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RADIOLOGY • CARDIOLOGY • INTERVENTION • SURGERY • IT • MANAGEMENT • EUROPE • ECONOMY • TRENDS • TECHNOLOGY

WHO SHOULD PERFORM CARDIAC IMAGING?

PATIENT SAFETY

Comparison of International Guidelines
Contrast Agents

PRODUCT COMPARISON CHART

Computed Tomography Systems in the Spotlight

COUNTRY FOCUS

Medical Imaging in the Czech Republic

Who Should Perform **Cardiac Imaging?**

Prof. Iain McCall

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Dear readers,

The controversy regarding who should undertake and report imaging investigations has been with us for many years and is ongoing. The increased complexity of imaging equipment, the wide range of imaging investigations and the depth of knowledge required to provide a comprehensive investigation service has strengthened the role of the radiologists and the economics of imaging has made the concentration of equipment and imaging staff into one department: this has been a key factor.

The complexity of and detail provided by modern imaging systems has also required radiologists themselves to focus on specific areas after the initial overall training in order to understand and respond to the requirements of clinical specialties. It is correct to say that radiologists need to understand the function and physiology as well as the anatomy and pathology of the body systems that they are imaging in order to provide a meaningful opinion in many disease processes and this must be incorporated into their training. In this sense, cardiology, the focus of this edition, is no different from other body systems. However, the debate in cardiology is compounded by the focused nature of the organ and the detailed knowledge required to understand its function.

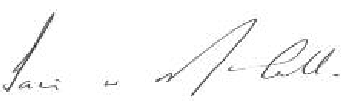
In this cover story, the cardiologist makes the assertion that they have the expert knowledge of function and physiology as well as anatomy and have been doing most of the angiographic work over the last years, although this was developed by radiologists. The radiologist makes the point that cardiologists undertaking all the imaging through self referral increases the amount of imaging undertaken and thus the overall cost. The complexity and sophistication of all the different imaging modalities is highlighted by our third contributor.

Much of this equipment requires considerable investment, detailed knowledge of its physical principles and capabilities and a very detailed knowledge of anatomy and pathological features. The equipment is also used for multiple systems and not limited to the heart although some dedicated equipment is available. In management terms it is not a good use of resources to have multiple separate clinical departments with their own complex equipment used for their own purposes. It is also a challenge for clinicians to keep up with the technological developments and their own clinical developments while running busy clinical departments.

Ultimately for the patient, the important issue is whether the clinicians providing their care, whether they be cardiologists or radiologists, are properly trained and competent. This does mean that radiologists providing cardiac imaging must undergo subspecialist training following their core general training in order to understand the complexities of function and physiology as well as pathology and anatomy. The European Society of Radiologists (ESR) in conjunction with the European Society of Cardiac Radiologists (ESCR) are providing a number of subspecialist training fellowships per year to ensure that this happens.

The solution for the patient and the healthcare economy is for cardiologists and subspecialist cardiac radiologists to work closely together using the centralised complex equipment with the more versatile and relatively inexpensive ultrasound equipment being immediately available adjacent to the clinics.

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



IMAGING MANAGEMENT VOLUME 10 ISSUE 4 2010

12 WHO SHOULD PERFORM CARDIAC IMAGING?

The present turf war over who should perform cardiac imaging is the lead subject for this edition's cover story. As the opening part of this section, two leading experts, including an eminent cardiologist and active member of the British Cardiological Society (BCS) and then a leading radiologist, Prof. Oudkerk, who as well as being head of a large department of radiology, is also President of the European Society of Cardiac Radiology (ESCR), take up the issue, with a view to creating a wider discussion on the subject. Such debate is essential if radiologists are to fully take into account the professional opportunities opening up in the field of cardiac imaging, with new techniques, tools and devices being developed regularly. This latter subject forms the basis for the remaining articles in the section, which will give a thorough overview not only of technological developments in the field, but also a market and industry overview.

COVER STORY

Who Should Perform Cardiac Imaging?

FEATURE: PATIENT SAFETY

COUNTRY FOCUS: THE CZECH REPUBLIC

In Every Issue

6 COMMISSION ADOPTS NUCLEAR MEDICINE COMMUNICATION

The European Commission has adopted a Communication to the European Parliament and to the Council on the medical applications of ionising radiation. It proposes a way forward to resolve the urgent issue of shortage of supply of radioisotopes for nuclear medicine. The Communication also identifies key issues to improve radiation protection of patients and medical staff, to avoid a rise in population exposure associated with the technological advances in CT and an increase of accidental exposures in radiotherapy.

7 NEW INDUSTRY PARTNERSHIP

CEA (The French Alternative Energies and Atomic Energy Commission), IRE (National Institute for Radioelements, Belgium) and IBA (Ion Beam Applications S.A., Belgium), three major industrials in the sector of manufacturing radioisotopes for medical examinations in Europe, have signed an agreement to secure the supply of Technetium (Tc-99m) beyond 2015. This agreement enables the companies to respond to European needs in medical exams, currently estimated at eight million exams per year.

Tissue Strain Imaging

A Promising Breakthrough for Ultrasound Liver Examinations

A new era is dawning for quicker, more accurate diagnoses of tissue anomalies in the liver, thanks to a research partnership between The University College London Hospital (UCLH) and Siemens Healthcare.

Professor William Lees of the University College London Hospital (UCLH) began researching the clinical potential of ultrasound Acoustic Radiation Force Imaging (ARFI) a year ago, and quickly realised that this technology might be a way to increase the clinical diagnostic information that results from conventional sonographic examinations.

"Tissue Strain Analytics adds an independent parameter to our existing morphological diagnostic process. No single parameter is going to enable us to characterise tissue with any degree of accuracy, but the more parameters we have, the more confident our diagnosis can be," states Professor Lees.

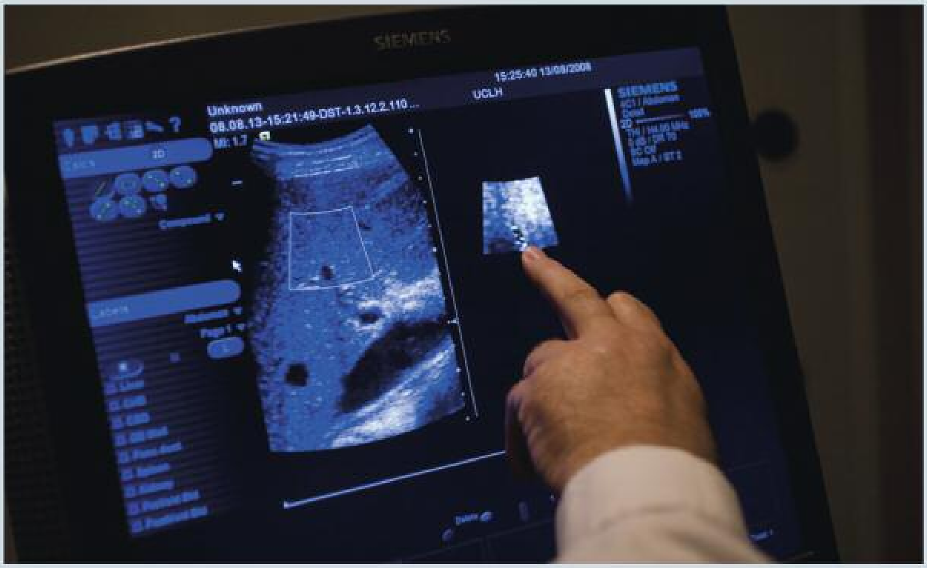
An evolution in ultrasound

An image is formed by applying a push pulse, which results in the relative displacement of tissue elements. The degree of displacement will vary with the specific stiffness properties. For example, soft tissue will experience greater displacement than very stiff tissue, which may displace a very small amount or not at all. Conventional ultrasound beams track the displacement of tissue.

This information is compared to the baseline image, resulting in a qualitative elastogram that visually represents the variation in stiffness within a region of interest. Today, this technology is only available by Siemens with the ACUSON S2000TM ultrasound system.

Breakthrough for Liver Examinations

Another application for ARFI technology is measurement of shear wave velocity. This is implemented by Virtual Touch Tissue Quantification. Shear waves, which travel at greater speeds in stiff tissue compared with soft tissue, are generated, and travel perpendicular to the push pulse. While they do not interact directly with the transducer, their movement may be tracked by detecting displacement of tissue progressive to the transmitted conventional ultrasound beam. "It is like hitting a board on the upside and feeling the effect at the ends, only with an extremely high accuracy in the measurement," states Lees.



> "In studies, Virtual Touch Imaging proved extremely sensitive in diagnosing fibrosis and distinguishing it from normal liver and cirrhosis."

This part of the Virtual Touch technology may prove to be a major breakthrough in identifying early stages of liver diseases causing cirrhosis. In studies, Virtual Touch Imaging proved extremely sensitive in diagnosing fibrosis and distinguishing it from normal liver and cirrhosis. Conventional ultrasound cannot detect fibrotic changes prior to cirrhosis.

"We will need more data to determine whether this new technology is also capable of tracking progression of fibrosis or responses to treatment, but I am very opti-

What is Tissue Strain Imaging?

- Tissue Strain Imaging is a breakthrough technology that allows visualisation of differences in the stiffness of tissues and pathologies that may otherwise appear very similar using conventional ultrasound imaging.
- Tissue Strain Imaging has the potential to provide immediate results.
- The technology is user-independent.
- Virtual Touch Imaging, together with conventional sonographic scans, may enable physicians to avoid unnecessary biopsies.

How does it work?

- Virtual Touch Tissue Imaging, the first commercially available implementation of Acoustic Radiation Force Imaging (ARFI), uses an acoustic 'push pulse' to interrogate the mechanical strain properties or stiffness of tissue, a method similar to a physical palpation exam.
- The images provide complementary information to the standard B-mode image by supplying insights into changes in tissue stiffness, which are often associated with pathology.
- Tissue Strain Imaging allows the user to obtain qualitative visual or quantitative value measurements of the mechanical stiffness properties of tissue.
- Grey scale images present a map of regions and localised areas with relatively high tissue stiffness showing relative stiffness in the tissue being examined.
- The resultant numeric values give a good understanding of the general condition of the tissue.

mistic that it will have this capability. We have been examining obese patients during the clinical studies already made, and Virtual Touch Imaging showed very good accuracy even then," states Lees.

Avoiding Unnecessary Biopsies

Virtual Touch applications may reduce unnecessary biopsies and other invasive procedures needed to give an accurate diagnosis through easy evaluation of anomalies. "These kinds of anomalies may be difficult to separate from malign tissue with other kinds of scanning technologies," states Lees. "This is typical of how Virtual Touch Imaging is helping us – we can avoid many biopsies and other uncomfortable and unnecessary examinations."

Using this technology with conventional sonographic scans and traditional biochemical examination, physicians may also be able to give a more reliable answer whether an anomaly is malign or benign. Lees continues, "I believe Virtual Touch Imaging will be an integral part of scanning procedures in the near future. Our clinical tests have shown a very high accuracy in separating malign, benign, and healthy tissue. The method is quick, user-independent and is totally unnoticeable for the patient."

More Validation Needed

Virtual Touch now needs to be validated against liver biopsy and biochemical testing for chronic liver disease. Experience shows that up to a thousand validated cases may be needed to be able to define its role. Professor Lees is convinced that Virtual Touch offers improved patient care on an individual basis. Physicians will be able to tell patients that they have nothing to worry about, or to proceed faster to additional examinations and treatment if this proves necessary,

"The benefit of Virtual Touch is that we can be more convinced of doing the right things and giving correct information to the patient. Both with traditional physical palpations and preceding ultrasound technologies, it is easier than you would imagine for a physician to press harder to get the result he or she was expecting before the examination." Professor Lees and the UCLH are now organising clinical tests for Virtual Touch, collaborating with a number of other clinics and hospitals in the UK. ■

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

COMMISSION ADDRESSES KEY ISSUES IN NUCLEAR MEDICINE, RADIOLOGY AND RADIOTHERAPY

Actions to Strengthen Regulatory Framework

The European Commission has adopted a Communication to the European Parliament and to the Council on the medical applications of ionising radiation. It proposes a way forward to resolve the urgent issue of shortage of supply of radioisotopes for nuclear medicine. The Communication also identifies key issues to improve radiation protection of patients and medical staff, to avoid a rise in population exposure associated with the technological advances in x-ray computed tomography imaging (CT) and an increase of accidental or unintended exposures in radiotherapy. This Communication was jointly proposed by Günther Oettinger, Commissioner responsible for Energy, and by John Dalli, Commissioner responsible for Health and Consumer Policy.

> "The Communication proposes a long-term perspective on the medical application of ionising radiation in the Union"

» Energy Commissioner Günther Oettinger said: "Nuclear medicine is essential for diagnosis and treatment of serious diseases like cancer, cardiovascular and brain diseases. At the same time, the overall population exposure to ionising radiation due to medical procedures overwhelms any other man-made exposure."

» Commissioner for Health and Consumer Policy John Dalli added that: "The shortage of radio isotopes needed for medical procedures as well as the need to improve patient and health professionals' protection against accidental or unintended exposures in radiotherapy, are important objectives of public health policy."

All over the world, the number of x-ray examinations is around four billion per year. In Europe, around nine million patients are treated each year with radioisotopes. It is the Commission's responsibility to help secure the availability of this technology to the benefit of human health. Today, the most widely used diagnostic radioisotope, Technetium-99m, is in short supply because it relies on an unsustainably low number of production reactors. Within the overall nuclear energy policy of the European Commission it is of crucial importance to provide incentives for further research reactors to contribute to its production and in the long-term for new research reactors to be built for this purpose. The Communication proposes a long-term perspective on the medical application of ionising radiation in the Union to stimulate discussions on the necessary actions, resources and distribution of responsibilities.

Actions to Strengthen Regulatory Framework

The following actions are proposed:

» *Strengthen the existing regulatory framework:* The current legislation (Directive 97/43/Euratom) will be upgraded to enhance regulatory supervision to ensure that the legal requirements are respected. This will be part of an overall consolidation of radiation protection legislation in 2011.

» *Raise awareness and safety culture:* The medical profession must receive adequate training and regular updates on good practice, and above all, made sensitive to its responsibility in ensuring both good medical care and adequate radiation protection. Awareness also needs to be raised among patients and among the general population.

» *Foster radiation protection and a sustainable supply and use of radioisotopes through research:* Actions within the Euratom and EU Framework Programmes and in the framework of the Sustainable Nuclear Energy Technology Platform (SNETP) should contribute to the improvement of radiation protection and to the development of research infrastructures and competences.

» *Financing mechanisms to ensure sustainable supply of radioisotopes:* The Commission assesses different financing mechanisms to ensure a sustainable supply of radioisotopes in the interest of public health.

» *Integration of policies:* Medical applications of ionising radiation call for good integration of different policies, on public health, research, trade and industry as well as radiation protection.

» *International cooperation:* The World Health Organisation (WHO) is very active in this area and the International Atomic Energy Agency (IAEA) has built up important programmes and information tools. The Commission will support all initiatives for coordinated efforts. ■

Further Reading

The following documents "The Communication on medical applications of ionising radiation and security of supply of radioisotopes for nuclear medicine", and "Commission staff working paper with annexes to this Communication" are available on the website: http://ec.europa.eu/energy/nuclear/radiation_protection/radiation_protection_en.htm

NEW INDUSTRY PARTNERSHIP **TO SECURE MANUFACTURE OF RADIOISOTOPES**

Safeguarding the Future of Nuclear Medicine

CEA (The French Alternative Energies and Atomic Energy Commission), IRE (National Institute for Radioelements, Belgium) and IBA (Ion Beam Applications S.A., Belgium), three major industrials in the sector of manufacturing radioisotopes for medical examinations in Europe, have signed an agreement to secure the supply of Technetium (Tc-99m) beyond 2015. This agreement enables the companies to respond to European needs in medical exams, currently estimated at eight million exams per year.

The supply of Tc-99m represents a major challenge in public health. This radioisotope is used in 80 percent of imaging scans performed in Europe. Its mother radioisotope Molybdenum (Mo-99) is manufactured in nuclear reactors worldwide whose numbers are steadily on the decline. The main reactors that manufacture Mo-99 are nearing the end of their lifecycle and, since 2008, have shown an increase in manufacturing problems that has led to several difficult periods. Any stoppage in Mo-99 production affects the availability of products used by specialists for patient exams, reducing the number of scans and, in turn, resulting in fewer diagnoses for treating serious illnesses.

In order to secure supplies for European hospitals, IBA and IRE, the main suppliers of Tc-99m and Mo-99 generators, and CEA, which operates research reactors that manufacture radioisotopes for medical use, initiated this strategic partnership.

This initiative combines the technological skills and know-how of each company to cover the entire radioisotope manufacturing and distribution chain:

- CEA will guarantee the irradiation of uranium targets in reactors;
- IRE will extract Mo-99 and deliver it to distributors of Tc-99m generators, and
- IBA/CIS bio, using Mo-99, will manufacture and distribute Tc-99m generators for hospitals.

The partnership will rely on the following equipment that has recently been put into operation, or is still under development by the three companies. "This agreement will enable us to limit the important uncertainty surrounding the supply of Tc-99m. For IBA, any advances in molecular imaging start with securing the sector's supply chain. Thanks to this agreement between CEA, IRE and IBA, molecular imaging will continue to develop and demonstrate its full potential not only for specialists, but also for patients," said Renaud Dehareng, COO, IBA Molecular.

"This is positive news for global healthcare, as this will ensure a new and welcomed supply source given the current shortage," added Jean-Michel Vanderhofstadt, managing director of IRE. "This partnership confirms IRE as one of the key actors in nuclear medicine in the world today. IRE manufactures approximately 30 percent of the world's Molybdenum-99 and now supplies radioisotopes worldwide. In addition to these commercial developments, we will continue to invest in safety, which remains our main priority." The three companies will work in the coming months on the technical specifications of RJH reactor's irradiation systems, with the goal of beginning Mo-99 manufacturing as soon as it is operational, planned for 2015.

The Future of Novel MR Imaging

The consortium of the project "European Network for Cell Imaging and Tracking Expertise" (ENCITE) has the ambitious mission to develop and test new MR and optical imaging methods and biomarkers to draw a more comprehensive picture of cell fate and the reaction of the immune system. In the end cell therapy shall be improved for the benefit of the European patient. To exploit the superb spatial and temporal resolution of MRI in molecular imaging applications, it is necessary to improve the sensitivity and specificity of the currently available probes:

- *Sensitivity*. A new high relaxivity tetrameric Gd-based agent has been shown to provide an impressive sevenfold sensitivity enhancement in respect to the commercial agents maintaining an analogous safety profile.
- *Specificity.* An enzyme responsive Gd probe has been synthesised and tested. It reports about the citivity of beta-galactosidase, an enzyme largely used by biologists as a reporter of gene expression.

Important advances have been made in the field of the new family of MRI-CEST agents (CEST= Chemical Exchange Saturation Transfer). These MRI probes have great advantages in respect to the classical relaxation agents. Being frequency-encoding systems, it is possible to visualise (using different colours) more probes in the same image as every CEST agent is responsive only to a specific irradiation frequency. In the project, a paramagnetic complex, present as a pair of nmr-detectable isomers, has been selected for its high sensitivity and its ability to act as pH sensor. Mapping pH appears to be an important task to get new functional information from MR images in the presence of relevant pathologies. Moreover, upon changing the Lanthanide ion in the complex, systems able to visualise different cell types have been prepared and successfully tested. ■

Last Call for Registrations for Management in Radiology!

As previously announced in this journal, Europe's most important management-focused congress for chairmen, senior managers and administrators, radiographic technologists, medical equipment industry personnel and those interested in better managing their role in diagnostic imaging facilities and departments, are welcome to attend the Management in Radiology (MIR) Annual Scientific Meeting, which takes place this year in Mallorca, Spain at the Hotel Gran Meliá Victoria, from October 14 – 15. Congress participants can benefit from a special promotional booking rate at the official congress hotel for their stay.

This year's scientific programme will share a variety of different useful tools and practical guidelines to assist those in a position of responsibility to streamline workflow, ensuring a quality service for patients and providing the latest hot topics in management in medical imaging. 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' license 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 radiologists and the radiographer;
» Update on the legal issues of teleradiology;
» Quality aspects and auditing of teleradiology, and
» The position of the European Society of Radiology on teleradiology.

You will find a full copy of the scientific programme later in this journal (see p. 30). MIR also kindly invites participants and their partners to take part in an evening event on Thursday, October 14, 19.30 to take place inside the Museum of Modern Art ('Museu Es Baluard') at the Plaça Porta Santa Catalina (www.esbaluard.org). During this event, there will be a guided tour through the museum, followed by a cocktail dinner which will be served on the museum's terrace. For the price of 25 euros per ticket, you can order your ticket directly during the registration process.

Previous MIR congress' programmes, as well as the friendly atmosphere at the event, and the outstanding evening events, have been highly regarded by participants from across the globe, who report that they received practical, useful information that they can take back to their daily working lives. The top presentations from the congress will be reported on in full for the first edition of IMAGING Management in 2011, where you can find an expanded version of the leading talks.

Further MIR news includes the annual winter meeting, which is scheduled to take place in the coming January, where a smaller group of participants will receive intensive management coaching from experienced leaders from the world of industry in business and management models and techniques. More information on this will be reported in this journal and can be found at the website noted below.

Further information on:
www.mir-online.org, www.myesr.org

CARS Congress 2011: Information Now Online

The annual CARS congress facilitates innovation and contributes to modern medicine on a worldwide basis. CARS' traditional focus on research and development for computer assisted systems and their applications in radiology and surgery has been a key player in the development of medical informatics for more than 25 years. Its close collaboration with the ISCAS, EuroPACS, CAR, CAD and CMI societies will continue as they jointly hold their annual meetings with the 25th CARS Congress in Berlin in 2011.

The CARS Congress Organising Committee invites you to be part of this extraordinary scientific/medical community, which gives medicine a new perspective. Join them in Berlin in June 2011, if you work in the fields of radiology, surgery, engineering, informatics and/or healthcare management and have an interest in topics, such as:

» Image- and model-guided interventions;
» Medical imaging;
» Image processing and visualisation;
» Computer aided diagnosis;
» Medical simulation and education;
» Surgical navigation and robotics;
» Model-guided medicine, and
» Personalised medicine.

New PACS applications, including IT infrastructures adapted for the operating room as well as related results from the DICOM and IHE working groups are also within the scope of CARS. Clinical specialties represented at CARS include:

» Image Guided Tumour Ablation Therapies;
» Cardiovascular Imaging;
» Computed Maxillofacial Imaging;
» Computer Assisted Radiation Therapy;
» Computer Assisted Orthopaedic and Spinal Surgery;
» Computer Assisted Head and Neck, and ENT Surgery;
» Image Guided Neurosurgery, and
» Minimally Invasive Cardiovascular and Thoracoabdominal Surgery.

Please note that the deadline for paper and abstract submissions for CARS 2011 in Berlin is January 10, 2011.

Further information on:
www.cars-int.org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CIRSE Raises UFE Awareness in Nine Languages

CIRSE has developed a website (www.uterinefibroids.eu) that provides vital information to patients, professionals and the public on the symptoms and possible treatment options of uterine fibroid embolisation (UFE) as part of its commitment to raising public awareness of new health solutions that are both highly effective and less invasive than many existing therapies.

Fibroids of the uterus, also known as leiomyoma, fibromyoma or myoma, were first treated with Uterine Fibroid Embolisation (UFE) in France in 1989. Since then, the procedure has become widely available and is now routinely performed in many European countries. In parallel to the growth of UFE, there has been a steep increase in scientific research and literature dedicated to UFE as a safe and effective medical procedure. Unfortunately, the general public and many patients suffering from fibroids have not yet heard of this comparatively new treatment alternative. Indeed, many gynaecologists and referring doctors remain unaware of its advantages.

To help address this situation CIRSE has set up this website to provide accurate and up-to-date information based on the scientific evidence, internationally published recommendations and the expertise of its membership. All of the information on the site has been written and reviewed by physicians and patient education professionals including T. Kröncke (DE) A. Nicholson (UK) P. Pelage (FR) J. Reekers (NL) J. Spies (U.S.) and M. Trojanowska (PL).

Further information is available on:
www.cirse.org and www.uterinefibroids.eu

ECRI Institute 17th Annual Web Conference

Drs. Francis Collins, Director of the National Institutes of Health, and Carolyn Clancy, Director, Agency for Healthcare Research and Quality, and more than 35 speakers from public and private sectors, are convening October 19 - 20, 2010, for ECRI Institute's 17th Annual Conference, Comparative Effectiveness and Personalised Medicine: An Essential Interface.

The conference is being held on the campus of the National Institutes of Health in Bethesda, Maryland, U.S. This meeting, free with advance registration, explores two critical streams of scientific inquiry - comparative effectiveness and personalised medicine - in order to better align evidence, infrastructure, and database needs, to highlight research challenges, and to address many aspects about regulatory, ethical, and societal factors affecting both fields. The conference is organised by ECRI Institute in cooperation with the Agency for Healthcare Research and Quality (AHRQ) and the National Institutes of Health (NIH), two central federal research bodies in the field of comparative effectiveness and personalised medicine.

> "Many patients suffering from fibroids have not yet heard of this comparatively new treatment alternative"

Further information on: www.ecri.org

IHE Tests Data Exchange Systems

At the recent Integrating the Healthcare Enterprise (IHE) European Connectathon 2010 in Bordeaux, seven companies tested systems for exchanging data between hospital device gateways using a protocol that covers data intended for use both in home and hospital-based devices.

Sharing this data improves capabilities for remote patient monitoring among an increasingly aging population, which has become a priority for health authorities across Europe and is being strongly encouraged by the European Commission. The testing at Connectathon was made possible by a landmark international agreement between IHE and the Continua Alliance to jointly support the IHE Device Enterprise Communication (DEC) Profile as an interface for sharing data between the gateways to which devices are connected.

These data hubs are used both in hospitals as well as in home-based configurations so that by sharing an interoperable interface the patient data from both types of devices can be fed into a single patient care management system, such as a health record system. "This is a significant step that changes the landscape for the developers of devices and the hubs, as well as developers of applications managing the data coming from these different sources," said Charles Parisot with GE Healthcare.

"Testing at Connectathon is a very positive sign that the first products using the protocols are now being developed and could appear later this year," he said, adding that companies testing to assure conformity to the new protocol include the leaders in patient monitoring, such as Draeger, Royal Philips Electronics and GE Healthcare. "Home-based devices that support in-home hospitalisation can reduce care costs and increase patient comfort".

Even more, these bedside devices also encourage patients and their family members to become directly involved in managing a patient's return to health. Home-based devices are not the only missing link in following patient care, said Parisot. The flow of data coming from the patient care devices widely used in hospital care from intensive care units to surgery has not been well standardised either, he said. He said that avoiding separate protocols for feeding data into EHR systems creates advantages for both classes of devices.

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

Sectra Reports Double Number of Mammography Systems Delivered

For its first-quarter operations this year, Sectra has reported increased demand for the company's mammography products. The number of Sectra MicroDose Mammography system deliveries more than doubled to 21 and contributed to the quarter's sales growth.

"During the quarter, we experienced major successes in Australia with our MicroDose system and our IT system for the processing of breast images. The latest orders make Sectra the largest company for breast imaging systems in the country," says Jan-Olof Brüer, President and CEO of Sectra AB.

Sectra is fully under way with upgrading existing customers' installations to the new generation of Sectra PACS, the company's principal product in medical IT. The product's properties for linking geographically spread healthcare clinics, was of core importance for the new orders Sectra secured during the quarter. Sectra displays a seasonal variation whereby most invoicing and earnings are traditionally generated during the third and fourth quarters. After the close of the quarter, Sectra signed a framework agreement with the European Council in Brussels for the delivery of the product for secure telephony that is deployed in all EU countries. This is the result of the European Council's procurement process, in which the Sectra Tiger XS was selected.

Siemens Makes its Factories Greener

Siemens is investing up to 100 million euros until the end of 2012 to make its factories greener. The company is currently analysing the environmental performance and energy efficiency of its some 300 most important sites worldwide. The goal is to reduce energy and CO_2 emissions by 20 percent by the end of 2011. Siemens is also offering the green test to its suppliers. In the next two years they are to check their companies' energy and environmental efficiency. "We want to be the first industrial enterprise in the world with an entirely environmentally friendly supply chain," said Barbara Kux, member of Siemens' Managing Board and Chief Sustainability Officer. It is estimated that the company's 1,000 most important suppliers alone could reduce their CO_2 emissions by 1.5 million tons a year and their energy costs by around 170 million euros.

In order to improve the energy and environmental records of its factories, Siemens is currently carrying out an inspection of its own production facilities, using the latest products of its environmental portfolio for the purpose. However, the supply chain does not begin at the factory gates – noticeable improvements could also be achieved with the supply firms. Siemens works particularly closely with around 1,000 suppliers. They were selected for their high purchasing volume and particularly energy-intensive production processes with energy accounting for up to 45 percent of their costs. They are thus particularly important if the energy consumption of Siemens' entire supply chain is to be permanently reduced. The 80 largest suppliers among them are to undergo an environmental and energy check by Siemens experts around once a week. A further approximately 80 suppliers are undertaking a one- to three-day check with the help of Siemens specialists. More than 800 are to make their own, web-based check. The remaining suppliers can carry out a shortened environmental check for their company online.

GE Healthcare Opens First Plant in Brazil

CEO Jeff Immelt recently announced that the location of the next Global Research Centre (GRC) will be in Brazil, one of four focus countries in GE's globalisation process, which also includes Russia, India and China. Brazil and South America are of critical importance to GE Healthcare's future.

For the last several years GE Healthcare has envisioned and laid the groundwork to establish a manufacturing facility to serve both the local market of Brazil and eventually all of Latin America. According to Claudia Goulart, President and CEO of GE Healthcare for Latin America, "This plant allows us to align ourselves with our commitment to Brazil, to the Latin America region and to the healthcare market in general."

The new plant, located in Contagem, Brazil, just outside of Belo Horizonte, represents a 50 million dollar investment over the next 10 years and is expected to bring over 700 jobs to the region through new employees, additional indirect resources (i.e., suppliers), distributors and new service personnel. This is a great example of a project that is not only good for GE, but also one that supports the local region with new employment opportunities.

The Brazil plant was established with a focus around "healthymagination". In the future, the plant will expand manufacturing to include PET, CT, MRI and monitoring systems. The Brazilian healthcare market is currently worth 600 million dollars, and the entire Latin America region is worth two billion dollars. Both markets are growing at a rate of eight percent a year.

Philips Introduces Enhanced Cardiac Ultrasound

Philips has announced enhancements to the iE33 xMATRIX cardiac ultrasound system designed to provide a more complete imaging solution for adult echocardiograms. In addition to the ergonomic design of the new X5-1 transducer, which aims to improve comfort and efficiency for the clinician, the system has been developed to help advance patient care by enabling expanded cardiac-related diagnostic capabilities related to ischaemic disease detection, structural heart disease assessment, as well as systolic and diastolic heart failure and arrhythmia.

New features of the iE33 xMATRIX ultrasound system include outstanding 2D and 3D image quality utilising a single transducer, near instantaneous acquisition of 3D volumes, new 3D workflow tools and visualised colour Doppler flow pattern during 3D exams. With the X5-1 and iRotate, a clinician can more easily obtain challenging 2D views, such as apical two-chamber. Rather than manually rotating the transducer and searching for a window that isn't obscured by ribs, rotation is achieved electronically to maintain the best acoustical window. When used in stress echo, iRotate allows clinicians to complete an entire stress echo protocol from the standard windows following peak exertion without rotating the X5-1 transducer.

WHO SHOULD PERFORM CARDIAC IMAGING?

Viewpoint of the Cardiologist

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Imaging the heart is a crucial component of clinical cardiology that provides invaluable information on structure, function, physiology and sometimes prognosis. In well-funded health systems, it is difficult to envisage managing the majority of patients without some form of cardiac imaging to provide accurate information important to clinical decision making.

Cardiac Imaging Different From All Other Imaging

Cardiac imaging is fundamentally different from all other forms of imaging due to the combination of several factors:

1. The heart is the only organ that continues to move while imaged, so moving images or motion correction are required, usually in addition to cardiac (ECG) gating;
2. While anatomy is important, assessing the movement (function) of the cardiac structures (particularly the myocardium and valves) is a very large proportion of the required information; and
3. The orientation of the heart is highly variable, precluding the use of standard imaging planes relative to the body, and requires significant interaction from the operator while imaging to obtain the appropriate image planes.

While other areas of imaging can involve some of these (e.g. operator interaction in abdominal ultrasound, functional assessment in barium swallow), the combination of all three is unique to cardiac imaging and directly relevant when assessing the requirements for performing this. There are many cardiac imaging modalities, including echocardiography, cardiac catheterisation, nuclear cardiac techniques, magnetic resonance imaging (MRI) and computed tomography (CT), though they share many of these requirements.

Who Should Perform Cardiac Imaging?

In assessing who should perform cardiac imaging, it is useful to ask two questions:

1. What is required of the practitioner to assess cardiac imaging optimally?; and
2. What provides the best setup for the patient?

To start with the first aspect, there are three main areas where knowledge and experience is required – the heart, the surrounding thoracic/abdominal regions (for some imaging modalities), and the imaging technique itself. It is clear that a detailed knowledge of cardiac anatomy, both normal and abnormal, is essential. In addition, a good understanding of the normal and abnormal function of all cardiac components is needed, including the motion of the myocardium and valves, flow patterns and differential pressures across valves and other cardiac structures (e.g. septal defects), perfusion of the myocardium by the coronary arteries, and cellular physiology (e.g. for uptake of nuclear isotopes). It is also important to understand the disease processes and patterns of cardiac damage/effects they can induce.

Some imaging modalities, predominantly CT and MRI, involve significant imaging of extra-cardiac structures, and knowledge is also required of the normal and abnormal anatomy of these, or provision made for a review of the images where required (e.g. by a radiologist, if not already involved with reporting the cardiac aspects). Good knowledge of the imaging technique, its optimal use, its limitations and awareness of the various artefacts are additional requirements in order to report appropriately.

Specific Cardiological Knowledge a Must

In addition to these general requirements, optimal cardiac imaging and reporting requires a good knowledge of several areas of clinical cardiology. These can affect both the interpretation of the images, and the assessment of the clinical consequences of the findings. The ability to integrate cardiovascular physiology is important – for example the effect of blood pressure or heart rate on left ventricular outflow tract obstruction, hypertrophic cardiomyopathy and aortic regurgitation are key aspects to take into account in the assessment. Similarly, understanding cardiac and extra-cardiac shunts is essential to the interpretation of left and right heart catheterisation (including cardiac pressures and oxygen saturations), echocardiography and cardiac MRI. The clinical consequences of a particular finding are also key ingredients of good interpretation – for example, whether the degree of coronary stenoses or valve dysfunction seen are sufficient to cause symptoms or ventricular dysfunction requires clinical knowledge and experience. The best reports use this clinical integration to provide an interpretation of the findings and their consequences in light of the clinical picture, rather than a 'technical' report with only a description of the image findings. This also highlights the last area that a cardiac imaging practitioner requires for good practice – the ability to integrate all cardiac imaging findings – this facilitates an integrated and coherent assessment of the heart, which is invaluable to patient management.

What is Best for the Patient?

The second question, indicated above, addresses the best setup for the patient. There are important safety considerations with cardiac imaging, as there are many aspects of cardiac investigations that carry significant risk. Examples include cardiac catheterisation, dobutamine or adenosine infusions for stress and perfusion studies (with echocardiography, nuclear or MRI), and exercise testing prior to nuclear or echo 'stress' testing (risk of arrhythmia/collapse). It is essential that the practitioner is able to deal with any potential complications of the imaging technique, including arrhythmia, cardiac arrest, hypotension and coronary dissection. In addition, there are significant advantages to the patient in having cardiac imaging provided in the context of a clinical consultation, where an informed discussion about the imaging findings and appropriate clinical management can take place. Not only is this time-efficient, but strengthens the doctor-patient relationship. While there are many areas of medicine (and indeed cardiology) where this isn't feasible, it is a major strength where it can be achieved, though it does limit the imaging to a cardiological setting.

It is clear that performing optimal cardiac imaging has a number of requirements, including a good understanding of the heart (including cardiac anatomy, function, physiology, and disease processes), the clinical context, the imaging techniques, the ability to deal with serious cardiac complications, and a knowledge of extra-cardiac anatomy. This requires specialist training and experience beyond the core aspects of general specialty training programmes. For cardiologists, extra knowledge is required on the imaging techniques and extra-cardiac structures (or integration with radiology for the latter). For radiologists, additional knowledge is required on cardiac anatomy, function and physiology, clinical context and dealing with cardiac complications.

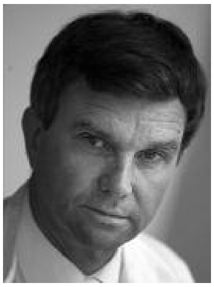
While both specialties have the potential ability to perform cardiac imaging, the degree of additional cardiac knowledge and experience required for radiologists is high, and this puts many off. Coupled with the emphasis on functional imaging and the need for the clinical context, it is often cardiologists who undertake cardiac imaging. Radiologists have been more involved with cardiac CT and MRI, likely due to their excellent knowledge of the non-cardiac uses of these techniques, though additional training and experience are still required to incorporate the requisite cardiac knowledge. These modalities do provide an area for collaboration however between cardiology and radiology, and many centres have forged good links.

Conclusions

In summary, the high degree of specialist cardiac knowledge, skills and experience required for optimal cardiac imaging means that the majority of the time, cardiologists have more of the necessary attributes and are the appropriate specialty to perform this. It is possible for radiologists to perform cardiac imaging, but a high level of additional training and experience is required, and the ability to place the imaging findings in the clinical context is more limited than for cardiologists. ■

WHO SHOULD
PERFORM CARDIAC IMAGING?

The Radiologist's Viewpoint



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Diagnostic imaging has come to play a central role in the management of cardiovascular diseases, and radiologists have been responsible for the development and validation of clinical applications in the field. The recent explosion of medical imaging procedures has once again focused attention on the general issue of self-referral in cardiology. Several studies have demonstrated that diagnostic imaging services are rendered with greater frequency and at greater cost when performed by cardiologists using ultrasound equipment in their offices. In fact, data suggests that the bulk of the increased use of imaging has been attributable to physicians who self-refer.

Concerns for Over-Referral of Cardiac Imaging Studies

Moreover, cardiologists have gained some expertise within the imaging procedures particular to their specialty. Therefore radiologists and cardiac surgeons are sometimes uncomfortable with the incentives inherent in self-referral. Insurers and clients are concerned with the appropriateness of their services. It is notable that cardiologists have tripled their billings for imaging services since 2000. In this paradigm, the utilisation of imaging modalities becomes dependent on the presence of the equipment at the location where the patient is admitted.

For essential and routine clinical questions such as the status of myocardial perfusion, there are more than five different modalities (including US, CT, MRI, SPECT and PET) to choose from, each of which can provide an answer. These modalities have a largely different diagnostic performance and costs vary considerably. There is ample evidence in existence as to which of these modalities could provide the best and safest procedure to answer the clinical question, but since the diagnostic pathway is paved by self-referral, these recommended techniques are almost not in use.

> "To achieve such expertise takes specialty training in diagnostic imaging of many years"

Integral Knowledge Necessary for Cost Containment

This is just one example that amply demonstrates the principle that an integral knowledge of all the available imaging modalities and their technical background is necessary to guide the clinical problem through the right diagnostic algorithm for the optimal and most cost-effective answer. To achieve such expertise takes specialty training in diagnostic imaging of many years, which should also take into account the imaging procedures of the pulmonary circulation and great vessels. Furthermore, the radiation safety and dose application to a patient-individualised level is a substantial part of the training and the work of the radiologists. It is remarkable that radiation over-exposure is reported most commonly in the field of cardiac imaging when such examinations are performed by cardiologists.

In summary, each of these worrying developments stress the need for a medical specialty in imaging and diagnosis that takes into account all of the existing and newly developed imaging modalities in optimal diagnostic algorithms, augmented by a fundamental training in the technical backgrounds of the modalities and their safe application in morphology and function without any chance for self-referral: a training for which radiologists are ideally suited. ■

CARDIAC **IMAGING**

Technology Markets Overview

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Cardiovascular diseases are ranked as the leading causes for mortality in most Western regions which has lead to development of preventive and curative measures. According to World Health Organization (WHO) estimates, 16.7 million people around the globe die of cardiovascular diseases each year. This is over 29 percent of all deaths globally. Recent studies suggest that the largest percentage increase would occur in the Eastern Mediterranean region and the largest number of deaths is likely to occur in the South-East Asia Region. Research also predicts the cardiovascular disease mortality rate in China to rise by 73 percent by 2030. Every year, four million deaths are caused by cardiac disorders in Europe, and the direct and indirect costs of such diseases amount to over 150 billion dollars annually.

Medical imaging is the fulcrum of diagnosis for most cardiovascular diseases. The cardiac market witnessed a slow down in 2008 - 2009 owing to the lack of reimbursements mostly for cardiac CT and cardiovascular MRI procedures. However, with the increase in the number of cardiovascular imaging procedures and technological advancements, the cardiac imaging market represents great potential.

Computed Tomography

The advent of computed tomography (CT) has revolutionised the face of radiological diagnosis. CT continues to be a central modality in both inpatient and outpatient care. It is one of the few modalities that have undergone transformation in terms of technological advancement and product innovation since its inception in the 1970's. The recent past has seen a transition from low end 16 slice systems to high end 320 slice systems. Recent studies estimate that over 62 million CT scans are obtained per year in the United States itself which includes four million for children. The economic downturn and limited annual budgets have forced hospitals to go in for low end slice configurations.

With the increase in awareness about radiation exposure and its effects in the long run the market is shifting towards a trend where vendors are looking at radiation dose reduction technologies and reconstruction software. The battle of the slices has drawn to a close with the focus now being on sharper images that involve lower radiation dosage and reduced examination time. CT scanners with lower dosage and greater image clarity ensuring better diagnosis and treatment, is likely to be the order of the day.

Key players like Philips have introduced reconstruction technologies like iDose which would reduce the dose by 80 percent in parts of the body particularly with high organ dose. A procedure which would typically deliver six to eight millisieverts with a technology like iDose would now deliver only 0.9 mSv. iDose can also reduce the dose of coronary CT angiography studies to 0.25 to 1 mSv, which is an 80 percent reduction over conventional filter back projection reconstruction.

Both Siemens and GE also offer "iterative reconstruction", a technique that involves algorithms that help reconstruct 2D and 3D images. This technique did not see much growth owing to its slow speed; however these limitations have been overcome. IRIS (Iterative Reconstruction in Image Space) by Siemens claims a dose reduction up to 60 percent, while GE's ASIR (Adaptive Statistical Iterative Reconstruction) packaged with their LightSpeed VCT XTe and their Discovery CT750 HD claims a dose reduction of 40 to 50 percent.

There is a growing trend towards advancements in scanning speed which reduces examination time which in turn results in lower doses. GE's SnapShot pulse technology helps reduce cardiac CT doses up to 83 percent. Siemens also offers SOMATOM Definition Flash Dual Source CT scanner with advanced scanning speed which is capable of doing an entire scan of the chest in 0.6 seconds. The market is shifting towards sharper image quality without having to pay the price of higher dose. CT Angiography (CTA) is gaining prominence as it is an effective tool for diagnosing coronary heart disease (CHD). The use of CTA is likely to increase owing to its ability to rule out cardiac events in patients who are considered to be at low risk of developing significant CHD.

Balancing Radiation Benefits and Risks

Studies suggest that radiation exposure associated with CT has increased substantially over the past few decades. This increase in exposure needs to be curbed. It is important to analyse from patient studies when CT imaging is a great benefit and when radiation risks might be greater than the

New, non-surgical treatment for uterine fibroids
A patient friendly alternative

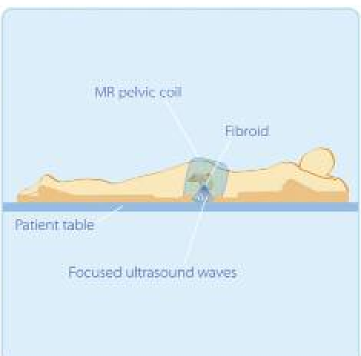
High Intensity Focused Ultrasound (HIFU) has long been known as a non-invasive therapy technique. It uses focused ultrasound waves to heat and coagulate tissue deep inside the body without damaging intervening tissue. However, the lack of a suitable guidance and monitoring technique and long treatment times has prevented its widespread medical use.

The perfect combination
With Sonalleve MR-HIFU, Philips now presents a system that enables exciting emerging non-invasive therapies. It brings the advantages of two modalities together by integrating an advanced High Intensity Focused Ultrasound system into the patient table of the Philips Achieva MR system.

Focused ultrasound
With High Intensity Focused Ultrasound therapy, a focused transducer is used to bundle ultrasound energy into a small volume at the target locations inside the body. During treatment, the ultrasound energy beam penetrates through the skin and soft tissue causing localized high temperatures only in the focus area, leaving the skin and intermediate tissue unharmed. Within a few seconds this produces a well-defined region of coagulative necrosis.

Combined with MR image guidance
3D anatomical images provide the reference data for treatment planning, while real-time temperature sensitive images follow the ablation process to provide information about treatment progress and monitor critical anatomical structures.

Ablation of uterine fibroids
Uterine fibroids are the most common benign tumors in pre-menopausal women. Fibroids occur in 20 to 50% of women of child-bearing age, and with increasing size produce pain, excessive menstrual bleeding, pressure, bloating and urinary and bowel compression symptoms. Fibroids may also cause infertility. Many women suffer from uterine fibroids but don't want to undergo surgery and continue to endure the condition in silence. Philips' new Sonalleve MR-HIFU system now offers a non-invasive treatment of uterine fibroids. The technique is much more convenient and comfortable than other therapeutic procedures such as hysterectomy, myomectomy or uterine artery embolization. These require hospital admission as an in-patient and sometimes weeks of recovery. In contrast, with Sonalleve fibroid therapy, patients can be treated as an out-patient, be out of the hospital the same day and almost fully recovered within a few days.



- Non-invasive therapy for uterine fibroids, a very common condition for women of child-bearing age
- Fast out-patient procedure with high patient compliance and short recovery times
- Safe and effective Procedure
- Volumetric heating with real-time feedback for high procedural efficiency and short procedure time
- Optimized MR system utilization through easy switching between diagnostic and therapeutic use

To learn more, please visit us at: www.philips.com/sonalleve

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benefits expected. This would help avoid or minimise unnecessary exposures.

There are no large scale studies or research to prove cancer risks associated with radiation exposure from CT scan imaging. Risk estimates obtained from recent studies have been derived from research conducted on atomic-bomb survivors. Although the risk estimates obtained from these studies are small, the concern is that this might pose a threat in the long run with the increased use of CT, resulting in a public health issue in the years to come. It is important to weigh the risks and benefits and analyse, if the potential benefit is better than the potential risk. The key factor is appropriate utilisation because CT when used appropriately; the benefits of diagnostic information outweigh the potential risks by far. In order to mitigate dose exposure it is important to identify the fine line between controlled dose and acquiring sufficient information for an assured diagnosis.

SPECT, SPECT/CT and PET/CT

With improvement in the quality of SPECT imaging it is likely to remain the dominant perfusion imaging system. The latest developments in this sector have been with regard to reduction in scan time. GE has introduced Discovery NM 530c capable of reducing scan time from 15 to 20 minutes for each scan to three to five minutes. This SPECT cardiac imaging system uses a cadmium zinc telluride-based high-speed, high-resolution camera that not only reduces scan time but also radiation exposure. This technology represents a cost effective solution to diagnose heart diseases.

Technological integration is likely to be a driver with the growing trend towards hybrid modalities. As a result, PET/CT and SPECT/CT systems are expected to witness positive growth. The advent of hybrid devices such as PET/CT, SPECT/CT, CTA (CT Angiography), which have CT as the cornerstone are likely to play a vital role in therapeutic intervention and oncology applications much more than cardiac. Owing to this, CT technology is likely to be at the forefront.

Magnetic Resonance Imaging

Cardiovascular MR (CMR) has a utilisation rate of 13 percent in the European regions and has been one of the most reliable modalities for myocardial infarction and cardiac ischaemia. It is also frequently used for the detection of cardiac tumours and CHD. CMR being a 4D high resolution imaging technique allows the evaluation of infarction and perfusion at the sub-endocardial level which may not be possible with other modalities. The modality offers a significant edge above cardiac catheterisation in detecting microvascular circulation changes and also in distinguishing atherosclerotic plaques from vulnerable plaques that could rupture easily causing myocardial infarction.

CMR also scores above nuclear imaging and ultrasound in the detection of valvular diseases in the right ventricle. Despite the several advantages that CMR has to offer above the other modalities, it is still sparingly used in European diagnostic settings owing to its high price and maintenance costs. Cardiovascular MR has evolved rapidly over the past ten years. High field 3T MRI permits microscopic resolution and near real – time 3D imaging. This along with tissue specific contrast agents will increasingly provide quantitative information. Technological advancements in cardiovascular MR are being driven by the need to overcome physiological constraints such as motion and blood flow.

Super paramagnetic iron oxide nano particles are likely to become the next generation of tissue specific contrast agents for MRI in another two years. One of the important developments in MR research has been the growing trend towards whole body ultra-high field systems. MR centres in Europe are investing in 7T MRI technology to realise the advantages and benefits of it in cardiac imaging. Recent cardiac studies performed with 7T provide detailed insights into cardiac anatomy. However 7T MR is not yet refined enough for use in cardiac applications as artifacts increase in proportion to field strength.

The MRI market constantly undergoes a technology upgrade through more sophisticated systems which have a negative impact on the sales of earlier systems. The mid field systems segment is by far the largest market and will continue to remain stable. The high field market is expected to experience a significant growth by 2015 while the ultra high market is expected to grow at a slower rate.

Low field systems are expected to witness a decline through 2015. 3T systems did not grow much in the recent past owing to issues with artifacts, patient comfort and versatility of use. However it has potential in the near future, if technical challenges and signal to noise ratio can be sorted out. 1.5T systems are expected to still have good years ahead as they are versatile, patient friendly and robust.

Echocardiography

The speed, safety and cost effectiveness of ultrasound gives it an edge above other imaging modalities. Echocardiography is usually the primary imaging procedure for cardiac diagnostics. Recent developments in ultrasound like 3D and 4D imaging have ensured good growth rates for this market. The latest advancements in this sector have been evaluating the structure of the heart and valve function. Technological advancements in 3D echocardiography allow a comprehensive analysis of the heart and all its aspects. There is continuous development of software applications such as 3D analysis of the atria, 3D quantification tools for valvular diseases and for 3D stress echo analysis.

Hand carried systems are gaining prominence globally with regions like Eastern Europe, Latin America and parts of Asia Pacific showing significant interest in this equipment. Radiological departments across the globe are replacing their cart based ultrasound systems with hand carried systems. Miniaturisation is a growing trend with hand carried ultrasound scanners being omnipresent and becoming smaller, faster and more affordable. Ultrasound equipment has a price advantage and even the most advanced ultrasound costs one-fifth of a basic MRI system.

Hospitals in Europe show a preference towards mid-range ultrasound equipment. Ultrasound software for post-processing images for enhanced analysis and dedicated probes are emerging to become the most important accessories for ultrasound equipment. Certain vendors are offering specialised ultrasound software that assist sonographers in interpreting the acquired image better.

Cardiology Imaging Markets

The market for cardiology imaging modalities is most certainly growing. With the increasing number of cardiovascular related diseases the utilisation rate of these diagnostic measures is bound to increase significantly. The cardiac imaging market is on a rise in Western Europe and also certain parts of Eastern Europe. China's healthcare sector is forecast to grow due to soaring demand and government support, which might seem appealing to private investors looking to invest in the market. China represents 40 percent of the world's population and growth of the world population is expected to result from these emerging market populations. China is likely to be one of the biggest global cardiac markets by 2015.

India also accounts for a major share in the world population. India's healthcare budget has gone up by nearly Rs.4,000 crore to Rs.21,113.33 crore (4.35 billion dollars) with the government expressing interest in rural healthcare. Healthcare organisations in India are looking to raise funds through private equity to invest in infrastructure and expansion plans. India also accounts for most of the diabetic patients.

Reimbursement continues to pose a threat to growth in the medical imaging market, and is an industry-wide constraint. Europe, as a diversified continent, has varied reimbursement policies: there is no common healthcare expenditure reimbursement policy as such. In addition, Europe offers very limited reimbursement for imaging procedures. Reimbursement levels are as low as 500 to 800 euros for MRI scans, which are high-cost procedures. The healthcare industry still continues to be bogged down by budgetary issues. European countries like Bulgaria have announced a 10 percent decrease in their healthcare budget for 2010. Ireland is also looking at implementing cuts of over one billion euros in healthcare in 2010.

The recession witnessed a decline in growth rates in the imaging sector in 2008 and 2009. Healthcare is becoming a costly affair across Europe with an increase in patient demand. Cost containment is expected to be the focus. The cardiac imaging IT area represents one of the quickest growth area in terms of revenue. Despite pricing pressures, the large market potential provides a positive outlook for the next few years. Large volumes of data produced by multi-slice systems will greatly increase demand for technology that addresses data storage, 3D visualisation and analysis. Ties between PACS and advanced visualisation vendors are strengthening. Advanced visualisation integration with cardiovascular PACS is looked upon as a necessity these days and PACS vendors have made efforts to offer basic 3D functionality into PACS.

Shifting Towards Safer Modalities

With the increase in awareness about radiation exposure the market is shifting towards safer imaging modalities and therefore the ultrasound market will continue to grow robustly and echocardiography is predicted to see a significant growth in terms of utilisation. The future seems promising in terms of potential markets and developments in advanced technology, and the early quarters of 2011 are expected to see slow and positive growth. The U.S. and Europe will continue to remain key markets while Asia, China and Japan are also recognised as potential markets. Technological integration is likely to be a driver with the advent of integration of positron emission tomography (PET) and magnetic resonance imaging (MRI). MRI and CT markets are expected to see a modest growth through to 2015. Resurgence is expected in medical imaging with a rise in utilisation and healthcare reformation. Demand for high tech imaging and a need for replacement systems will result in a rise for MRI scanners, particularly the 1.5 T and 3T segment. ■

Leuven Hospital Group Sees Benefits of Tomosynthesis in Women with Dense Breasts

The largest hospital group in Belgium with four campuses and almost 1,900 beds, Leuven University Hospitals performs 17,000 diagnostic mammograms and 8,000 ultrasound examinations a year. As a teaching and research institution, the hospital group has access to the latest technologies, enabling the hospitals in the group to provide the highest levels of patient care while conducting clinical studies to optimise the performance and application of the latest equipment.

Dr. Chantal Van Ongeval, a radiologist who reads diagnostic and screening breast examinations, notes that the hospital group is often the first medical institution in Europe to implement cutting-edge radiology technologies like tomosynthesis.

Early Adopters of Tomosynthesis

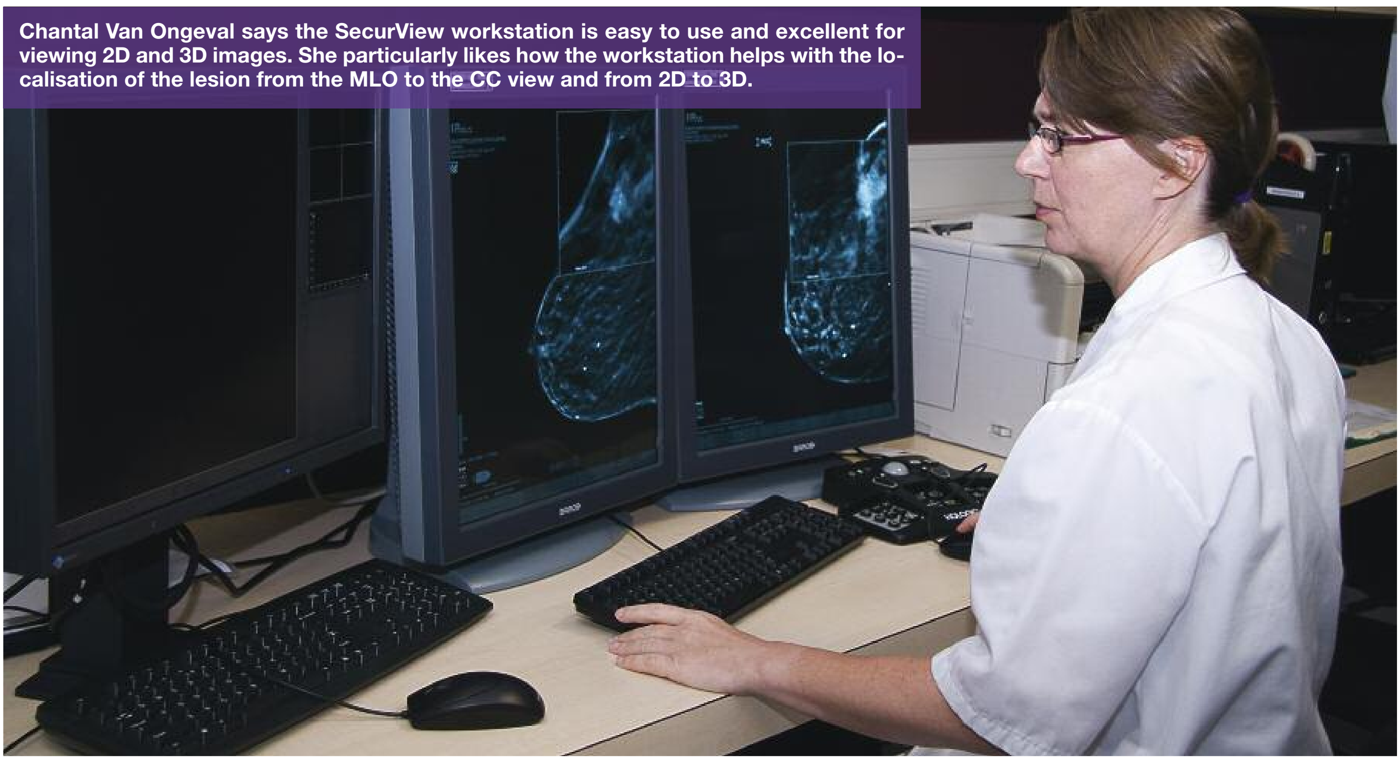
In 2009, when tomosynthesis was approved for use in breast imaging in Europe, Leuven University Hospitals installed a Hologic Selenia® Dimensions® breast tomosynthesis system. Similar to a digital mammography system in appearance, the x-ray tube of the system moves in a 15 degree arc while the breast is compressed, taking a series of low-dose images. These images are reconstructed into a series of slices that can be displayed individually or in cine' mode. The slices enable radiologists to see a 3D view of the breast, eliminating the issue of overlapping tissue, which can obscure views.

Although the evaluation of breast tomosynthesis is still in the data collection phase, Dr. Van Ongeval and her team have already seen some of the benefits of tomosynthesis.

"I have come to the same opinion regarding tomosynthesis as I have found in many professional articles, papers, presentations, symposia and seminars, which is that tomosynthesis is beneficial for the detection of spiculated masses," states Dr. Van Ongeval.

"If a breast has different densities due to glandular tissues or if you see some distortion and you're not sure if it is a lesion or normal breast tissue, then tomosynthesis also helps with diagnostic work and pre-operative evaluations, and it is useful if you see multifocal lesions or need to see extensions. However, for symptomatic patients, for whom no abnormalities are found on 2D or 3D mammography, other radiological examinations are still necessary."

Chantal Van Ongeval says the SecurView workstation is easy to use and excellent for viewing 2D and 3D images. She particularly likes how the workstation helps with the localisation of the lesion from the MLO to the CC view and from 2D to 3D.



Dr. Van Ongeval notes that tomosynthesis is particularly useful in evaluating breasts with different densities due to glandular tissues; if you see some distortion and you're not sure if it is a lesion, and for multifocal lesions where you need to see extensions.

"At this time we are using tomosynthesis as an additional modality for our diagnostic examinations," Dr. Van Ongeval notes. "It is difficult to differentiate dense breast tissue from small stellate dense lesions, but with tomosynthesis this is much easier."

Hologic's Dimensions System Acquires 2D and 3D Images in a Single Compression

Leuven University Hospitals began the transition from analogue mammography to digital systems in 2004. Today they have four digital mammography systems, including a Selenia digital mammography system and the new Hologic Selenia Dimensions tomosynthesis system.

"We replaced our analogue systems gradually, first going to CR and then to FFDM as we moved to more efficient systems," states Dr. Van Ongeval. "Selenia Dimensions is very fluent, very fast. The patient is not aware of the multiple images which are taken because it is all done in one compression."

Dr. Van Ongeval and her team routinely take both 2D and 3D views for diagnostic mammograms. She notes, "The specificity is better with tomosynthesis because we know what we are seeing. We have found small lesions in dense breasts using 3D that are difficult to find on normal 2D imaging."

"It is difficult to differentiate dense breast tissue from small stellate dense lesions, but with tomosynthesis this is much easier."

Dr. Van Ongeval likes the ability to view both 2D and 3D images simultaneously on the Hologic SecurView® workstation. "The SecurView workstation is excellent. We see the 2D and 3D images immediately, and it is very easy to go from 2D to 3D and back and forth. If you view the tomosynthesis image, it gives you the place in the Mediolateral-oblique (MLO) then you can go from this to the Cranio-caudal (CC). This helps with the localisation of the lesion. Our radiologists find the workstation very easy to use."

Tomosynthesis Images Provide More Information

"The image quality of the Selenia Dimensions system is very good," explains Dr. Van Ongeval. "You can discriminate small stellate lesions from glandular tissue. This will be helpful in a screening environment as it is important to have a high specificity of mammography at as low as possible dose." Because tomosynthesis images differ from 2D images, training is important to properly read the images. Dr. Van Ongeval and her team took a Hologic hands-on tomosynthesis workshop recently and felt the training helped make them more comfortable in reading the new 2D+3D images.

NON-INVASIVE CARDIAC **IMAGING MODALITIES**

Adding Clinical Value

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Dturing recent years, efforts from both the medical and engineering communities have led to enormous advances in the field of noninvasive cardiovascular imaging, strengthening its key role in cardiologic diagnosis making and therapy guidance. The strengths and weaknesses of the new developments in the four main cardiac non-invasive imaging modalities: nuclear imaging, multi-slice cardiac computed tomography (CCT), cardiovascular magnetic resonance imaging (CMR) and echocardiography, will be discussed in the following paper.

Nuclear Medicine

Single-photon emission computed tomography (SPECT) uses the gamma radiation of 99Technetiun labelled methoxyisobutylisonitrile (Mibi), a substance, which distributes with the blood flow and is taken up by the myocardial cells like potassium. The detection of stress-induced ischaemia is based on comparing images after two injections, one at peak stress and one under resting conditions. This method is well established in cardiology. ECG gating with usually 8-16 bins per cycle, improves spatial resolution and allows investigation of regional and global function of the LV. Gated SPECT based global function estimates are proven to be highly reproducible.

Recent attempts have expanded regional function assessment by SPECT to the clinical setting of cardiac resynchronisation therapy (CRT). The phase analysis of gated regional myocardial signals has been suggested as a predictor of CRT response and proposed as a criterion for patient selection (Chen 2005). It must be argued, however, that the poor temporal resolution of the technique (ca. 60ms per bin) is sufficient to resolve the short regional functional delays occurring in this disease (20 – 40 ms). Furthermore, assessment of function is limited to the radial motion of the myocardium only, neglecting all other directions of motion and, thus, reflecting the complex myocardial deformation incompletely.

Positron Emission Tomography (PET) uses the co-incidental detection of photons on opposite detectors to reconstruct the distribution of β+-radiating 18 Fluorodeoxyglucose in the heart. It is more sensitive than SPECT, has a slightly higher resolution and can quantify perfusion in absolute numbers, which allows the most sensitive assessment of myocardial viability. Higher costs and difficulties due to short-lived tracers explain its limited availability.

The recent development of hybrid PET and CT scanners allow the co-registration of highly resolved anatomical CT data with functional information from PET. Such "fusion imaging" has particular value in oncology, but cardiologic applications have been proposed as well. The added value of such fusion images in the broad cardiologic routine, however, remains to be proven.

Cardiac CT

Computed tomography reconstructs a volume data set of regional x-ray attenuation values by advancing a rotating unit of an x-ray source together with several rows of detectors along the long axis of the body. A volume covering the entire heart can nowadays be scanned in a few seconds, thus within a breathhold. Current generation CT scanners allow assessment of coronary artery anatomy noninvasively with a good spatial resolution.

The particular attenuation of x-rays by calcifications results in a very good ability to exclude relevant coronary artery disease but does not allow a sufficiently accurate evaluation of stenosis severity. Therefore, CT angiography (CTA) has been suggested as a tool to rule out coronary artery disease, especially in symptomatic patients with intermediate probability.

Recent developments in the field of cardiac CT focus on improving temporal and spatial resolution as well as volume coverage, paralleled by a reduction of radiation exposure. Currently however, CTA cannot replace selective conventional coronary angiography in the diagnosis of coronary artery disease. Furthermore, a subsequent treatment of a detected stenosis (e.g. by placing a stent) is not possible and would anyway require an additional invasive procedure.

Different patterns of myocardial enhancement have been demonstrated in animal models and humans, early and late, after contrast administration. Although cardiac CT therefore appears capable of detecting myocardial ischaemia and scar tissue, data are still preliminary. Therefore established and radiation-free MR investigations are usually preferred in the clinic.

The use of ionising radiation is a major drawback of nuclear medicine and cardiac CT. A dynamic cardiac radionuclide study and a chest CT examination are equivalent to approximately 2.7, respectively 3.6 years of exposure to natural background radiation (European Commission Referral Guidelines for Imaging, 2000). When choosing any ionising radiation based imaging modality, the principles of "justification, optimisation and responsible use" as stated in CE Euratom Directive 97/43 on health protection of individuals in relation to medical exposure must be followed. According to the above-mentioned referral guidelines, non-ionising techniques should be preferred whenever they give grossly comparable information and are locally available.

Cardiovascular Magnetic Resonance Imaging (CMR)

Cardiovascular MRI uses high intensity magnetic fields to influence the spin orientation of atoms in the body. Additional radiofrequency fields introduce a precessional motion of the atoms, the return from which produces a detectable magnetic signal that is used for imaging. CMR generates 3D images of the cardiovascular system with good spatial resolution and contrast. Special sequences for perfusion, blood flow and blood vessel imaging have been developed.

CMR offers excellent anatomic still and cine images of heart and great vessels, accurate measurements of cardiac volumes, mass, ejection fraction, as well as information about myocardial perfusion and fibrosis, blood flow and velocity, while avoiding the use of ionising radiation. An increase in magnetic field strength up to currently 3 Tesla allowed further improvement of image quality. The analysis of myocardial signal intensity several minutes after contrast application (delayed enhancement technique) allows the sensitive and accurate detection of myocardial damage (Fig. 1), which makes CMR the state of the art technique for scar detection (Curtin, 2009).

Coronary magnetic resonance angiography (MRA) has recently improved, but yields a spatial resolution that is currently still inferior to CTA. CMR examinations under ergometric or pharmacologic stress utilise contrast enhanced myocardial perfusion imaging or classic regional wall motion analysis (Nandalur, 2007). Magnetic saturation of the myocardium in a line or grid pattern introduces detectable tissue markers that can be used to quantify myocardial motion and deformation objectively and with good accuracy (tagging). However, the limited temporal resolution of CMR data sets allows no accurate interrogation of fast (e.g. diastolic) events. Analysis of tagging data is tedious, which reserves this technique for research purposes while clinical wall motion assessment relies on the trained eye of the reader.

Fusion of 3D image data sets from either MRI or CT with fluoroscopy data can be used to guide electrical mapping and ablation during electrophysiological studies (Ector 2008). A future real-time CMR guidance of electrophysiological procedures appears possible (Nazarian 2009). The use of CMR is limited in the presence of metal implants and implanted devices. Furthermore, the advantages of this technique are in part balanced by high costs, immobility and the need for time-consuming offline analysis.

Echocardiography

In clinical cardiology, echocardiography is the standard tool for evaluating morphology and function of the heart and the great vessels. Diagnostic and prognostic value has been extensively studied over the years, making it the first line modality in noninvasive cardiovascular imaging. Echocardiography is relatively inexpensive, widely available, portable, fast and accurate. It is therefore integrated in the management guidelines of most cardiovascular disorders. Compared to other modalities, ultrasonic imaging has an excellent temporal resolution. Images are, to a great extent, visually analysed, making diagnostic results observer dependent. Recent developments focus mainly on new ways of quantifying particularly myocardial function and introducing 3D imaging to clinical echocardiography.

Myocardial deformation imaging

Assessment of regional and global myocardial function is one of the main goals of almost any echocardiographic examination. Traditional visual interpretation requires a long learning curve and makes results observer dependent. During the last decade, Tissue Doppler Imaging (TDI) and TDI

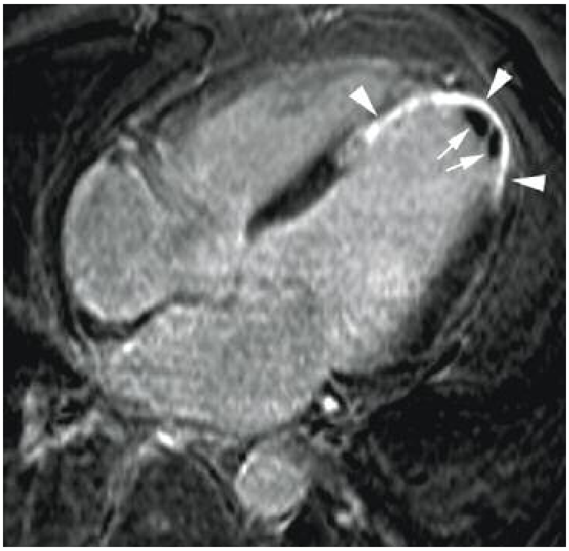

Figure 1.

Delayed enhancement cardiac MRI in a patient with an old myocardial infarction showing scar (arrow heads) and thrombi in the left ventricle (arrows). Courtesy Prof. Dr. J. Bogaert, Catholic University Leuven.

based myocardial deformation assessment emerged as a helpful technique for regional and global function assessment (Fig. 2). Doppler based velocity and deformation imaging have been validated and extensively studied in a variety of cardiac pathologies. They proved to be of particular advantage in the assessment of LV diastolic function, regional dysfunction and LV dyssynchrony.

As the one-dimensional approach of the technique makes it susceptible to misalignment between the ultrasound beam and the motion/deformation direction to be investigated, speckle tracking methods (Fig. 3) were developed as an appealing alternative by different vendors. Speckle tracking is

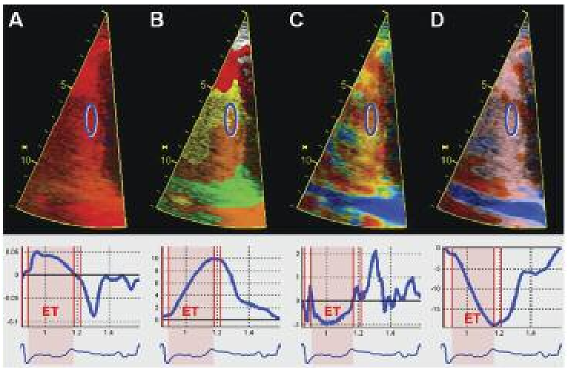

Figure 2.

Tissue Doppler Imaging. Typical velocity (A), displacement (B), strain rate (C) and strain (D) curves from the mid segment of the inferior wall in a normal subject. The red lines represent valves openings and closures; ET ejection time.

based on the frame-by-frame tracking of image features of the myocardial texture which allows a two-dimensional estimate of myocardial motion and deformation. Applications of the speckle tracking techniques are comparable to those of Doppler measurements. The advantage of an easier and faster post-processing together with the option to generate a plethora of derived parameters is compensated by the somewhat lower temporal resolution of tracking techniques, the difficulty to detect tracking errors and a higher dependence on image quality.

Particle imaging velocimetry

Very recently, tracking techniques have also been applied to contrast enhanced intracavitary blood flow. According

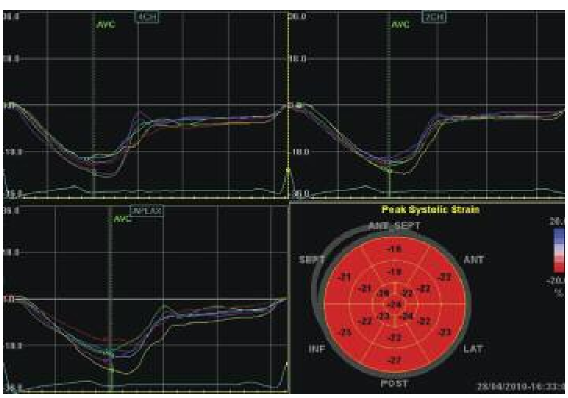

Figure 3.

Bulls eye representation of segmental systolic strain by speckle tracking in a normal person

to data in LV models (Pedrizzetti 2005, Domenichini 2005), first studies show significant changes in intracardiac flow patterns in pathology, e.g. dilative cardiomyopathy (Hong 2008) or mitral valve prosthesis (Faludi 2010).

Contrast echocardiography

One of the promises of the last decade was echocardiographic myocardial perfusion imaging using echo-contrast agents. However, while contrast echocardiography has proven to be a valuable clinical tool for endocardial delineation in difficult to image patients, accurate echocardiographic perfusion estimates still remain a challenge and are not performed clinically. Likewise, the anticipated option of targeted drug delivery through contrast agents (Bekeredjian 2005) has not yet left its pre-clinical state.

Three dimensional echocardiography

Advances in transducer technology have led to 3D transducers with matrix arrays with more than 3,000 elements capable of acquiring echo data from a pyramidal 3D volume. These developments have been facilitated by further advances in circuit miniaturisation, which allowed placing the entire beam former within the handle of the transducer (Bhan 2010). The latest generations of scanners allow the acquisition of a full volume dataset in one cardiac cycle, precluding the need for multiple ECG gated subvolume acquisition followed by online reconstruction with around 20 volumes per second.

The added clinical value of transthoracic 3D echocardiography remains to be proven. The current quality of reconstructed image planes is still inferior to regular images and often insufficient to allow the visual assessment of cardiac morphology. The clearest clinical advantages lies in the quantification of absolute cardiac chamber volumes, mass and ejection fraction, the accuracy and reproducibility of which is now comparable to that of MRI. Furthermore, the 3D approach allows for the first time an accurate echocardiographic assessment of the complex geometry of the right ventricle (Niemann 2007). The recent incorporation of real-time 3DE technology in a transoesophageal probe allows for the first time to image complex 3D structures like mitral valve leaflets in detail with good quality (Sugeng 2008). Its feasibility for more anterior structures like the aortic and tricuspid valves is much lower (Sugeng 2008).

The largest potential of 3D TEE appears to lie in the guidance of percutaneous treatment procedures such as atrial septal defect closures, stented valve implantations and electrophysiological ablation interventions (Budts 2008, Lodato 2009, Balzer 2008). The potential and value of 3D

AUTHOR GUIDELINES

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Article texts must contain:

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- Affiliation: department and institution, city and country;
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- 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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Thank you,
The IMAGING Management Editorial Team

imaging based myocardial function assessment remains to be investigated.

Hand-carried ultrasound scanners

Since a few months, hand-held ultrasound scanners are available from two major vendors. They are designed for triage or focus scans and have currently a limited functionality. First studies, however, have already shown the advantageous use of these devices in a clinical setting (Egan 2008). Further studies are needed to clarify the role of these devices in clinical routine.

Summary

Cardiac noninvasive imaging is a field that benefits enormously from the fast evolution of technology. Even established classical imaging modalities have been further developed and constantly refined over the past years. While the role of nuclear imaging seems to reach a plateau and the rise of CCT appears to slow down, MRI and echocardiography remain the workhorses of cardiologic imaging and gain more importance in clinical routine. In several clinical settings, different imaging modalities complement each other, emphasising the importance of cardiologists being trained and actively involved in all cardiac imaging modalities.

This became the driving force for a development towards a cardiologic imaging sub-speciality in many European countries. Only this will allow to combine the knowledge about strengths and weaknesses of the different advanced modalities with the specific cardiologic background which is needed to appropriately interpret the findings and to yield an optimal clinical value for the patient. ■

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

TOWARDS IMPROVING CARDIAC ANALYSIS CAPABILITIES

The Role of Multi-view Fusion 3D Echocardiography

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Cardiovascular disease remains the leading cause of deaths in Europe. It is also the primary cause of disease burden on the healthcare sector. To reduce the mortality rate, it is vital to diagnose cardiac diseases early and follow up their treatment. Two-dimensional (2D) echocardiography is the frontline imaging modality for noninvasive cardiac functional analysis. However, 2D echocardiography suffers from inherent shortcomings since it portrays a 2D representation of the complex shaped three-dimensional (3D) structures of the heart, which additionally has complex twisting motion. Therefore, functional analysis from 2D echocardiography is performed under geometrical assumptions, influencing its clinical value. Consequently, this brings significant subjectivity and variability to the analysis procedure. Real-time 3D echocardiography (RT3DE) is increasingly seen as an additional modality choice, since it captures the 3D shape and motion of the heart and offers improved accuracy and reproducibility for measuring important clinical parameters (e.g., volume and ejection fraction). However, the uptake of RT3DE in cardiology clinics has been slow, which can be attributed to two main factors. Firstly, often the images from RT3DE scanners suffer from lower quality, including lower temporal resolution, when compared to the state-of-the art 2D images. Moreover, RT3DE has limited field-of-view (FOV) and missing anatomical information.

Secondly, wider use of RT3DE is dependent upon the accurate and easy to perform delineation of the left ventricle (LV) boundaries. Automated LV delineation and tracking throughout the cardiac cycle from RT3DE is a non-trivial problem, while manual analysis is tedious, time-consuming and highly operator dependent. In summary, it is expected that improvements in RT3DE image quality and introduction of reliable and robust automated analysis methods will significantly influence much wider application of this very promising imaging modality in cardiology clinics worldwide.

Multi-view Fusion 3D Echocardiography

In this article, we present an overview of multi-view fusion 3D echocardiography as a solution to overcome the aforementioned limitations of RT3DE. Firstly, multiple RT3DE images having complementary information are acquired from different probe positions. Subsequently, these multiple RT3DE images are aligned and fused together in order to improve imaging of salient structures of the heart. The resultant image is defined as multi-view fused image, while each individual RT3DE image is called single view image. The multi-view fusion improves the image quality, increases anatomical information, and enlarges the captured field of view. In addition, it makes easier and more accurate automated analysis possible, because of the increased anatomical information in the image. This feature will potentially lead towards improving the capabilities of cardiac disease diagnosis.

How Does it Work?

An image acquisition protocol acquires multiple images of the heart from different trans thoracic apical view positions of the RT3DE probe. Particular care was exercised in designing this special protocol, such that the acquired multiple single view images have complementary anatomical information, while covering a wider FOV. The first image was acquired by placing the probe near the LV apex. More images were acquired by moving the probe laterally, medially, and one intercostal space above and below the first apical position. The probe movement was adjusted between multiple acquisitions by the sonographer to include all salient structures of the heart within wider FOV.

Due to freehand movement of the probe between multiple acquisitions, the multiple single view images differ between each other. However, the images have plenty of overlap owing to the small gap between probe positions. This overlap is used to determine the similarity between multiple single view images and transform them accordingly. Normalised cross correlation is used to measure the similarity between images. Keeping the first single view image (acquired from near the apex) fixed, other single view images are transformed for translation and rotation to bring them into correspondence with the fixed image.

Once the multiple images are aligned, the images are fused to blend together the complementary information from all the single view images. For this purpose, a method was developed that preserves the salient structures from each of the individual single view image. The method is based on a signal processing technique called the wavelet transform, which enables the decomposition of the image into signal and noise components that are then fused accordingly. The developed method is simple, efficient, fast, and has the ability to fuse any number of single view images. Figure 1 presents an example showing the multiple single view images and the result of multi-view fusion.

The results demonstrate that multi-view fusion brings considerable improvements in image quality and anatomical information present in the image. For the work in this article, full volume ECG gated RT3DE volumetric images were acquired from a Philips iE33 echocardiography scan-

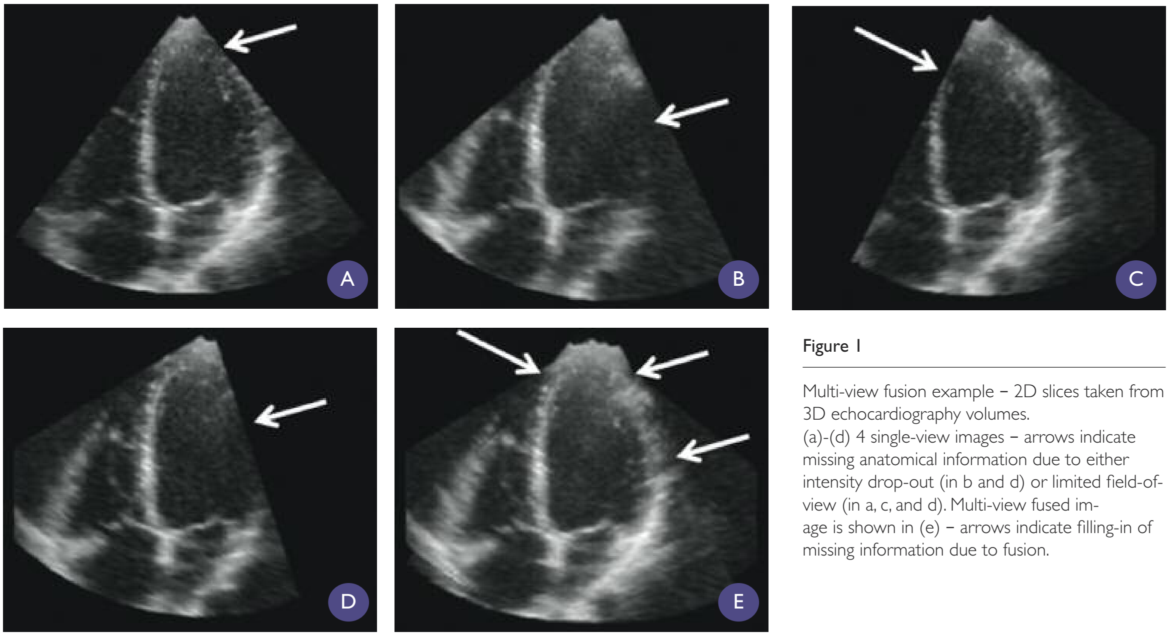


Figure 1

Multi-view fusion example – 2D slices taken from 3D echocardiography volumes.
(a)-(d) 4 single-view images – arrows indicate missing anatomical information due to either intensity drop-out (in b and d) or limited field-of-view (in a, c, and d). Multi-view fused image is shown in (e) – arrows indicate filling-in of missing information due to fusion.

ner using X3-1 matrix array probe. In principle, this technique should also work on images acquired using matrix array probes from other vendor (e.g., GE, Siemens, and Toshiba).

Improving Anatomical Structure Information

The anatomical structure information is defined here as inner (endocardial) and outer (epicardial) boundaries of the myocardial muscle. This kind of structural information is vital for LV delineation (for the measurement of volume, ejection fraction, and cardiac mass) and LV tracking (for wall motion analysis). For each subject, the amount of structural information is computed for single view images and compared against the multi-view fused image. Studying a database of 36 volunteers, it was found that multi-view fusion 3D echo cardiography images preserve complementary salient structures from the single view images and have on average 12 percent more structural information compared to standard single view RT3DE images (Rajpoot et al., 2009a).

Improving Automated Analysis

To assess the completeness of anatomical information and its impact on automated analysis, a semi automatic image-driven LV endocardial delineation algorithm was developed. For each subject, this algorithm was evaluated on single view and the multi-view fused image. For reference, an expert echocardiographer identified the endocardial borders in end-diastolic (ED) and end-systolic (ES) frames of each volume sequence. For each case the LV delineation algorithm was applied to the ED and ES frames of both the single view and the multi-view fused images. Successful convergence of the LV delineation method, to reach near the true LV endocardial border border delineated by experienced cardiologist), was observed and quantified (Rajpoot et al., 2009b).

For single view images, the LV delineation algorithm failed 88.2 percent of times at ED and 58.8 percent of times at ES. In comparison, for the multi-view fused images, the algorithm failed only 23.5 percent of times at ED and 2.9 percent of times at ES. Figure 2 shows an example LV delineation result on single view and multi-view fused images. The results indicate that the relatively fewer failures on multi-view fused images are an outcome of improvement in image quality and completeness of anatomical information.

Improving Image Quality

Single view and multi-view images were further assessed for completeness of anatomical information and for suitability to assess myocardial function (Szmigielski et al., 2009; Szmigielski et al., 2010). Two experienced echocardiographers selected the short-axis (SAX) and long axis (LAX) views from the 3D images and reviewed a total of 512 cardiac segments each for single view RT3DE and multi-view fused RT3DE images. Each segment was scored into one of the four categories: good quality, intermediate quality, poor quality, and out of sector. The results show that, due to multi-view fusion, the percentage point increase in good quality segments was 37.1 percent. The percentage point decrease in intermediate quality segments was 12.7 percent. The percentage point decrease in poor quality segments was 19.7 percent, while the percentage point decrease in out of sector segments was 4.7 percent.

Thus, the results show that fusion brings a considerable increase in the number of good quality segments and a notable decrease in the number of intermediate, poor quality, and out of sector segments. This demonstrates that multi-view fusion improves complementary salient structures from the single view images.

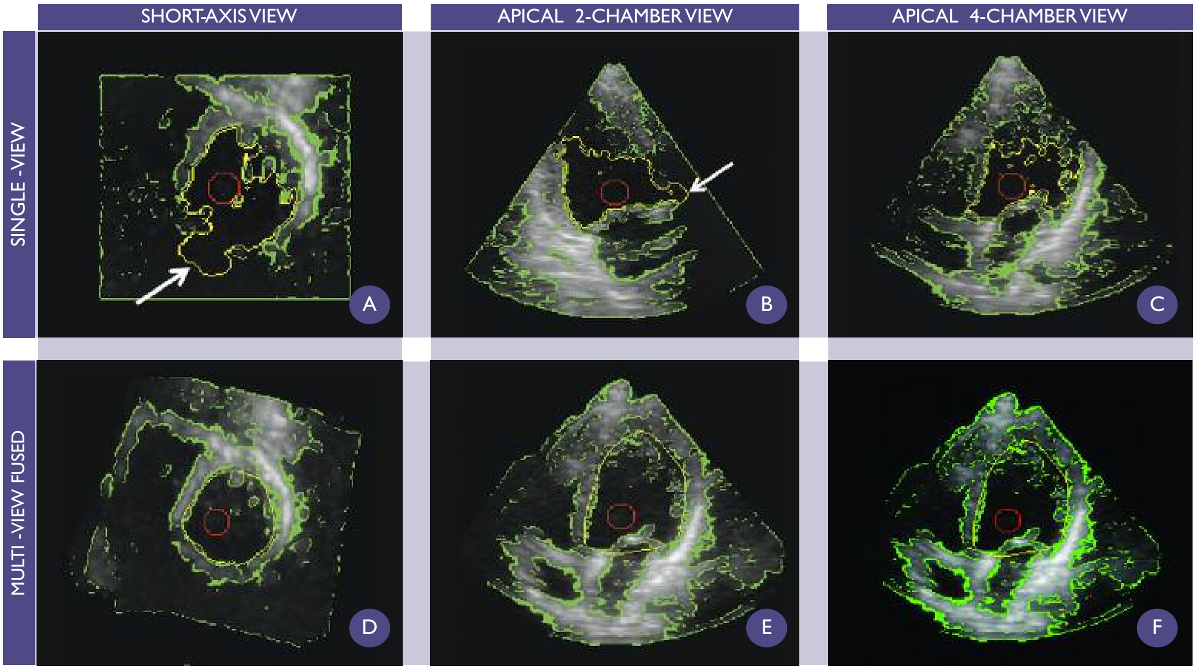
Conclusions

Due to its ability to offer more accurate and complete cardiac analysis, multi-view fusion 3D echocardiography can play an important role in the future. Furthermore, this concept of multi-view fusion can certainly be useful in other areas such as stress 3D echocardiography, transoesophageal 3D echocardiography, and foetal 3D echocardiography.

Multi-view fusion 3D echocardiography results in a striking improvement in image quality. For clinical application, the current offline fusion process needs to be streamlined. In principle, it is possible to implement the fusion process into the echocardiography scanner and perform fusion in the background while scanning. It is very likely that multi-view fusion will reduce false echocardiography diagnosis and provide better monitoring of heart disease. However, this needs to be proven in major clinical trials including stress echocardiography, contrast and 3D echocardiography. The trial studies will show how much better outcome can be achieved by the improved image quality and whether this is cost effective in comparison to other imaging modalities such as magnetic resonance imaging. ■

A bibliography for this article is available on request to the Managing Editor at editorial@imagingmanagement.org

Figure 2: Segmentation results on standard viewing planes of an ED frame. *Red* — automatic initialization of the delineation algorithm. *Green* — edge-indicator features to guide the algorithm. *Yellow* — delineation result. Arrows indicate failure of the delineation algorithm due to leakage (a and b).



Management In Radiology

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Annual Scientific Meeting

October 14–15, 2010, Mallorca/ES

Thursday, October 14

08.30–10.30 **Workflow and Image Management**
Chairman: **Peter Mildenberger**

08.30–09.00 Image compression issues
David Koff

09.00–09.30 How long should we keep our images?
Laurence Sutton

09.30–10.00 Structured reporting
Mansoor Fatehi

10.00–10.30 eLearning self assessment, on-line resources
Peter Pokieser

10.30–10.50 **Coffee Break**

10.50–11.05 **Radiology in Network - from theory to action**
Henrik Agrell

11.05–11.35 **How to win every argument!**
Stephen Baker

11.35–13.05 **Regrettable Management Decisions Forum**
Chairman: **Philip Gishen**

"The management decision I most regret and why"
Series of short presentations with audience debate

Stephen Baker, Michel Claudon, Luis Donoso, Jarl Jakobsen, José Vilar, Jan Schillebeeckx

13.05–14.00 **Lunch Break**

14.00–15.10 **Safety Issues**
Chairman: **Michel Claudon**

14.00–14.20 Advice on Consultant Radiologist Upskilling
Salman Zaman

14.20–14.50 How to improve process optimisation in an imaging department
Hans-Peter Busch

14.50–15.10 Safety lessons for Radiologists from Air Traffic Controllers
Richard Fitzgerald

15.10–15.30 **Coffee Break**

15.30–17.00 **Audit Session**
Chairman: **Jane Adam**

15.30–16.00 Renewing doctors' licence to practice. How do we know if we are good enough?
Jane Adam

16.00–16.30 Clinical Audit - ESR perspective
Maurizio Centonze

16.30–17.00 Audit Live
Sue Barter

19.30 **Evening Event**

Friday, October 15

09.00–10.30 **Management of Radiation Protection**
Chairman: **Peter Vock**

09.00–09.30 Management of radiation protection in fluoroscopy-guided imaging: responsibilities of the department chairman, the radiologists and the radiographer
Reinhard Loose

09.30–10.00 How do the ICRP, the EC, and the national authorities impact on the duties of the chairman of a department of radiology?
Madan Rehani

10.00–10.30 Imaging in pregnancy: how to define the policy of your department of radiology
Peter Vock

10.30–11.00 **Coffee Break**

11.00–12.30 **Teleradiology Session**
Chairman: **Davide Caramella**

11.00–11.30 Update on the legal issues of teleradiology
Jan Schillebeeckx

11.30–12.00 From classic practice to new trends in teleradiology
José Albillos

12.00–12.30 The position of the ESR on teleradiology
Luis Donoso

12.30–13.30 **Lunch Break**

13.30–15.00 **SEGECA (Sección de Gestión y Calidad de la SERAM) Session dedicated to the Spanish Management Society**

13.30–14.00 The Spanish Society of Management and Quality in Radiology: Brief summary of this society and its major accomplishments
Pablo Valdés, Isabel Gonzalez

14.00–14.30 The state of IT in Spanish Radiology: Several interesting experiences with IT in Spain
José Albillos

14.30–15.00 Outsourcing of MRI in the Valencia Community. The experience after 15 years: A very critical approach to the outsourcing of technology probably useful for those areas that are thinking about this solution
José Vilar, Isabel Gonzalez

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MODEL	SOMATOM Definition Flash	SOMATOM Definition AS+
WHERE MARKETED	Worldwide	Worldwide
FDA CLEARANCE	Yes	Yes
CE MARK (MDD)	Yes	Yes
TYPE	Dual Source / Multislice	Multislice
Number of slices acquired simultaneously	2 x 128	128
Perfusion imaging	Yes	Yes
Extended coverage perfusion	Whole organ perfusion and dynamic CTA acquisition of up to 48 cm	Whole organ perfusion and dynamic CTA acquisition of up to 27 cm
Coverage, cm	15	14
Dual-energy acquisition	Yes, 12 FDA approved applications	Not specified
Dual-energy technology description	Dual source dual energy	NA
Impact on radiation dose	Dose neutral	NA
RADIATION DOSE		
Dose-modulation technique	CARE Dose4D	CARE Dose4D
Dynamic z-collimation	Standard, Adaptive Dose Shield	Standard, Adaptive Dose Shield
Iterative reconstruction	Yes, IRIS	Yes, IRIS
Pediatric-specific dose control	Flash Spiral and special pediatric protocols included	Special pediatric protocols included
IMAGE RECONSTRUCTION		
Computer CPU	2 x Xeon 3.0 GHz processor	2 x Xeon 3.0 GHz processor
Scan FOVs, cm	50; Yes 78 extended FOV	50; Yes 78 extended FOV
Reconstruction matrices	512 x 512	512 x 512
Maximum reconstruction rate, (512 x 512), ips	40	40
Per slice, sec	40 images/sec	40 images/sec
Real-time partial image reconstruction	Real-time display	Real-time display
SYSTEM INTEGRATION		
DICOM	Yes	Yes
CT image storage SCU/SCP	Yes	Yes
Enhanced CT storage SCU/SCP	Yes	Yes
Query/retrieve SCU and SCP	Yes	Yes
Storage commitment SCU	Yes	Yes
Modality performed procedure step SCU	Yes	Yes
IHE profiles supported	Yes	Yes
OTHER SPECIFICATIONS	Adaptive Dose Shield, CARE Dose4D; Selective Photon Shield; Adaptive Signal Boost; Adaptive 3D Intervention; CARE Bolus; syngo InSpace4D; syngo Fly Through; syngo Dental; syngo Pulmo; HeartView DSCT; syngo Circulation; syngo Cardio BestPhase; syngo InSpace4D Advanced Vessel Analysis; syngo Calcium Scoring; Adaptive 4D Spiral, 4D Noise Reduction, syngo Neuro Perfusion; Neuro BestContrast, syngo Body Perfusion; syngo Image Fusion; syngo LungCARE; syngo LungCARE with Nodule Enhanced Viewing (NEV); syngo Colonography; syngo Colonography with Polyp Enhanced Viewing (PEV); z-UHR, UHR; SureView; z-sharp	Adaptive Dose Shield, CARE Dose4D; Adaptive Signal Boost; Adaptive 3D Intervention; CARE Bolus; syngo InSpace4D; syngo Fly Through; syngo Dental; syngo Osteo; syngo Pulmo; HeartView; syngo Circulation; syngo Cardio BestPhase; syngo InSpace4D Advanced Vessel Analysis; syngo Calcium Scoring; Adaptive 4D Spiral, 4D Noise Reduction, syngo Neuro Perfusion; Neuro BestContrast, syngo Body Perfusion; syngo Image Fusion; syngo LungCARE; syngo LungCARE with Nodule Enhanced Viewing (NEV); syngo Colonography; syngo Colonography with Polyp Enhanced Viewing (PEV); z-UHR, UHR; SureView; z-sharp
LAST UPDATED	September 2010	September 2010

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	SOMATOM Definition AS	SOMATOM Emotion 16	SOMATOM Emotion 6	SOMATOM Spirit
	Worldwide	Worldwide	Worldwide	Worldwide
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
	Multislice	Multislice	Multislice	Multislice
	20, 40 or 64	16	6	2
	Yes	Yes	Yes	Yes
	Yes	Not specified	Not specified	Not specified
	7	1.92	1.8	1.0
	Not specified	NA	NA	NA
	NA	NA	NA	NA
	NA	NA	NA	NA
	CARE Dose4D	CARE Dose4D	CARE Dose4D	CARE Dose4D
	Standard, Adaptive Dose Shield			
	Yes, IRIS	NA	NA	NA
	Special pediatric protocols included	Special pediatric protocols included	Special pediatric protocols included	Special pediatric protocols included
	2 x Xeon 3.0 GHz processor	Xeon E5540 Quad Core HT 2,53 GHz	Xeon E5540 Quad Core HT 2,53 GHz	Xeon E5540 Quad Core HT 2.53 GHz
	50; Yes 78 extended FOV	50; Yes 70	50; Yes 70	50; Yes 70
	512 x 512	512 x 512	512 x 512	512 x 512
	20 (20 slice configuration) 40 (40, 64 Excel, 64 slice conf.)	up to 16	Up to 8	Up to 5
	40 images/sec	0.0625	0.125	0.2
	Real-time display	Real-time display	Real-time display	Real-time display
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes
	Adaptive Dose Shield, CARE Dose4D; Adaptive Signal Boost; Adaptive 3D Intervention; CARE Bolus; syngo InSpace4D; syngo Fly Through; syngo Dental; syngo Osteo; syngo Pulmo; HeartView; syngo Circulation; syngo Cardio BestPhase; syngo InSpace4D Advanced Vessel Analysis; syngo Calcium Scoring; Adaptive 4D Spiral, 4D Noise Reduction, syngo Neuro Perfusion; Neuro BestContrast, syngo Body Perfusion; syngo Image Fusion; syngo LungCARE; syngo LungCARE with Nodule Enhanced Viewing (NEV); syngo Colonography; syngo Colonography with Polyp Enhanced Viewing (PEV); z-UHR, UHR; SureView; z-sharp	Adaptive Dose Shield, CARE Dose4D; CARE Vision CT with HandCARE; CARE Bolus; syngo InSpace4D; syngo Fly Through; syngo Dental; syngo Osteo; syngo Pulmo; HeartView; syngo Circulation; syngo InSpace4D Advanced Vessel Analysis; syngo Calcium Scoring; syngo Neuro Perfusion; syngo Neuro DSA; syngo Body Perfusion; syngo Image Fusion; syngo LungCARE; syngo LungCARE with Nodule Enhanced Viewing (NEV); syngo CT Oncology; syngo Colonography; syngo Colonography with Polyp Enhanced Viewing (PEV); Respiratory gating and triggering CT; SureView	Adaptive Dose Shield, CARE Dose4D; CARE Vision CT with HandCARE; CARE Bolus; syngo InSpace4D; syngo Fly Through; syngo Dental; syngo Osteo; syngo Pulmo; HeartView; syngo Circulation; syngo InSpace4D Advanced Vessel Analysis; syngo Calcium Scoring; syngo Neuro Perfusion; syngo Neuro DSA; syngo Body Perfusion; syngo Image Fusion; syngo LungCARE; syngo LungCARE with Nodule Enhanced Viewing (NEV); syngo CT Oncology; syngo Colonography; syngo Colonography with Polyp Enhanced Viewing (PEV); Respiratory gating and triggering CT; SureView	SureView; CARE Dose4D; CARE Bolus CT; syngo Fly Through; syngo Dental CT; syngo Osteo CT; syngo Neuro Perfusion CT; syngo Body Perfusion CT; syngo VRT; syngo Pulmo CT; syngo 3D Bone Removal
	September 2010	September 2010	September 2010	September 2010

MODEL	Discovery CT750 HD	LightSpeed VCT	Optima CT660
WHERE MARKETED	World wide	World wide	World wide
FDA CLEARANCE	Yes	Yes	wip
CE MARK (MDD)	Yes	Yes	Yes
TYPE	Multislice High Definition Low dose	Multislice Low dose	Multislice Low dose
Number of slices acquired simultaneously	128sl from 64 channel & 40 mm Gemstone detector	128sl from 64 channel & 40 mm detector	128sl from 64 channel & 40 mm detector
Perfusion imaging	Yes	Yes	Yes
Extended coverage perfusion	Yes	Yes	Yes
Coverage, cm	up to 31,5 cm	up to 31,5 cm	up to 31,5 cm
Dual-energy acquisition	FDA Approved. 14 applications with 2 families: - Tissue Characterization in emergency, oncology, neurology, muskuloskeletal, etc… - IQ improvement: brain contrast optimization, beam hardening correction, metal artifact correction in vascular surgery, orthopedics, oncology, etc...)	N/A	N/A
Dual-energy technology description	Gemstone UltraFast KV Switching, 0.5 ms temporal resolution, 50 cm FOV, Raw data Multi Material Decomposition (up to 8) & Monochromatic images from 40 to 140 Kev & Metal Artifact Correction	N/A	N/A
Impact on Radiation dose	No dose penalty	N/A	N/A
RADIATION DOSE	OptiDose	OptiDose	OptiDose
Dose-modulation technique	Volara DAS, OptiDose, Color Coding for Kids, 3-D dose modulation, ECG dose modulation, beam tracking, short geometry	Volara DAS, OptiDose, Color Coding for Kids, 3-D dose modulation, ECG dose modulation, beam tracking, short geometry	Volara DAS, OptiDose, Color Coding for Kids, 3-D dose modulation, ECG dose modulation, beam tracking, short geometry
Dynamic z-collimation	Dynamic Z-Axis tracking	Dynamic Z-Axis tracking	N/A
Iterative reconstruction	FDA Approved. ASiR Raw data based reconstruction with advanced noise modeling. Reconstruction unit designed to have seamless workflow.	FDA Approved. ASiR Raw data based reconstruction with advanced noise modeling. Reconstruction unit designed to have seamless workflow.	FDA Approved, ASiR Raw data based reconstruction with advanced noise modeling. Reconstruction unit designed to have seamless workflow.
Pediatric-specific dose control	Color Coding for Kids & FeatherLight Application Protocols.	Color Coding for Kids & FeatherLight Application Protocols.	Color Coding for Kids & FeatherLight Application Protocols.
IMAGE RECONSTRUCTION			
Computer CPU	Open architecture/Linux	Open architecture/Linux	Open architecture/Linux
Scan FOVs, cm	25, 50	25, 50	25, 50
Reconstruction matrices	512 x 512	512 x 512	512 x 512
Maximum reconstruction rate, (512 x 512), ips	Up to 35 frames/sec	Up to 35 frames/sec	Up to 16 frames/sec
Per slice, sec	N/A	N/A	N/A
Real-time partial image reconstruction	Yes	Yes	N/A
SYSTEM INTEGRATION			
DICOM	As defined in DICOM Conformance Statement	As defined in DICOM Conformance Statement	As defined in DICOM Conformance Statement
CT image storage SCU/SCP	Yes	Yes	Yes
Enhanced CT storage SCU/SCP	No	No	No
Query/retrieve SCU and SCP	Yes	Yes	Yes
Storage commitment SCU	Yes	Yes	Yes
Modality performed procedure step SCU	Yes	Yes	Yes
IHE profiles supported	Yes	Yes	Yes
OTHER SPECIFICATIONS	High Definition Gemstone imaging Chain, 230 micron resolution across Whole body, 500 slices dynamic imaging	High speed & efficiency imaging chain, high throughput, 500 slices dynamic imaging	60% energy saving with Energy saving mode, only 18 m2 requirement, 500 slices dynamic imaging, New ergonomic design with touch screen on gantry
LAST UPDATED	June 2010	September 2010	September 2010

GE Healthcare	GE Healthcare	GE Healthcare	GE Healthcare
BrightSpeed	**Brivo CT325**	**Discovery 590 RT**	**Optima 580 Series**
World wide	World wide	World wide	World wide
Yes	Yes	Yes	Yes
Yes	WIP	Yes	Yes
Multislice Low dose	Multislice	Wide bore RT multislicee	Wide bore RT multislicee
4/8/16 sl from 4/8/16 channel 20 mm detector	2 sl from 2 sl detector		8/16 sl from 8/16 channel detector
Yes	Yes	Yes	Yes
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
OptiDose	OptiDose	OptiDose	OptiDose
Volara DAS, OptiDose, Color Coding for Kids, 3-D dose modulation, ECG dose modulation, beam tracking, short geometry	Volara DAS, OptiDose, 3-D dose modulation,beam tracking, short geometry	Volara DAS, OptiDose, Color Coding for Kids, 3-D dose modulation, ECG dose modulation, beam tracking	Volara DAS, OptiDose, Color Coding for Kids, 3-D dose modulation,beam tracking
N/A	N	N/A	N/A
FDA Pending. ASiR Raw data based reconstruction with advanced noise modeling. Reconstruction unit designed to have seamless workflow.	N/A	FDA Pending. ASiR Raw data based reconstruction with advanced noise modeling. Reconstruction unit designed to have seamless workflow.	FDA Pending. ASiR Raw data based reconstruction with advanced noise modeling. Reconstruction unit designed to have seamless workflow.
Color Coding for Kids & FeatherLight Application Protocols.	Dedicated pediatric protocol & FeatherLight Application Protocols.	Color Coding for Kids & FeatherLight Application Protocols.	Color Coding for Kids & FeatherLight Application Protocols.
Open architecture/Linux	Open architecture/Linux	Open architecture/Linux	Open architecture/Linux
25, 50	25, 50	25, 50	25, 50
512 x 512	512 x 512	512 x 512	512 x 512
Up to 16 frames/sec	N/A	Up to 16 frames/sec	Up to 16 frames/sec
N/A		N/A	N/A
N/A	N/A	N/A	N/A
As defined in DICOM Conformance Statement	As defined in DICOM Conformance Statement	As defined in DICOM Conformance Statement	As defined in DICOM Conformance Statement
Yes	Yes	Yes	Yes
No	No	No	No
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
Fast (Up to 50 slices coverage speed with pitch booster)	Submillimeter CT, only 11.4 m2 requirement	High definition RT Simulation CT - ASiR included - Power and resolution optimized - TG66 table	Routine RT simulation CT - TG66 table - Upgradable platform on resolution, speed, power
March 2010	September 2010		

	PHILIPS	PHILIPS	PHILIPS	PHILIPS
MODEL	Brilliance iCT	Brilliance 64-Channel with Essence technology	Brilliance 16-slice	Brilliance Big Bore
WHERE MARKETED	Worldwide	Worldwide	Worldwide	Worldwide
FDA CLEARANCE	Yes	Yes	Yes	Yes
CE MARK (MDD)	Yes	Yes	Yes	Yes
TYPE	Multislice	Multislice	Multislice	Multislice
Number of slices acquired simultaneously	256	64	16	16
Perfusion imaging	Advanced brain perfusion and functional CT	Advanced brain perfusion and functional CT	Advanced brain perfusion and functional CT	Not specified
Extended coverage perfusion	Jog mode	Jog mode	Jog mode	Not specified
Coverage, cm	16	8	4.8	Not specified
Dual-energy acquisition	Dual Energy	NA	NA	NA
Dual-energy technology description	Dual KV acquisition with auto MA compensation	NA	NA	NA
Impact on Radiation dose	Auto kv/mAs adjustment	NA	NA	Not specified
RADIATION DOSE				
Dose-modulation technique	DoseRight ACS (automatic current selection), DoseRight D-DOM (rotational dose modulation), DoseRight Z-DOM (longitudinal dose modulation), IntelliBeam filters, wedge filters, Eclipse DoseRight collimator	DoseRight ACS (automatic current selection), DoseRight D-DOM (rotational dose modulation), DoseRight Z-DOM (longitudinal dose modulation)	DoseRight ACS (automatic current selection), DoseRight D-DOM (rotational dose modulation), DoseRight Z-DOM (longitudinal dose modulation)	DoseRight ACS (automatic current selection), DoseRight D-DOM (rotational dose modulation), DoseRight Z-DOM (longitudinal dose modulation)
Dynamic z-collimation	Yes	NA	NA	NA
Iterative reconstruction	iDose	iDose	NA	NA
Pediatric-specific dose control	Pediatric protocols	Pediatric protocols	Pediatric protocols	Pediatric protocols
IMAGE RECONSTRUCTION				
Computer CPU	Intel, Windows OS	Intel, Windows OS	Intel, Windows OS	Intel, Windows OS
Scan FOVs, cm	Up to 50	Up to 50	Up to 50	Up to 60
Reconstruction matrices	256 x 256, 512 x 512; 768 x 768, 1024 x 1024	256 x 256, 512 x 512; 768 x 768, 1024 x 1024	256 x 256, 512 x 512, 768 x 768, 1024 x 1024	256 x 256, 512 x 512, 768 x 768, 1024 x 1024
Maximum reconstruction rate, (512 x 512), ips	Not specified	Not specified	Not specified	Not specified
Per slice, sec	Up to 20 images/sec with 3-D cone beam	Up to 20 images/sec with 3-D cone beam	Up to 20 images/sec with 3-D cone beam	Up to 20 images/sec with 3-D cone beam
Real-time partial image reconstruction	Not specified	Not specified	Not specified	Not specified
SYSTEM INTEGRATION				
DICOM	Yes	Yes	Yes	Yes
CT image storage SCU/SCP	Yes	Not specified	Not specified	Not specified
Enhanced CT storage SCU/SCP	No	No	No	No
Query/retrieve SCU and SCP	Yes	Yes	Yes	Yes
Storage commitment SCU	Yes	Not specified	Not specified	Not specified
Modality performed procedure step SCU	Yes	Yes	Yes	Yes
IHE profiles supported	Yes	Yes	Yes	Yes
OTHER SPECIFICATIONS	Includes Essence technology, a synergy of X-ray tube, detector, and reconstruction feature.	Includes Essence technology, a synergy of X-ray tube, detector, and reconstruction features.	Spiral AutoStart, isotropic imaging, functional imaging (perfusion), dental CT, bone-mineral analysis (Q-BMAP), CT endoscopy, large volume coverage, and thin slice.	Spiral AutoStart, isotropic imaging, functional imaging (perfusion), dental CT, bone-mineral analysis (Q-BMAP), CT endoscopy.
LAST UPDATED	March 2008	September 2010	September 2010	March 2008

	Brilliance Big Bore Oncology Configuration	MX 16-slice	ECLOS16
	Worldwide	Worldwide	Asia, Europe, North America
	Yes	Yes	Yes
	Yes	Yes	Yes
	Multislice	Multislice	Multislice
	16	16	16
	Not specified	Advanced brain perfusion and functional CT, on Workstation	NA Yes
	Not specified	NA	NA
	Not specified	NA	NA
	NA	NA	NA
	NA	NA	
	Not specified	NA	
	DoseWise, DoseRight ACS (automatic current selection), DoseRight DOM (dynamic dose modulation)	DoseRight ACS (automatic current selection), DoseRight DOM (rotational and longitudinal dose modulation)	Adaptive mA, IntelliEC
	NA	NA	
	NA	NA	
	Not specified	Pediatric protocols	Pediatric protocols
	Intel, Windows OS	Intel, Windows OS	Dual CPU (proprietary Hitachi DSP boards)
	Up to 60	Up to 50	2-50, 1 mm steps
	256 x 256, 512 x 512; Yes 768 x 768, 1024 x 1024	512 x 512, 768 x 768, 1024 x 1024	512 x 512
	Not specified	Not specified	5 (20img/sec with Live Recon option)
	Up to 20 images/sec with 3-D cone beam	Up to 6 images/sec with 3-D cone beam	0.2
	Not specified	Not specified	Reconstruction concurrent with scanning
	Yes	Yes	Yes
	Not specified	No	Standard
	No	No	Yes
	Yes	Q/R SCU	Yes
	Not specified	Not specified	Yes
	Yes	Yes	Yes
	Yes	Not specified	Yes
	Spiral AutoStart, isotropic imaging, functional imaging (perfusion), dental CT, bone-mineral analysis (Q-BMAP), CT endoscopy.	Spiral AutoStart, isotropic imaging, functional imaging (perfusion), dental CT, bone-mineral analysis (Q-BMAP), CT endoscopy, large volume coverage, and thin slice.	None specified.
	March 2008	September 2010	March 2008

PATIENT SAFETY & MRI CONTRAST AGENTS

Part Two: Signs & Symptoms and What do Guidelines Say?

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NSF Signs & Symptoms

In some patients that go on to develop nephrogenic systemic fibrosis, localised non-progressive skin thickening and induration may be the only manifestation, though this can be particularly problematic if this interferes with dialysis shunt access. In more severe cases skin thickening adjacent to joints can lead to contractures and hence impaired mobility while in the most severe cases (a minority) the disease is relentlessly progressive and can be fatal. As yet there are no effective treatments though regression following improvement in renal function, particularly after transplantation is described and recently there is a report that the use of Imatinib mesilate (Gleevec) can be beneficial.

Newer reports based on larger series with case control analysis have better determined the risk of development of NSF as between 3 - 5 percent of patients in end-stage renal failure on dialysis exposed to GBCAs. These studies have also shown a form of dose-response relationship, i.e. those patients exposed to higher doses or repeat examinations were more likely to develop NSF. However, it should also be noted that of course this means that nearly 97% of these patients on renal replacement therapy do not develop clinical features of NSF, as such this is not clear causation but rather a strong association.

Further work finding of gadolinium retained in the skin biopsy specimens from NSF patients even many months after contrast exposure indicates a role for gadolinium in the pathogenesis of NSF. The transmetallation theory suggests that the gadolinium cation (Gd^{+++}) is exchanged from the GBCA chelate for other cations, perhaps promoted by disturbed acid-base balance along with the very prolonged time that these agents remain in the body in renal failure patients.

How the gadolinium then mediates the development of NSF is not clear but it is thought that circulating fibrocytes migrate to the extravascular space and initiate inappropriate collagen deposition resulting in the clinically manifest disease process. However, clearly the majority of patients in renal failure who have had GBCAs administered have not developed NSF and as yet the other factors that must additionally determine the development of this disease have to be elucidated.

Background to Guideline Creation

This knowledge is important when drawing up guidelines as we can only truly assess risk once causation is fully elucidated, in the meanwhile the following areas have fed into guideline creation:

Renal Failure – Renal failure is a requirement for the manifestation of this condition, but at just what level of renal impairment does the risk become a clinical problem? The vast majority of cases have occurred in patients with stage 5 chronic kidney disease (CKD) – i.e. effectively those at

The NSF Story

Reports were published in 2006 linking the use of GBCAs with the hitherto little known condition, nephrogenic systemic fibrosis (NSF) as first described by Dr Shawn Cowper in 2000 as a scleromyxoedema-like skin thickening in patients on dialysis, he initially called this nephrogenic fibrosing dermopathy (NFD). The cause, however, remained obscure despite intensive investigation and various theories were proposed but never proven. The condition was renamed nephrogenic systemic fibrosis once it was determined that the fibrosis not only affects the skin but also muscles including the diaphragm and heart along with other internal organs. A paper proposing a link to GBCAs was published by the Austrian nephrologist Thomas Grobner after he observed that the cohort of his patients with NSF had all at recently had contrast enhanced MRI studies, in this paper he stated that the contrast used was 'gadolinium DTPA', However, after later consultation with the radiologists involved this was retracted and a correction published as the agent implicated was gadolinium DTPA-BMA (gadodiamide). Since then other groups have corroborated this association finding an incidence of up to 5 percent in patients in severe renal failure administered gadolinium based contrast agents subsequently developing NSF. The second report was that of Marckmann & Thomsen from Copenhagen following which the FDA issued a warning in June 2006.

the stage of requiring dialysis or established on dialysis with an estimated glomerular filtration rate (eGFR) of less then 15 ml/min. While there have been a few cases with estimated GFRs greater than this they have all been in the context of acute renal injury where estimation of GFR using the formulae designed for chronic renal disease markedly underestimates the actual degree of renal impairment. Investigations looking into the occurrence of NSF in patients with stable less severe renal disease (CKD stage 3 moderate, eGFR of 30 - 59 ml/min/1.73m2 & CKD stage 4 severe 15 - 29 ml/min/1.73m2 have confirmed that this is a disease limited to those with established renal failure (CKD stage 5) and acute kidney injury scenarios. However, many of the current guidelines were developed before this had become entirely clear, hence the differences in the level of renal impairment thought to be a risk.

Dialysis – Does dialysis in relation to GBCA administration help? Currently the role of immediate post-MRI dialysis is uncertain, while there is little positive evidence that it can help to avert NSF it is theoretically attractive and the current ACR and CAR guidelines recommend its use. However, it is likely this dialysis really does need to be immediate, as NSF has certainly occurred in patients despite same day dialysis post-MRI. This is clearly only practicable where patients already have dialysis access in place prior to the MRI scan. Perhaps equally or more important is to have had the patient adequately dialysed prior to the administration of GBCAs as there certainly seems to be increasing evidence that poor dialysis prior to GBCA enhanced MRI is a risk factor but this has not been addressed in any of the guidelines.

Dose of Contrast Agent – How have guidelines approached the issue of GBCA dose? The doses associated with NSF in the published literature have mainly been in the 0.2 mmol/kg to 0.3 mmol/kg range (i.e. double and triple 'standard' dose) as often used for CE-MRA and cardiac MRI. The rise in NSF incidence does indeed parallel the use of higher doses in cardiac and vascular studies with very few reports of NSF following single/standard dose administration despite many administrations to patients at high risk of the agents most associated with development of NSF. However, the discussions regarding dose in the guidelines were not the most prominent aspects in the guidelines that originally emerged, though more recent updates have focussed more on this issue. Perhaps the most explicit is the statement in the RANZCR document -

- 'Use the minimum diagnostically adequate dose of gadolinium (there is some evidence for a "dose-risk" relationship)'
- The RCR guidelines state - 'Give the lowest dose possible to achieve a diagnostic examination'
- The EMEA states - 'Dose should be restricted to the minimum recommended dose in patients with severe kidney problems'
- ESUR - 'In all patients use the smallest amount of contrast medium necessary for a diagnostic result'
- The latest ACR guidance has this year also suggested using the lowest dose compatible with a diagnostic examination and avoiding high dose in at risk patients.

Which Agents are Linked to NSF?

Whether the various different GBCAs are more or less likely to predispose patients to NSF is another important issue. There is increasing evidence of differences between the available agents, particularly from pre-clinical work but the guidelines tackle this in different ways, partly through geographic concerns. For example the U.S. oriented guidelines deal with a market where there is a more limited choice with fewer cyclic agents available.

The large majority of reported cases have been with gadodiamide with fewer involving gadoversetamide and gadopentate dimeglumine - all linear chelates. There are no severe cases confirmed following sole administration of gadobenate dimeglumine (the linear chelate with the highest stability indices and 3 percent hepatobiliary excretion) and none to date with sole administration of any of the cyclic chelates gadoteridol, gadoterate meglumine or gadobutrol.

If transmetallation is an important step in the pathogenesis of NSF then the more stable agents should be safer. The European and Australasian guidelines took this on board with an approach assigning the ionic linear chelates gadodiamide, gadoversetamide and gadopentate dimeglumine a higher risk profile as compared to the cyclic chelates especially. More recently the ACR guidelines have also adopted an approach in the version 7 revision to their Manual on Contrast Media that divides the agents into three classes according to their association with unconfounded cases of NSF and volume of utlisation. In group 1 gadodiamide, gadoversetamide and gadopentate dimeglumine are recommended not to be used in high risk patients (eGFR < 30, end-stage renal disease on chronic dialysis and acute kidney injury).

The potential for hepatobiliary excretion of some of the agents may be a theoretical advantage for administration in patients with renal failure (but preserved hepatic function). As yet there is no clinical evidence to support this supposition though it is mentioned in the RANZCR document where regarding the factors affecting the choice of agent the following is stated – *'Use of agents which have significant biliary excretion, as well as (or instead of) renal excretion. However, there is little reported experience with this strategy'*

Certainly the formulation of the GBCA used appears to be important with the cyclic chelates that have highest stability constants generally deemed to be those with the lowest risk. Whether this issue has been incorporated into the various guidelines relates to the commercial environment in which the specific guidelines operate, specifically whether there is appropriate choice of licensed products.

Other Factors

We know that most patients in renal failure administered GBCAs even in high dose do not develop NSF hence other factors must contribute. However, they have not been elucidated and although there are suspicions regarding erythropoietin treatment, iron levels, phosphate binding therapies etc. none of these other features has been confirmed hence none has entered into any of the guidelines. The type of dialysis does seem to influence risk, in that peritoneal dialysis is the least efficient at clearing exogenously administered compounds and the RANZCR guidance specifically states – *'Avoid all gadolinium-based MRI contrast agents in patients receiving peritoneal dialysis (clearance of the agent in these patients is very slow; in one study, their measured risk of NSF was seven times higher than that of haemodialysis patients)'*

The converse of this question of course is whether there are protective factors against the development of NSF. This would be critically important as if a modifiable factor was found then protection could then be given to allow safer GBCA enhanced MRI studies when required.

Prior Research Essential

In practice, the implications are that those involved in imaging must know more about their patients prior to MRI scanning than has been the case up until now and guidelines help to promote this. For example, knowledge of renal functional status is most useful at the time of scan request prior to scheduling and this requires education of the referrer, more easily achieved with the backing of guidance that is perceived as credible and reflecting best practice from a respected professional body.

Where patients with severe renal impairment are considered for MRI with contrast then a judgment needs to be made as to whether the risks of GBCA use as we currently perceive them outweigh the risks of alternative imaging techniques. In vascular imaging the hazards of conventional arteriography with arterial puncture, ionising radiation and iodinated contrast media. If GBCA are to be used then the lowest dose feasible is currently advocated (such as half usual dose) and here GBCAs with increased specific relaxivity could be advantageous.

Conclusion

GBCAs remain extremely safe for the vast majority of patients and exams. Obviously with the intense research focus our knowledge will continue to evolve. Current guidelines have differences that reflect differing interpretations of the initial knowledge available in this field coloured by the local regulatory and commercial environments specific to the audiences they address though the markets are changing with increasing availability of the more stable linear and cyclic agents.

For example, this helps to explain the fact that until recently there has been less focus on the differences between linear and cyclic chelate GBCAs in the U.S. guidance where the choice of agents is relatively restricted compared to Europe. Thankfully, with the recent ACR guidance changes the U.S. and European guidelines are now much more comparable. The issue of a dose response similarly received little attention until recently and is not seen as a relevant issue in Japan where high dose techniques have traditionally not been used.

> "We know that most patients in renal failure administered GBCAs even in high dose do not develop NSF hence other factors must contribute."

Perhaps the most glaring omission from most of the guidelines is a balanced discussion of the relative risks of alternative imaging modalities or the risk of lack of appropriate investigation in order to put the guidance in context since alternative imaging strategies will also entail degrees of risk either directly (e.g. contrast nephropathy, ionising radiation) or indirectly through lower diagnostic accuracy. Obviously, due to their nature the detail of the various guidelines will always lag behind the improving scientific knowledge, hence it is in the interests of all that mechanisms are found to ensure regular update and revision to guidelines as and when new relevant knowledge becomes available. ■

A list of recommended reading is available on request to the Managing Editor at editorial@imagingmanagement.org


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

AN OVERVIEW OF THE CZECH SOCIETY OF RADIOLOGY

History & Activities of the Society

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History of the Czech Radiological Society

The Czech Radiological Society of the "J. E. Purkyne" Czech Medical Association was founded on July 28, 1924 in Prague under the name of the Czechoslovak Society for Röntgenology and Radiology. At the initiation of Pilsen radiologist Dr. Antonin Čipera, and founder Dr. Rudolf Jedlicka, the first Czechoslovak radiological congress was organised in 1926 to mark the 30th anniversary of Roentgen's discovery.

Until 1948, the society sought recognition for radiology as an independent field from the outside world. After the Second World War the Czech Radiological Society focused on educational activities at pre- and postgraduate educational levels, on professional development and on scientific endeavours. In 1953, after the establishment of the Institute for Postgraduate Education, a separate x-ray department was constructed.

The Velvet Revolution of November 1989 opened a new chapter in Czech radiology. Gradually, it became possible for Czech radiologists to renew contacts with academics at centres abroad and to establish new contacts, which greatly helped in the exchange of information and experiences. Technology and equipment in workplaces began to be modernised as well, and centres were equipped with state-of-the-art systems. After the "Velvet Divorce" of Czechoslovakia in 1994, Czech radiology developed independently of its sister society in Slovakia.

Member Services

The radiological society provides its members with educational opportunities, promotes radiologic technology as a career, and monitors relevant legislation that affects the profession. It is also responsible for setting standards of practice for the radiologic profession. Members of Czech Society of Radiology include the medical personnel who perform diagnostic imaging examinations and also those who deliver radiation therapy treatments. They may specialise in a specific area of radiologic technology, such as CT, mammography, MRI or nuclear medicine. The radiological society committee is made up of the president, vice-president, scientific secretary and seven members.

CONTINUES ON P. 47 »

Fast Facts About Healthcare in the Czech Republic

The number of inhabitants of the Czech Republic is over 10.2 million*, of whom approximately 65 percent live in urban areas. There are currently more than 25,000 (mainly private) healthcare providers. Diseases of the circulatory system are the most frequent cause of death. From the early 1990s, considerable changes were made in the healthcare system. A complete reconstruction of the healthcare facilities and authorities was achieved and a health insurance system created. There was an almost complete privatisation of primary healthcare. State administration at district level was abolished at the end of 2002. In certain cases, communities are the owners and operators of small hospitals.

Healthcare in the Czech Republic is provided primarily on the basis of statutory health insurance, currently provided by nine health insurance funds. The three main features of the healthcare system in the Czech Republic are as follows: social health insurance with universal membership, funded through contributions by individuals, employers and the State; diversity of provision, with mainly private ambulatory care providers and public hospitals which have contractual arrangements with the insurance fund; and joint negotiations by key players on coverage and reimbursement issues.

In 1992, the health insurance system was adopted as the principal means of financing healthcare. The General Health Insurance Fund (GHIF) and branch health insurance funds were established. There were up to 27 health insurance funds at one period in the mid-1990s; by 2000, the number decreased to nine. Both state and private healthcare facilities made contracts with health insurance funds, involving payment from the outset on a fee-for-service basis. For payment purposes, an extensive list of healthcare procedures was created. Not all of the reforms have been successful. Some were controversial and today the Czech healthcare system is facing a number of problems resulting from the process. One of these is overutilisation of services and another is the relatively low income of physicians. *(*as of 1 July 2002 source: World Health Organisation WHO)*

INTERVIEW: **RADIOLOGY IN THE CZECH REPUBLIC**

Providing a Quality Service on Limited Funding

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Please tell us how you came to work in medical imaging.

I come from a family of physicians. My father was a neurologist, my mother was a paediatrician and adolescent physician, my uncle was an ORL specialist, my aunt was a paediatrician and another aunt of mine was a gynaecologist. It was rather a given fact, then, that my future studies would be at the faculty of medicine. Along with the faculty of medicine I studied technology, which, among other things, directed my interest towards radiology, which I had already practiced as a student. Upon graduating in 1985, I started working at a radiology department. In 1986, after one year of military service, I started working at the radiology clinic at St. Anne's University Hospital Brno. In 2001, I became the head of that clinic. Since the beginning of my professional career I have been committed to abdominal and gastrointestinal radiology. In 1988, I performed the first enteroclysis in the Czech Republic. After 1989, I extended my area of interest to non-vascular interventions and oncological radiology, including interventional radiology. The radiology clinic at the Faculty Hospital Brno is now the leading department in these areas in the Czech Republic and Slovakia.

Are you involved professionally with international societies for radiology?

Yes, I am a member of several professional societies – ECR, RSNA, ARRS, CIRSE, ESGAR, SGR and others. I am also a representative of the Czech Radiology Society in some of these societies.

Please give us an overview of the department of radiology in which you work.

The University Hospital Brno (UHB) competes with University Hospital Motol in Prague for the position as the largest hospital in the Czech Republic. The UHB currently has four CT units and three for magnetic resonance. It is fully digitised and we have had PACS for the last 10 years. Our hospital performs a comprehensive range of radiology procedures, including radiology interventions, neuroradiology and mammography screening.

Our hospital has 2,280 beds. Each year it attends to some 38,000 patients and nearly 1,100,000 outpatients. In our hospital there are two separate radiology departments: the radiology clinic and the children's radiology department, the latter of which is located in a separate children's hospital that is organisationally part of UHB. At the radiology clinic, we attend to around 130,000 patients a year who undergo some 220,000 examinations.

Facility	Number of patients	Number of examinations
Angiography	704	1,610
Densitometry	1,176	2,406
Intervention	600	1,062
Magnetic resonance	3,829	5,899
Computed tomography	6,526	8,777
X-ray	44,428	69,944
Radioscopy	316	317
Ultrasound	10,375	23,850
	67,954	113,865

Table 1:
University Hospital Brno / Number of patients and examinations within a specified time period (1 Jan 2010 – 30 June 2010)

Are sufficient numbers of medical residents attracted to radiology in the Czech Republic?

There are around 1,500 radiologists in the Czech Republic, and every year some 30 radiologists receive their certifications. Preparation takes five years, which means that about 150 radiologists are in preparation at any given time. A number of the physicians go abroad after receiving their certifications. Around 45 radiologists have to be certified each year so that their numbers do not decrease. An issue, however, is just how many radiologists are really needed. From the market point of view, radiologists are in constant demand both abroad and in the Czech Republic. The Czech Republic even has leading positions that are vacant, including positions for heads of clinics. To satisfy the demand, another 300 radiologists would be needed in the Czech Republic.

Would you say that medical imaging is adequately financially compensated as a profession in the Czech Republic in comparison with other European countries?

Of course it is not. The salary is very difficult to determine and estimate. Generally, we can say that a basic physician's gross monthly salary is around CZK 20,000 (EUR 810), and a specialised physician's salary depends on the length of his or her work experience. The average salary of a physician who works 40 hours a week and is on call four times per week (from 2 p.m. to 7 a.m. the next day) and has one weekend duty (24 hours on Saturday or Sunday), who is 40 years old, has full qualifications and is not in the position of a chief physician or head of a clinic is around CZK 30,000 – 50,000 (EUR 1,200 – 2,025) gross, including all benefits, extra allowances and bonuses. In the private sector this can reach CZK 60,000 – 90,000 (EUR 2,430 – 3,645) per month. The maximum salary in radiology can be around CZK 100,000 – 150,000 (EUR 4,050 – 6,075) gross per month. This is one of the reasons why younger physicians in particular are interested in working abroad.

Is continuing education important for radiologists in the Czech Republic after mandatory training is complete?

Continuing education in radiology is important mainly for physicians who have private practices and their own offices. Physicians have to earn so-called credits, which are assigned to individual events by the Czech Medical Chamber. The number of credits is a condition for obtaining a licence. All of this is relatively benevolent, but the interest in congresses and courses in the Czech Republic is immense. The national congress is regularly attended by around 600 – 700 radiologists and there are a number of events that have 200 – 300 participants on average. Virtually all events attract more people than their capacity allows. Educational events are coordinated by the committee of the Czech Radiology Society, which assigns them with a "quality certificate". Apart from the national congress, which is held once every two years, there are two national events in interventional radiology each year, a three-day MR course, a one-week MR and CT course, a CT school for young physicians, a three-day ultrasound congress, a neuroradiology congress, a paediatric radiology congress, an abdominal and gastrointestinal radiology congress, and several other events. All the aforementioned congresses are mainly educational and most communications are in the form of invited lectures.

Are there any dedicated management or administration courses taught to radiology students?

There are no such courses. There are, however, MBA courses focused on healthcare, and there is also an annual meeting of senior physicians from radiology departments.

What are the main management challenges you experience in your working life?

In my opinion, the major issue is the large number of so-called "large radiology departments" in the Czech Republic. There are 10 radiology clinics and another six departments have clinic status (which means they are connected to faculties of medicine). In addition, there are seven other large departments in regional hospitals. These 23 departments would like to be the equivalent of large departments abroad in terms of the number of their procedures. A large radiology department in the Czech Republic, however, has not more than 30 physicians, including residents, and very rarely is there more than one associate professor or a professor. Moreover, in most such departments there are no academic workers. The publication activity of these departments is very low or nonexistent. To establish a large radiology department on a par with large departments abroad is thus absolutely impossible.

The quality of radiology – and by that I mean practical radiology – is high, but the quality of research, science and experimental work is low. The typical budget of a large department is around CZK 4,500,000 (EUR 182,000) per month. This money is used for purchasing contrast agents and the usual materials that are necessary day to day, including instrumentation. That considerably limits the ability to perform costly procedures. Thus, from an economic viewpoint, the running of a radiology clinic – and that is fully within the competence of the head of a clinic – is a big challenge and a difficult task.

As the concentration of large departments is high, these departments also have rather small geographic areas that they naturally serve. There are in the Czech Republic, I estimate, around 20 radiology departments whose management is convinced they do quality radiology within the whole range of procedures, including interventions. These departments thus have natural service areas of around 500,000 inhabitants, considering that the population of the Czech Republic is 10,000,000. ■

HOT TOPICS IN MEDICAL IMAGING **IN THE CZECH REPUBLIC**

Contrast-Enhanced Ultrasound (CEUS)

Contrast-enhanced ultrasound (CEUS) offers such benefits as the lack of need for ionising radiation, the possibility of real-time imaging, of the application of a second contrast media injection a few minutes after the first one, the possibility for quantification and the higher sensitivity and specificity offered by this technique in the detection and characterisation of small lesions under 1.5 cm. As CEUS represents an innovative approach to imaging of the vascularity on the macro- and microcirculation it has become a useful diagnostic tool in everyday practice in the Czech Republic.

Role of Conventional Ultrasound

The role of conventional ultrasound in imaging many organs in the body is limited to conventional colour and spectral Doppler imaging. Although Doppler imaging may provide valuable directional blood flow information, it is most effective for evaluating large blood vessels with fast-flowing blood. The ability of Doppler imaging to detect blood flow at the parenchymal level, where the tissue is moving at the same speed or faster than the blood that perfuses it, is limited.

The development of sonographic contrast agents based on microbubbles has allowed us to detect flow in circulations at a level lower than would otherwise be possible. This invention has also stimulated development of contrast-specific imaging, which means special hardware and software systems produced by different ultrasound manufacturers. These methods could identify the echo from the contrast media and thereby suppress that from solid tissue, so they provide a real-time "subtraction".

CEUS and CT/MR

CEUS shows high concordance with computed tomography (CT) or magnetic resonance (MR) imaging, especially for the arterial phase. Discordance in the portal venous phase may reflect the tendency of CT and MR contrast agents to diffuse into the interstitium unlike with microbubbles. Intravenous sonographic contrast agents are confined to intravascular spaces and therefore don't leak through the vessel wall.

In 2004, we started to use the second generation of contrast agents, which are resistant to pressure changes occurring in the left ventricle and pulmonary capillaries, and have stability more than six hours after preparation of the solution as well as persistence in the blood-pool nearly ten minutes after intravenous bolus. Our experience during this period was included in an international multi-centre study made by Bracco and since then the use of contrast media in ultrasound examinations has become much more popular.

Reimbursement for CEUS Procedures

Contrast media was approved for use in the Czech Republic a while ago, now. However, it was not refunded by health insurance companies, so many radiological departments did not use it. Since January 2010, one of the contrast media agents (SonoVue, Bracco) is refunded by health insurance companies in certain circumstances. Thus the interest in CEUS in this country has increased a lot. With the guidance of our department, three teaching centres were established in the Czech Republic accordingly, where radiologists can learn not only a theory to understand the behaviour of bubbles when exposed to an ultrasound beam, as well as the basic physics, technology and the principle of contrast-specific imaging, but in these three-day hands-on workshops they can also examine real patients personally, try different machine pre-settings and see many types of pathological findings. After the course they obtain a certificate of competency. This certificate is essential to have the right to sign a contract with the health insurance company.

Courses in CEUS in Big Demand

There is very big demand for such courses, inter alia because skilled radiologists can then routinely perform contrast ultrasound examinations in their department. In each teaching centre around four courses are held per year in the Czech language, and in our department two international CEUS symposium workshops in English take place annually. This system is co-organised by the Czech Radiological Society and by the president of this society, doc. MUDr. Marek Mechl, Ph.D., MBA, who also co-signs the certificate. Once a year all CEUS users must attend the meeting where they have to present their experiences.

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Performing CEUS exams is relatively easy, we need just the appropriate ultrasound machine that allows contrast-specific imaging, contrast media for ultrasound imaging and, of course, image interpretation skills. The administration of the contrast agent is provided by one nurse and one medical doctor – in our country this must be a trained radiologist. Recording and storing the cine-loop allows a second reading later.

In comparison to other modalities as CT or MR, CEUS has many advantages, as an absence of ionising radiation, high cost-effectiveness, high patient compliance, it can provide a real time imaging - not only two or three selected perfusion phases, it has the possibility of a second contrast media injection after few minutes, enables one-stop-shopping in incidentally found lesions, therapeutic monitoring, nowadays there is high-quality quantification software available in the market and it has proven high accuracy in providing specific contrast-enhancement patterns that are comparable to those obtained on MRI. ■

PREPARING FOR A CAREER **IN MEDICAL IMAGING**

Education & Training in the Czech Republic

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In the Czech Republic today, preparation for a career in radiology begins at a radiology department and lasts for four years. The first two years comprise the so-called foundation, of which the first year is common for all fields. The second year is then directed towards individual methods – six months of radiography, two months of radioscopy and four months of ultrasound. The remaining three years are intended for specialised training. This training is divided into:

- The first part focusing on CT training (12 months);
- The second part (24 months) which is further divided into:
  - » Magnetic resonance (seven months);
  - » Intervention radiology basics (two months);
  - » Comprehensive diagnosis of breast diseases (three months);
  - » Nuclear medicine (two months), and
  - » Training in one particular radiology field (10 months).

Departments can obtain accreditation for the entire education programme (so-called full accreditation) or for certain of its parts only.

At present, there are eight faculties of medicine and 10 radiology clinics in the Czech Republic. Approximately 30 physicians receive their certifications in radiology each year. The educational system in specialist postgraduate studies has a long tradition in the Czech Republic. Postgraduate studies are organised by the Institute of Postgraduate Medical Education (IPME). This facility, established by the Ministry of Health, has individual departments corresponding to certified areas, including a radiology department.

Relevant departments organise theoretical pre-certification preparation and the actual certification itself. Theoretical pre-certification preparation is compulsory. The certification exam itself takes place in Prague at the premises of the Institute and consists of a written test, practical interpretation of medical images and theoretical questions. It takes one full day.

Members of the certification committee are appointed on a permanent basis by the Minister of Health based on nominations from a professional radiology society, IPME, faculties of medicine and the Czech Medical Chamber. The certification committee itself has five members, and the chairman of the committee is the head of the department of radiology of IPME or his or her deputy. The certification exam usually takes place twice a year – in spring and autumn. A part of the preparation is the obligation to attend theoretical courses comprising of 200 instruction hours. These courses are chiefly organised by IPME, the Czech Radiological Society and a fully-accredited department.

Transformation of Postgraduate Studies

Prior to joining the EU, the Czech Republic had an established system of two-stage postgraduate studies. Each physician had to receive the first-stage certificate. He or she prepared for this certificate at his or her place of work for three years. Those physicians who wanted to specialise in their field, continuing an academic career or holding leading positions could have passed the second-stage certificate. Preparation for that certification also lasted for three years. Everything was organised by IPME, the relevant department and the certification committee. There were no accredited departments, no established system of residents and fellows. Upon graduating, physicians started working at a department and usually worked there until they retired. They had a permanent work contract.

This system provided for a relatively high quality, although it largely depended on how demanding and high quality the management of the relevant department of IPME was.

After joining the EU, there were a number of legislative changes in the Czech Republic. These resulted in the establishment of a certification committee whose members are appointed by the Minister of Health for the period of four years on the basis of nominations from a professional radiology society, IPME, faculties of medicine, and the Czech Medical Chamber. The certification committee is in particular responsible for preparation of the education programme and certification of departments. Another obligation is that a graduate physician has to begin by working at an accredited department.

Radiology & Nuclear Medicine Accreditation Separate

At present, accreditation in radiology and in nuclear medicine are separate from one another. Nuclear medicine has a common basis with radiology, however, and the two fields are gradually merging. Previously, nuclear medicine was a so-called follow-up or second-stage certification. First a physician had to receive his or her certifications in internal medicine and only then he or she could receive certification in nuclear medicine.

Moreover, the Czech Republic has three continuing professional education courses for further certifications. The continuing education courses in radiology are now interventional radiology, paediatric radiology and neuroradiology.

Preparation again takes place at accredited departments and lasts for two years. The education programme is prepared by the relevant accreditation committees for intervention radiology, neuroradiology and paediatric radiology. The exam is organised by relevant IPME departments. Another possibility, which exists not only in radiology but also in other fields, is recognition of so-called certified skills. We are now considering that a certified skill could be a condition for neurointerventions or PET-CT.

The accreditation committee and a professional society are together preparing additional modifications to the education programme, but these are rather minor. There is also ongoing discussion about how to divide the accreditation departments – whether it is better to centralise everything or, vice versa, to allow partial accreditation to as high a number of departments as possible. An issue still remaining open is whether at least the central role of IPME as an organiser and coordinator of postgraduate studies shall be preserved or whether certification, and including the exam, will be organised by individual faculties of medicine. ■

CONTINUES FROM P. 42 » Currently in the Czech Republic there are 1,550 radiologists and a further 300 physicians in the process of preparing their specialisation to work in the field. Overall, there are 600 radiology departments located in the Czech Republic. The academic community includes 13 professors and associated professors.

Radiology in the Czech Republic includes (according to the present statutory standards) four basic disciplines: radiology and imaging methods (general radiology) and three other specialised fields: interventional radiology, neuroradiology, and paediatric radiology. These medical examinations require erudition in specialised procedures and are carried out by radiologists with specialised training in the areas mentioned above.

The Czech Radiological Society publishes a reviewed research journal entitled "Česká Radiologie" – Czech Radiology, which continues the tradition of Czechoslovak Radiology. This journal is published quarterly. The radiological society organises a biannual national congress and many other specialised initiatives such as MRI meeting sections, CT courses, abdominal radiologic diagnostics courses, and more.

International Cooperation

The Czech Radiology Society is a full member of the Radiology Section of UEMS (Union des Médecins Spécialistes) in Brussels, where we are represented by two national delegates. Through this representation, we participate in the creation of radiological legislation within the EU and accept the advice of the EU and EURATOM in the field of radiation protection. As a full member of the European Society of Radiology (ESR), via the election of members participating in their bodies, this route is being increasingly developed in our participation in international research projects and multi-centre trials. The ESR also helps to develop bilateral contacts between the national radiological societies in Europe and in Central Europe. ■

FURTHER READING

Ferda J., Hlava A., Mechl M., Valek V., Elias P., Kreuzberg B., 111 Years of Radiology in the Heart of Europe: Czech Radiology 1896-2007, AJR 2008; 190:1462-1465

www.crs.cz/cs/spolecnost/historie.html

KEY CONFERENCES & EVENTS

OCTOBER

09 – 13 **European Association of Nuclear Medicine (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

14 – 17 **Ultraschall**
Mainz, Germany
www.ultraschall2010.de

NOVEMBER

03 - 05 **European Course on Paediatric Radiology**
Florence, Italy
www.aimgroup.it/2010/ecpr

11 – 12 **3rd Barcelona PET-CT, Advanced CT & Hybrid Imaging Course**
Barcelona, Spain
www.barcelonapet-ct.com

28 – 03 **RSNA Annual Scientific Meeting**
Chicago, U.S.
www.rsna.org

DECEMBER

10 – 12 **'Diving Into Cardiac Imaging' Congress**
Grand Cayman, Cayman Islands
www.uphs.upenn.edu

JANUARY 2011

06 – 08 **4th Leuven Course on Head & Neck Imaging**
Leuven, Belgium
www.headandneckimaging.be

13 – 15 **14th International MRI Symposium**
Garmisch-Partenkirchen, Germany
www.mr2011.org

19 – 20 **IT@Networking Awards 2011**
Brussels, Belgium
www.itandnetworking.org

20 – 22 **Management in Radiology – Winter Course**
Bad Wiessee, Germany
www.mir-online.org

FEBRUARY 2011

17 – 20 **Breast MRI Course**
Arizona, U.S.
www.proscaneducation.com

24 – 26 **ECCO 6th Annual Congress: Inflammatory Bowel Disease**
Dublin, Ireland
www.ecco11.ecco-ibd.ie

25 – 27 **7th European Congress on Haematomic Malignancies**
Budapest, Hungary
www.imedex.com

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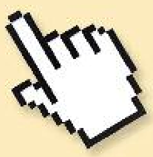

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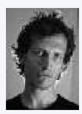

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