knowledge base in pelvic ultrasound and pelvic pain in particular. In 2008 I was inducted into the Order of Canada as an Officer for my work in ultrasound and contributions to healthcare in Canada.

How far has Canada advanced in terms of developing a nationwide EPR?

Canada Health Infoway began a programme about eight years ago to foster and develop a nationwide interoperable electronic health record (EHR) for Canadians connected with a radiology information management and PACS system. They provided a national framework and some match-

ing funds for provinces. This was a stimulus for each institution and province to begin the process of digitisation of radiology. In Manitoba the process involved all of the province's hospitals and that has just been completed. Because the process was province wide, single software vendors were chosen to ensure access of images and information across the province. Of our 10 provinces and three territories, all are at different stages of progress towards EHRs. Infoway's vision for 2015 includes having EHR infostructure in place across the country and implementing standardised electronic records in physician offices and physician order entry systems in hospitals, and including some degree of decision support for physicians such as clinical practice guidelines.

How are radiologists from abroad integrated into the healthcare system?

To practice in Canada, a radiologist must have passed the examinations of the College of Physicians and Surgeons of Canada. Exceptions are made for some with foreign certification especially the American Board of Radiology. During the 90s, when there was an acute shortage of radiologists, there was an influx of South African and British trained radiologists who were given temporary privileges if they practiced in underserviced areas. These temporary foreign workers were later given full registration, allowing those interested to move within Canada on a more permanent status. The rules have changed since then, and with few exceptions, all foreign graduates have to pass the Canadian radiology exams. Basic English language requirements are present in all provinces with the exception of Québec, which requires everyone who wants to work in Québec to pass a French written and oral test of proficiency.

What sort of audit/accreditation systems are in place in your department?

Healthcare is under the jurisdictions of each of our provinces and territories. Regulations in Canada legislated by the provincial Colleges of Physicians and Surgeons require yearly checking and reporting of radiation emitting imaging equipment in hospitals and offices. There is also checking of the processes and protocols in the imaging department. Audits are required by hospital standards departments but are not done in clinics. System accreditation is spotty now. Quality of care protocols are now starting to appear in hospitals across Canada. This has been a serious gap in the past. The best assessment of the necessity of exam referrals is using an electronic order entry system with appropriateness criteria or imaging referral guidelines in place as decision support. The CAR would like to see province-wide adoption of guidelines in this format. Our association plays a role in the area of accreditation too.

Do you consider yourself to be a hands-on manager?

Yes, very much so. I believe that the radiologist is an integral member of the healthcare team and as such, must be the problem solver of the team. This is also the vision of the CAR and a vision that as president I have shared with all Canadian radiologists and hope they take it to heart so that the future of the profession will be secure. The best part of my day is when I am called upon by a clinician to help them and their patients with a problem. Being available, accessible and willing to assist is what the service component of radiology is all about. ■

Author
Dr. Martin Reed

Chair of the CAR Guidelines Working Group

Canadian Association of Radiologists

CLINICAL DECISION **SUPPORT SYSTEM**

Increasing Appropriateness of Exams in Canada

Medical imaging is a critical component of the care that health professionals provide. However, mounting evidence demonstrates that between 10 - 20% of imaging studies are unnecessary. Any clinical intervention without clear purpose or patient benefit creates waste and negatively affects quality of care. Rising costs alone for imaging are a looming threat to health system sustainability. Spending for diagnostic imaging in Canada has increased markedly and now exceeds an estimated 2.2 billion dollars in operational costs alone. Eliminating even 10 percent of unnecessary tests could eradicate 220 million dollars in wasteful spending each year.

Recognising that healthcare professionals must assume responsibility for ensuring that the work they do is neces-

sary and appropriate, the Canadian Association of Radiologists (CAR), the national association representing all radiologists in Canada, introduced a set of evidence-based clinical guidelines in Canada in 2005 based on the guidelines of the Royal College of Radiologists in the United Kingdom. An update of the CAR guidelines will be completed this year. These diagnostic imaging referral guidelines help physicians order the most appropriate imaging exam for the clinical presentation. When physicians choose the best test first it results in more effective and efficient use of imaging equipment and health human resources (radiologists, technologists and others). It also improves patient care and safety by shortening wait times for patients who stand to benefit most and by reducing unnecessary exposure to medical radiation.

Although CAR imaging referral guidelines are available in booklet, PDF and CD formats and on physician websites, the CAR recognised that for maximal effect, guidelines must be made seamlessly available as part of the clinician's regular workflow. To achieve this, the guidelines have been integrated into a computerised physician order entry (CPOE) system for diagnostic imaging with attendant computerised clinical decision support (CCDS). The CAR believes that this is the most effective way of implementing guidelines to ensure that imaging resources are used most appropriately and effectively.

The CAR tested the effectiveness of providing its diagnostic imaging referral guidelines through the computerised clinical decision support and CPOE in two settings in the province of Manitoba, a tertiary care children's hospital (Winnipeg; completed 2007) and a rural family practice clinic (Steinbach; completed 2009). The side bar describes how the system works. Results of the studies suggested that 10 - 20% of imaging requests were inappropriate. The CAR has a third study currently underway at a children's hospital in Winnipeg to study how to improve compliance with the best practice guidelines. Several other provinces are separately undertaking or exploring guidelines implementation initiatives.

This delivery model of computerised clinical decision support can serve as a prototype for other areas of medicine, and the lessons learned can assist in the integration of other types of decision support into Electronic Health Records in Canada, a current healthcare priority. Canada Health Infoway, a not-for-profit organisation funded by the federal government, is working with the provinces and territories to foster and accelerate the development and adoption of electronic health information systems for all Canadians. Canada Health Infoway's report EHR: 2015 Advancing Canada's Next Generation of Healthcare at a Glance identifies one of its emerging 2015 priorities to be to "unlock additional quality and safety benefits by enabling decision support and communication across the care continuum."

Working together towards maximum digitisation in the delivery of medical imaging care will require focused attention to address the technological challenges of systems integration and Canada's unique requirements in a multi-system healthcare delivery structure (10 provinces, three territories). Attending to medical imaging appropriateness in a way that fits within a digitised healthcare system will be one of many methods needed to reduce imaging costs and preserve system sustainability in a way that is patient-focused and maximises appropriateness, quality and safety. ■

» INFO BOX:

The CPOE and computerised clinical decision support system in the CAR appropriateness studies operated as follows:

1. The physician logs into the system and acquires the necessary demographic data about the patient automatically from the electronic admission/transfer/discharge system.
5. The physician orders an imaging study from a series of drop down menus and then provides the relevant clinical information by clicking on appropriate items in lists of relevant history, signs and symptoms and differential diagnoses. There are also free text fields to enable the physician to provide more detailed information.
3. If the imaging study ordered is appropriate for the clinical information provided, according to the guidelines, the request can automatically be sent to the Diagnostic Imaging Department or be faxed to that site or be given directly to the patient to take to the imaging site.
4. However, if the imaging study ordered is not recommended by the guidelines, the relevant guideline appears on the screen, either recommending a more appropriate imaging study or suggesting that no imaging is required.
5. The physician can then continue with the original order by overriding the guideline, or follow the advice of the guideline.
6. The software will also indicate to the physician if the patient has had the same imaging study ordered through the software within the previous month (duplicate order advice).
7. All the details of each order process are saved within the software and are available for later analysis.

PROFILE OF THE CANADIAN ASSOCIATION OF RADIOLOGISTS

The Voice for Radiology in Canada

Sources

Information kindly provided by the Canadian Association of Radiologists

The Canadian Association of Radiologists (CAR) is the national voice of radiology committed to maintaining the highest standards of care, promoting patient safety and helping radiologists contribute to the very best healthcare for patients. The CAR is particularly active on three fronts:

- Working with governments, health professionals and technology leaders to make optimal use of diagnostic imaging.
- Serving as the voice of Canadian radiology so that governments, the public and news media are fully informed about the benefits and risks of diagnostic imaging, the challenges faced and the solutions the CAR proposes.
- Creating, accrediting and promoting opportunities for continuing medical education and research.

An important part of the CAR's focus on quality is the development of diagnostic imaging referral guidelines, which assist physicians in ordering the most appropriate imaging test for patients. The association recognises that for maximal effect, guidelines must be a seamless part of the physician's regular workflow and thus guidelines have been integrated into a computerised order entry (CPOE) system for diagnostic imaging. The goal is to include guidelines as a part of every RIS and CPOE in every healthcare system in Canada. The CAR is part of an international committee, in cooperation with the International Radiology Quality Network (IRQN), creating international guidelines that can also be adapted to developing countries, for presentation to the World Health Organisation (WHO). The CAR held its first national guidelines symposium in 2009 and an international guidelines symposium in 2010 in Montréal.

Accreditation Programmes

The accreditation of imaging facilities, equipment and staff is an important part of ensuring quality healthcare. The association currently provides quality accreditation services through its mammography accreditation programme, which has been in operation for 15 years. It currently accredits over 600 units, and has introduced accreditation of digital mammography. The CAR has also launched a bone mineral densitometry programme in 2010 and plans to expand its accreditation services in the years ahead.As part of its quality assurance (QA) services, the CAR develops evidence-based standards that define principles of practice to obtain the best radiological results. The CAR continues to update its standards and introduce new ones.

Education

The CAR supports lifelong learning for radiologists by acting as an accrediting agent of continuing medical education events on behalf of the Royal College of Physicians and Surgeons of Canada and holding its own continuing medical education (CME)/continuing professional development (CPD) events each year. The CAR's biggest educational event is its Annual Scientific Meeting (ASM). The 2011 CAR ASM will be held in collaboration with the Société canadienne-française de radiologie in Montréal from April 28 to May 1, 2011, with a theme of Image Wisely – Image with Care.

Communications and Stakeholders

The association produces a dedicated CAR Journal four to five times per year, within which there is the opportunity to earn CME credits. An updated website (www.car.ca) is to be launched to augment the association's position as the source for radiology information in Canada. The CAR will expand its communications to members and stakeholders with a quarterly e-publication that not only contains news from the CAR, but from its provincial association colleagues and articles of interest with a national and international perspective. The CAR creates educational materials for medical professionals and/or the public. One such item introduced in 2009 was its "Do you need that scan?" brochure, which educates the public and healthcare providers about radiation exposure. The Canadian Radiological Foundation (CRF) is the charitable arm of the CAR. The CAR and CRF are committed to continuing research that is critical to improve healthcare for Canadians. ■

Vienna

March 3–7

ECR 2011

European Congress of Radiology

The annual meeting of ESR European Society of Radiology myESR.org

AGENDA 2010

Key Conferences & Events

AUGUST

11 – 14 **2010 Annual Meeting & Postgraduate Course in Trauma & Emergency Radiology**
Seattle, US
www.erad.org

20 – 21 **ESOR ASKLEPIOS Course on Advanced Abdominal Imaging**
Santiago, US
www.myesr.org

22 – 27 **14th International Congress of Immunology**
Kobe, Japan
www.ici2010.org

SEPTEMBER

2 – 4 **Breast CORE Meeting**
Bruges, Belgium
www.diagnostic-imaging.be

9 – 12 **16th International Society of Radiographers & Radiological Technologists Annual Congress**
Gold Coast, Australia
www.2010issrt.org

9 – 11 **23rd European Society of Head & Neck Radiology Annual Meeting**
Vienna, Austria
www.ezshnr2010.org

15 – 17 **Congresio Argentino de Radiología**
Buenos Aires, Argentina
www.sar.org.ar

24 – 25 **8th Interventional MRI Symposium**
Leipzig, Germany
www.uni-leipzig.de/radiologie

30 – 03 **International Diagnostic Course Greece**
Anavyssos, Greece
www.idkd.org

OCTOBER

02 – 06 **CIRSE Annual Scientific Meeting Valencia, Spain**
www.cirse.org

07 – 08 **Healthcare IT Awards Brussels, Belgium**
www.itandnetworking.org

09 – 13 **EANM Annual Scientific Congress**
Vienna, Austria
www.eanm.org

14 – 16 **9th Annual Symposium on Advances in Breast MRI**
Las Vegas, Nevada
radiologycme.stanford.edu/dest

14 – 15 **Management in Radiology (MIR) Annual Scientific Meeting**
Mallorca, Spain
www.mir-online.org

14 – 17 **RANZCR Annual Congress and Scientific Meeting**
Perth, Australia
www.ranzcr2010.com

18 – 20 **Korean Congress of Radiology**
Seoul, Korea
www.kcr4u.org

20 – 23 **Ultraschall 2010**
Mainz, Germany
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