

I M A G I N G

M a n a g e m e n t

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

CONTROVERSIES IN BREAST IMAGING



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An Update on Audit

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Controversies in Breast Screening

Dear readers,

This edition, our cover story focuses on recent controversies associated with screening mammography. The media have lately drawn much attention to studies that question the safety and efficacy of breast screening, and here we summarise why this controversy has arisen, and provide a balanced account of the advantages and disadvantages of breast screening, as well as coverage of new tools currently in development that should aid in the increased diagnostic accuracy of results.

Firstly, a paper by Prof. Per Skaane, a well-respected authority on the subject, reasserts evidence that breast cancer screening decreases mortality rates and provides a useful list of recent studies into the matter. This is echoed by a paper from Dr. Wong, a breast radiologist in the U.S. where recent alterations to screening guidelines cautioned against routine screening in the 40 – 49 age group not excepted by patients with the associated co-morbidities. Additionally, we interview a group of leading experts in the UK noted for their investigation into breast imaging technology, to ask about their recently published research into the cost-effectiveness of CAD, a hot topic at the moment.

New advances in breast screening applications will undoubtedly continue to drive accuracy and safety, particularly in examinations of women with dense breasts. These advances may do much to guard against over diagnosis, another area in which there is work to be done. Undoubtedly, the most potent tool in dealing with each of these areas, is greater dissemination of information to the patients themselves: at a time when radiologists are being urged to take note of the need for direct patient-to-patient contact and communication, this is another instance in which

greater efforts and a larger awareness of the importance of the presence of the radiologist, can only be for the good.

In this edition, we also publish a review of the recently held Management in Radiology (MIR) congress, which took place in Nice, France. This annual professional meeting aimed at leaders, managers and administrators of radiology departments worldwide, this year invited junior radiologists to attend a unique pre-congress meeting to hone their interview skills and provided focused careers advice. As each year passes, MIR grows in both audience and scope of subject matter.

This year's congress drew a higher audience participation level than previous editions, while the addition of the junior radiologists lent a fresh perspective to the mix. As usual, MIR stands out from other, larger congresses in that its unique focus means that those present are there to share and learn about management topics such as this year's focus on Standards in Reporting, Coding & Finances, and Clinical Decision Support. Led by Prof. Peter Mildemberger, Chairman of the MIR organisation, the meeting was greatly strengthened by local colleagues Prof. Elisabeth Schouman-Claes, and Prof. Yves Menu, who attracted an increased French audience to the meeting. More information as well as photos can be found within.

To share your feedback or submit your management-based paper, email editorial@imagingmanagement.org.

Best,




Prof. Iain McCall

Editor-in-Chief
editorial
[@imagingmanagement.org](mailto:editorial@imagingmanagement.org)

Controversies in Breast Screening

This cover story examines current controversies in breast cancer screening: is it safe for patients, is it effective, is there a clear cost-benefit ratio and for which age brackets does this apply? The list of questions that have arisen in the media in recent years in relation to screening mammography continues to grow. In essence, what scientists aim to identify, is whether routine breast cancer screening is worthwhile. This year, a paper published in the British Medical Journal that aimed to compare trends in breast cancer mortality within three pairs of neighbouring European countries in relation to the implementation of screening, cast a shadow on the efficacy of breast cancer screening programmes. Here we shed light on the pros and pitfalls of breast cancer screening.



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EUROPEAN NEWS

ESR PUBLISHES POSITION PAPER
ON IMAGE COMPRESSION

The European Society of Radiology (ESR) has published a position paper on the "Usability of irreversible image compression in radiological imaging". This paper is the result of a groundbreaking Expert Panel Session, held prior to the Management in Radiology (MIR) Annual Scientific Congress last year in Mallorca.

Each year, a select number of experts in medical imaging management gather for the Annual Scientific Meeting of MIR, to discuss their professional challenges and solutions amongst a like-minded audience. This made the meeting an ideal ground for leaders in imaging IT to come together and develop and debate the different aspects of using image compression to relieve the pressure on the field of imaging in managing the data explosion that has followed increasing demand for scans by patients and referrers.

Following the Expert Panel Session, a number of key figures, including David Koff (Canada), Laurence Sutton (UK) and others presented their opinions during the MIR congress itself. **The publication of this Position Paper is the latest area of development, and will be reinforced by a cover story on this topic during Issue V of IMAGING Management this year.**

The ESR states that: "The usability of image compression has been a relevant topic in radiological image management for a long time. Despite some well-prepared recommendations by the national radiological societies in Canada, Germany and the United Kingdom, there are still different concerns by users and vendors about implementing such tools."

The paper summarises the results of this process. It is focused on the use of "diagnostically acceptable irreversible compression" (DAIC). The paper is of interest for radiologists, picture archiving and communication systems (PACS) administrators, researchers, vendors and imaging management service providers. Therefore, special background information and detailed technical information

are also part of the paper; to present the best overview.

To attend the 2012 edition of the Management in Radiology Annual Scientific Meeting, or for more information, please visit www.mir-online.org, where you will find the programme and registration details. All those interested in the management aspects of their career in medical imaging are encouraged to take part. The Expert Panel on Image Compression in Palma de Mallorca in October 13, 2010 was kindly supported by Agfa Healthcare, Cerner Deutschland, GE Healthcare Information Technologies, Philips Healthcare, Siemens AG, Healthcare Sector and VISUS. The full scientific paper is available for download on www.myesr.org.

EU'S MEDRAPET PROJECT TO HOLD 2012
WORKSHOP: PLACES LIMITED

As previously reported in this journal (News: Vol. 11, Iss. 2), the European Commission recently launched the MEDRAPET (MEDical RAdiation Protection Education and Training) project to assess the implementation of the Medical Exposure Directive provisions related to radiation protection education and training of medical professionals in the EU Member States and update the Radiation Protection 116 Guidelines. As part of this, a workshop will be held from April 21 – 23, 2012 in Athens, Greece, with the aim of facilitating the discussion on issues related to radiation protection education and training of medical professionals in the EU member states. The MEDRAPET project is currently conducting an EU-wide study to establish the status in the member states regarding medical radiation protection education and training. Results of this study are going to be discussed during the MEDRAPET Workshop.

The outcomes will form the basis for a European Guidance on radiation protection education and training of medical professionals. The workshop provides a platform for all medical professionals to exchange knowledge, share experience and discuss challenges and solutions to existing problems known in radiation protection education and training. For those

interested in taking part, please note that while this workshop requires no registration fees, the maximum number of places is 100.

The professional organisations involved include the European Society of Radiology (ESR) as coordinator as well as the European Federation of Organizations for Medical Physics (EFOMP), the European Federation of Radiographer Societies (EFRS), the European Society for Therapeutic Radiology and Oncology (ESTRO), the European Association of Nuclear Medicine (EANM) and the Cardiovascular and Interventional Radiological Society of Europe (CIRSE). Detailed information about MEDRAPET can be found at the project website. (www.medrapet.eu)

JOINT COMMISSION PUBLISHES RADIATION
SAFETY RECOMMENDATIONS

The Joint Commission has published a report that delivers information to healthcare providers regarding the provision of radiation-involved imaging services, cautioning against high dosages, which increase the risk for long-term damage. The report states that "Over the past two decades, the U.S. population's total exposure to ionising radiation has nearly doubled. If a patient receives repeated doses, harm can also occur due to the cumulative effect of those multiple doses over time". Conversely, using insufficient radiation may increase the risk of misdiagnosis, delayed treatment, or, if the initial test is inadequate, repeat testing with the attendant exposure to even more radiation. The risks associated with the use of ionising radiation in diagnostic imaging include cancer, burns and other injuries.

Furthermore, x-rays are officially classified as a carcinogen by the World Health Organization's International Agency for Research on Cancer, the Agency for Toxic Substances and Disease Registry of the Centers for Disease Control and Prevention, and the National Institute of Environmental Health Sciences.

The report details that from the 72 million CT (computerised tomography) scans performed in the U.S. during 2007, one study estimated that 29,000 future cancers and 14,500 future deaths could develop due to radiation

INNOVATIVE CAMPAIGN MANAGEMENT

MINDBYTE COMMUNICATIONS (MB) FACILITATES THE FULFILMENT of your goals with modern, innovative communications campaigns. MB helps disseminate the right information to targeted groups and encourages

essential networking with different stakeholders through publications, websites, congresses, events, videos, education and working groups.

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(cancer incidence = 0.04 percent). Another study estimates the incidence of cancer related to CT radiation at 0.02 to 0.04 percent. While these studies' conclusions rely upon some currently unverified scientific assumptions – namely, a linear relationship between radiation dose and risk even at very low exposures – they do highlight the need to maintain radiation doses as low as reasonably achievable when obtaining needed diagnostic information.

Although experts disagree on the extent of the risks of cancer from diagnostic imaging, there is agreement that care should be taken to weigh the medical necessity of a given level of radiation exposure against the risks, and that steps should be taken to eliminate avoidable exposure to radiation.

The full report is available at:
http://www.jointcommission.org/assets/1/18/SEA_471.PDF

ASSOCIATION NEWS



CARS 2012 TO TAKE PLACE IN PISA, ITALY

The organisers of the annual CARS congress wish to invite you to attend next year's edition of their meeting, as well as that of their partner societies. Following the long-term successful cooperation with the ISCAS, EuroPACS, CAR, CAD and CMI societies, in 2012 these scientific communities will jointly hold their annual meetings for the first time in Italy, with the 26th CARS Congress in Pisa. The Congress will also be part of the Bioengineering Week, which will start in Rome on June 24 and move to Pisa for joining the CARS.

The organisers note that at CARS you will have the opportunity to meet scholars and experts in the fields of radiology, surgery, en-

gineering, informatics and/or healthcare management who have an interest in topics, such as

- Image- and model-guided interventions
- Advanced medical imaging
- Image processing and visualisation
- Computer aided diagnosis
- Medical simulation and eLearning
- 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. The deadline for paper and abstract submissions for CARS 2012 in Pisa is January 10, 2012.

www.cars-int.org



IHE CONNECTATHON BRINGS NEW DOMAINS TO LIFE

At this year's edition of the European Connectathon a new IHE Domain for pharmacy that enables electronic prescription exchanges in both hospital and community settings was tested for the first time, and the first European testing of the IHE Domain for personal care devices was successfully completed. The development of two new IHE Domains for endoscopy and dental were also announced. "The clear success of the European Connectathon is in bringing together stakeholders from diverse groups for hands-on problem-solving that contributes to real progress advancing interoperability between healthcare systems," said Peter Kunecke, the Co-Chair of IHE-Europe representing vendors.

According to Jacqueline Surugue, the User Co-Chair for IHE-Europe, "The remarkable achievement at this year's Connectathon was

extending the open collaboration methods of IHE-Europe to create a cooperative environment where decision makers could find a way forward to meet the complex challenges in improving healthcare delivery for patients." In further news from the association, during the IHE-Europe General Assembly at the Connectathon, Jacqueline Surugue was re-elected to a new two-year term as User Co-Chair. Further updates on next year's edition of the IHE-Europe Connectathon will be reported in this journal.

www.ihe-europe.org



CIRSE LAUNCHES CAVAL FILTER RETRIEVAL REGISTRY

Prof. Michael Lee has issued an open invitation as Primary Investigator to members of the Cardiovascular and Interventional Radiological Society of Europe (CIRSE) to commence a registry that will assess the success of caval filter retrieval. Says Lee: "There is a dearth of information in the literature regarding filter retrieval at present. CIRSE has therefore organised this registry, which it believes is an important project and we very much hope that you will support it."

Furthermore, while the primary end point of the registry is to assess the success of filter retrieval among the different filter types, the secondary end points include assessing complications during retrieval and dwell time of different filter types.

All CIRSE members are invited to participate. The registry will run for twelve months and it is hoped to obtain data on at least five hundred filter retrieval procedures. Authorship on the final paper will depend on the number of filter retrievals entered in the registry. The five largest contributors will become authors.

www.cirse.org

CORPORATE UPDATE

HITACHI ALOKA MEDICAL UPDATE ON U.S. OPERATIONS

Hitachi Aloka Medical, Ltd, the global dedicated ultrasound business created by Hitachi Medical Corporation's acquisition of Aloka Co., Ltd., announced details of its United States operations. With its international headquarters in Tokyo, Japan, Hitachi Aloka Medical, Ltd. encompasses the ultrasound division of both Hitachi Medical Corporation and Aloka Co., Ltd. The new company will centralise its U.S. business operations in Wallingford, CT, at the site of Aloka Co., Ltd.'s former U.S. headquarters.

Hitachi Aloka Medical America will have responsibility for all sales, service, marketing and clinical application support of Aloka America ultrasound equipment and Hitachi ultrasound systems of Twinsburg, OH-based Hitachi Medical Systems America. The company will integrate and continue to support both Hitachi and Aloka ultrasound products. The company further announces the appointment of David R. Famiglietti to General Manager of Hitachi Aloka Medical America. Famiglietti has more than 35 years of experience in the medical device/healthcare industry, most recently serving as COO of Aloka America. Famiglietti will lead the company's business operations in the United States and Canada.

HOLOGIC WINS TOP MEDICAL AWARD FOR SELÉNIA DIMENSIONS

Hologic have announced that their Selenia Dimensions 2D/3D mammography system won a gold Medical Design Excellence Award (MDEA) at the Medical Design and Manufacturing East 2011 Conference and Exposition. The award recognises Hologic for innovation in design and engineering for Selenia Dimensions, the first commercially available tomosynthesis system for breast cancer screening and diagnosis. The company states that unlike prior-generation mammography systems, which generate two-

dimensional (2D) images, a breast tomosynthesis system produces three-dimensional (3D) images which are intended to reveal the inner architecture of the breast, free from the distortion typically caused by tissue shadowing or density.

PHILIPS INKS 400TH BRILLIANCE ICT CONTRACT

Philips have signed the 400th contract for their Brilliance iCT scanners, which are installed at locations around the world. Among the hospitals to select the Philips iCT, the most powerful scanner available globally, is China's Shandong Tumour Hospital and Institute, which marked a milestone by receiving the 300th shipment.

"As an oncology hospital, we were seeking a solution that would provide high quality, sharp images with low dose and we found that with Brilliance iCT," said Wenwu Li, M.D., Chief, radiology, Shandong Tumour Hospital & Institute. "The technology is well-suited to support accurate staging for surgery and liver analysis, all vital in our efforts to best serve our patients." The newest software version on the iCT released in April provides users new ways of managing dose without sacrificing image quality. The version also includes iDose4, Philips latest iterative reconstruction technique.

SIEMENS PROVIDES SYNGO®.VIA TO BOSTON GROUP FOR INTERVENTIONAL RESEARCH

Siemens Healthcare announced that its syngo®.via advanced visualisation software will be exclusively used by researchers from the National Center for Image Guided Therapy (NCIGT) at Brigham and Women's Hospital in Boston. Supported by the National Institutes of Health, NCIGT is a research group dedicated to advancing image guided interventional techniques with some of the newest diagnostic imaging tools from Siemens Healthcare coupled with interventional surgical systems. Co-directed by two radiologists, Ferenc A. Jolesz, MD, and

Clare M. Tempany, MD, the NCIGT's physicians and researchers are committed to making strides in less-invasive, more patient-centric procedural medicine. To help them achieve these goals, they have turned to a combination of Siemens diagnostic imaging modalities and imaging IT. They plan to install Siemens syngo.via across all radiology workstations to provide advanced visualisation functionality. Physicians also plan to develop new image guided therapeutic approaches and to improve a number of already validated interventional procedures, including image guided therapy in open brain surgery, radiation treatment of prostate cancer and gynaecological tumours, breast conserving therapy, MRI-guided cryoablation, treatment of atrial and ventricular fibrillation and brain tumour laser ablation.

AGFA CONTINUES EXPANSION OF DR PORTFOLIO

Agfa HealthCare continues to drive expansion of its DR portfolio, by announcing that its mobile direct radiography (DR) system, the DX-D 100, is available for delivery in the United States and Canada. This unit combines full mobility with Agfa HealthCare's image processing designed to allow high-quality radiology exams to be efficiently performed in mobile environments, including intensive care units (ICUs), emergency departments, operating rooms or at the bedside.

The DX-D 100 uses Agfa HealthCare's NX workstation and is supported by MUSICA2, Agfa HealthCare's image processing software, for contrast detail and image quality. It is available with conventional gadolinium or high-DQE Cesium DR panels for dose sensitive patients. Using either a WiFi connection or wired network capabilities, the patient worklist is downloaded to the DX-D 100 from the facility's radiology information system (RIS). Immediately following image acquisition, images can be sent to the picture archiving and communication system (PACS) or to an imager for printing. ■

GLOBAL HEALTHCARE TECHNOLOGY CONGRESS

18 – 19 JANUARY 2012

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IT @ Networking Awards 2012, is a global healthcare IT and medical technology competition, recognising and promoting outstanding healthcare IT and medical technology projects.

COMPETING SCIENCE

Today, shrinking funds require us to deliver more for less. We experience this reality in all aspects of life, even in science. Hospital departments, healthcare institutions and regions have to create professional business cases to receive sufficient funding to realise their projects.

The *IT @ Networking Awards 2012 (IT @ 2012)*, recognises this new reality: excellent projects are competing against each other in order to win. The Expert Panel, attending peers and competitors can cast their vote supporting their favourite implementations.

HOW IT WORKS

IT @ 2012 is a fast-paced, interactive event with two presentation rounds:

Day 1 – MindByte Presentation - each presenter is given 5 minutes to highlight the key advantages of his project and persuade the audience to vote for them. This is followed by a 5 minute Q&A by with the audience who vote based on the presentation/voting criteria. Only the top 8 rated projects will succeed and move into the next presentation round.

Day 2 – WorkBench Presentation – each presenter is given 25 minutes to provide an

ARE IT & MEDICAL COMPETITION



JANUARY 2012 THÉÂTRE DU VAUDEVILLE BRUSSELS

in-depth insight into their project. The aim is that the audience will support the project. Corporate supported projects are allowed to highlight the industry angle in the Work-Bench session.

In a 15 minute Q&A session all questions can be answered, followed by the final vote to cast the winner.

THE PRESENTATION / VOTING CRITERIA

IT @ 2012 will highlight installations from all areas in healthcare to support cross-departmental understanding. All presenters are required to follow a strict structure allowing the audience to compare on common grounds:

1. THE IMPORTANCE OF TECHNOLOGY

- What technology was used and how was it integrated into the workplace?

2. BENEFITS

- Has the project helped those it was designed to help?
- Has the project changed how tasks are performed?
- What new advantages or opportunities does the project provide?

3. ORIGINALITY

- What makes the solution special?
- Are there any original features?
- Is it the first, the only, the best or the most effective application of its kind?
- Is it an improvement on existing implementations?

4. DIFFICULTY

- What important obstacles had to be overcome?
- Were there any technical or organisational problems?

5. SUCCESS

- Has the project achieved or exceeded its goals?
- How do you see the project's success affecting other applications, your facility or other organisations?
- How quickly would the users accept the implications of this innovation?

6. IMPACT

- What is your overall impression of the project?

THE VOTING SYSTEM

IT @ 2012 uses a highly sophisticated voting system with two separated groups of voters: the expert panel and the audience/presenters, each with 50 % impact.

Based on the Bayesian Model the expert panel is setting a trend. To avoid bias, every vote from the audience out of a credible margin will be automatically disqualified.

WHY IT @ 2012 SO DIFFERENT?

The main difference lies in the element of competition. Presenters from across the world must present their idea to the highest standard, master all questions and persuade the audience and judges that their solution de-

serves to win. By allowing presenters to cross-examine their competitors, the Q&A sessions take on a new dimension.

IT @ 2012 requires the open disclosure of difficulties during planning and implementation of the solutions and how these issues were solved. This allows the audience to learn from others' mistakes and bring new methods and solutions back to their own institutions.

WHY ATTEND?

IT and medical technology is of key importance to healthcare. Intelligent IT solutions increase cost-effectiveness, productivity and safety.

IT @ 2012 will expand your knowledge on different medical technology and IT solutions from all areas in healthcare and supports a cross-departmental understanding like no other event.

HOW TO REGISTER

To register, please visit:

<https://www.conftool.net/itawards2012/>

LOCATION

IT @ 2012 will take in Brussels, the capital of Europe.

Hotel reservations can be obtained through www.booking.com.

For more information please visit our website www.itandnetworking.org or contact us on +32/2/2868501 or send an email to office@hitm.eu

We look forward to seeing you in January!

CONTROVERSIES IN MAMMOGRAPHIC SCREENING

A Never-Ending Debate



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Breast cancer screening has proved to be effective in reducing mortality, and many experts consider mammographic screening to be one of the major medical successes of recent decades. The use of screening mammography is based on the assumption that breast cancer is a progressive disease, and consequently its earlier detection and diagnosis will lead to an improved prognosis for affected women. The goal of mammographic screening is to detect preclinical ductal carcinoma in-situ (DCIS) and lymph node-negative invasive cancers of less than 15 mm, which have a good prognosis.

The randomised controlled trials (RCT) carried out about 30 - 45 years ago are of great importance since their results represent the scientific basis for the widespread use of organised mammographic screening services today. Expert panels have concluded that a mortality reduction of about 25 percent was achieved among women invited to screening as compared with the control groups. Unfortunately, these trials were (similar to most other randomised trials) not perfectly designed, could not answer all the questions, and the results were conflicting. During the last one to two decades, there has been decreased mortality from breast cancer due to several reasons, including improved breast cancer therapy, increased cancer awareness, and probably reduced intake of hormone replacement therapy (HRT).

Since mammographic screening has been carried out opportunistically in most Western countries in addition to the standardisation of population-based mammography screening, it becomes more and more difficult to evaluate the effects of organised screening programmes. Opponents of screening have, during the last years, postulated that the decrease in mortality rates from breast cancer is mainly due to improved therapy and only to a lesser degree caused by mammographic screening.

It is important to be aware that side-effects are inherent in screening, but the number of such events should of course be kept at a minimum. A hot topic regarding mammographic screening is the age of the women participating, i.e. the target groups, that should be included. The main controversies and side-effects of mammographic screening are:

- Its actual effectiveness on mortality reduction;
- Screening in the younger age group (40 - 49 years);
- Overdiagnosis (and consequently overtreatment), and
- False positive results.

Mortality Reduction

The evidence should be obvious – so why question it?

International expert groups have concluded that the mortality reduction shown by the randomised control trials was about 25 percent. It is important to be aware that the result of the RCTs is based on invitation to screening regardless of whether the invited women actually attended or not (non-attenders). And women in the control group did have mammography (contamination). Furthermore, the RCTs did not use double reading, not always using a two-view examination as is commonly done today, the screening intervals were occasionally longer than two years, and the image quality was inferior compared with today's technology. All these circumstances indicate that the results from the RCTs in fact underestimate the potential effect of mammographic screening. Accordingly, analyses of organised service screening programmes have concluded that women actually attending the mammographic screening examinations will have a mortality reduction in the range of 35 - 40 percent, and perhaps even more.

Regretfully, even so-called evidence-based analyses from neutral public and federal agencies are occasionally published based on subjectively selected material with dubious or misleading conclusions

Opponents of mammographic screening, especially from the Scandinavian countries, have recently published several studies concluding that the mortality reduction due to mammographic screening is rather small, if there is a mortality reduction at all. It is obvious that either the many supporters of screening or the few very critical opponents have made some serious mistakes in their analyses. The best way to answer the question regarding effects of mammographic screening on breast cancer mortality is through randomised controlled trials.

However, it may not be possible to carry out such trials any more. Evaluation of organised service screening pro-

grammes is a difficult task, and there are a lot of factors that might cause serious bias in the analyses: Opportunistic screening for many years, non-attenders, the long observation period necessary to demonstrate the effect on mortality, the decreasing incidence of breast cancer seen during the last decade, access to cancer- and mortality registries on individual patient levels, and overall versus breast cancer specific mortality are only some of the great challenges for evaluating the effect of mammographic screening.

Regretfully, even so-called “evidence-based” analyses from neutral public and federal agencies are occasionally published based on subjectively selected material with dubious or misleading conclusions. The consequence is that there seems to be a never ending controversy regarding the effectiveness of mammographic screening.

Screening for the 40 - 49 Age Group

Do we need more proof of effectiveness?

Some of the initial meta-analyses of data from the RCTs did not demonstrate convincing evidence of mortality reduction in women aged 40 to 49 years due to several reasons. However, subsequent meta-analyses including later follow-up data before demonstrate a significant mortality reduction also for this younger age group.

A main reason for scepticism regarding mammography in the younger group is the lower sensitivity for mammography in women with dense breast parenchyma. Dense breasts are far more commonly found in younger than in older women. Mammography has a sensitivity of about 90 percent in women with fatty breasts as compared with only about 50 percent or even less in the very young group as shown by multimodality (mammography, ultrasound, and MRI) screening in high-risk women.

New advanced applications including full-field digital mammography (FFDM), computer-aided detection (CAD), and the new technique of tomosynthesis may probably improve the sensitivity of screening examinations in women with dense breasts somewhat but not sufficiently. A hot upcoming topic is so-called personalised (or individualised) breast cancer screening using ultrasonography and MRI depending on age, risk profile, and breast density. For women aged less than 50 years the screening intervals should be shorter than the two-year interval recommended in Europe for women aged 50 - 69 years.

In Sweden, approximately 50 percent of the counties invited women aged 40 - 49 years and the remaining 50 percent invited only women aged greater than 50 years to their service screening programmes. In a recently published study from Sweden, having an average of 16 years follow-up, it

was shown that women aged 40 - 49 years attending the screening programme had a significant mortality reduction of 29 percent as compared with the younger age group in the counties not offering mammographic screening.

Overdiagnosis

Is it possible to quantify the harm of screening?

Overdiagnosis is the detection of cancer that would not have presented clinically during the woman's lifetime and thus would not have been diagnosed in the absence of screening. Cancers detected at screening that would not have presented clinically represent the major form of harm in mammography screening. Overdiagnosis could be regarded as an extreme type of so-called lead time bias. Some cases of overdiagnosis are inevitable.

There are two aspects regarding overdiagnosis: First, the extent of the problem, i.e. how many cancers will be diagnosed in a screening programme that would never have progressed; and second, the harm caused to individuals. Several studies have tried to quantify the problem of overdiagnosis. The estimation of overdiagnosis in mammography screening reported in the literature varies between one and 52 percent. Then, the next question is of course how it is possible that experts come to such quite different results.

A main problem when estimating the frequency of overdiagnosis is the gradual implementation of mammography screening in almost all countries. Another problem has been whether the increasing detection of DCIS should be considered as an indication of overdiagnosis. DCIS was an unusual diagnosis before the implementation of mammography screening but today they represent about 20 - 25 percent of the screening-detected cancers. Thus, varying overdiagnosis estimates could also be influenced by the threshold for recall of subtle nonspecific lesions. A question occasionally raised is whether overdiagnosis is an issue for mammography screening interpretation, i.e. for radiologists. Radiologists seldomly use this term because it is at this time not possible in mammography to differentiate aggressive subtle cancers from small cancers that would represent an overdiagnosis. In general it is suggested that overdiagnosis (or over-detection), if exists, is associated with the detection of DCIS and some small invasive cancers.

The over-detection might be driven by improved technological developments, including FFDM, CAD, and advanced biopsy techniques such as vacuum-assisted biopsy. Although nobody knows the magnitude of overdiagnosis, most experts consider the harm caused by screening to be not more than 10 percent.

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3D Ultrasound Opens Door to New Applications in Mammography

Siemens Acuson S2000 Automated Breast Volume Scanner

With its recent acquisition of a Siemens ACUSON S2000™ Automated Breast Volume Scanner (ABVS), the radiology department of the Jeroen Bosch Ziekenhuis (JBZ) in 's-Hertogenbosch, The Netherlands, is the first institution to use this new system in The Netherlands. A second system became operational at the St. Radboud University Nijmegen Medical Centre (RUNMC) two months later. Both institutes are about to begin further clinical research using the ACUSON S2000 ABVS with promising initial results regarding the value of 3D ultrasound. More than 160 ABVS systems are already installed world-wide and multiple studies have already been set up in Germany, the United States of America, Japan and the Netherlands (RUNMC and JBZ). These studies specifically address the sensitivity, specificity and positive predictive value of 3D ultrasound compared with 2D ultrasound and MRI.

Performing a handheld 2D ultrasound is inextricably dependent on the individual manipulating the transducer. During real-time image interpretation, tissue anomalies may occasionally be overlooked. The shortage of experienced sonographers and the time required for thorough examinations are obstacles that have thus far limited the application of hand held ultrasound in breast diagnostics, especially screening. 2D ultrasound is mostly used as an additional imag-

ing modality following mammography. The results of the American College of Radiology Imaging Network (ACRIN) 6666 study (Berg et al., JAMA 2008), which showed that combined use of the two modalities allows more tumours to be traced in women with a high risk of breast cancer and a dense glandular breast tissue structure. The study not only showed that over half of the women aged under 50 have more than 50 percent glandular tissue but also that the sensitivity of mammography with these women levels

that evaluation of the generated images takes 2-4 minutes per breast, much faster than hand held ultrasound.

An additional advantage of 3D ultrasound is the unique way in which the anatomy of the breast is rendered through a reconstruction of three orthogonal planes: transverse, sagittal and coronal. This third orientation allows slice-by-slice evaluation of the anatomy, from the skin down to the thoracic wall, a view currently not available using conventional 2D ultrasound. At the ABVS Workplace, the clinician can later adjust slice thicknesses down to a minimum of 0.5 mm. The coronal orientation turns out to be particularly well-suited for depicting anomalies in the make-up of glandular breast tissue. Small tumours with spiculae are best rendered in a coronal orientation.

The ACUSON S2000 ABVS features adaptive ergonomics to ensure accurate and consistent results for you and your patient. The adjustable scanner arm allows easy manipulation of the transducer pod with minimal compression so patients can relax and breathe comfortably during the exam. The unique one-button locking mechanism simplifies and expedites volume acquisition and addresses the common problem of repetitive stress injuries.

- **eSie Touch elasticity imaging**, a qualitative imaging technique that provides further insight into potential pathology by displaying the relative stiffness of tissue

“To make a precise diagnosis, you need the best information delivered efficiently. The ACUSON S2000 ABVS allows you to experience detailed, 3D images of intricate breast anatomy and pathology.”

ing modality following mammography. **The arrival of automated 3D ultrasound has the potential to change that.** Preprogrammed trajectories ensure that images of every part of the breast are generated by scanning the entire breast. The actual procedure is performed by a radiology technician or sonographer. The ensuing data are evaluated by a radiologist at a 3D workstation by analysing the images of the breast in any desired direction.

Combining Ultrasound & Mammography

Interest in a combined mammography/ ultrasound screening protocol was raised by

out at 30 - 48 percent. Berg et al. (JAMA 2008) showed that the addition of ultrasound to mammography increased tumour detection sensitivity to 77.5 percent. Their proposal is to introduce ultrasound as a supplementary screening modality.

Advantages of ABVS

The ABVS technique reduces the subjectivity of ultrasound and makes it easier to verify results and compare them with mammographic and 3D-MRI findings, transforming ultrasound into a tool for double reading and improved diagnostic precision. First experiences with the 3D ultrasound system show

- **Virtual Touch Tissue Imaging** and Tissue Quantification, a quantitative imaging technique and measurement tool to analyse and follow-up reproducibly and user independently absolute stiffness of tissue
- **Fatty tissue imaging** optimizes the visualization of fatty tissue in real-time by enhancing lateral and contrast resolution
- **Dynamic TCE™ tissue contrast enhancement technology** enhances borders and reduces speckle/noise in an entire volume, not just data “slices,” greatly improving subtle tissue differentiation
- **Advanced SieClear™ spatial compounding** enhances anatomic border definition and improves tissue contrast; electronic beam steering rapidly acquires overlapping images from different view angles
- **Advanced transducer technology** incorporates Hanafy lens technology and twice the elements with half the space to improve slice thickness, image uniformity and contrast resolution

Scientific Research

Presently in Europe and the United States, MRI is recommended as an additional screening modality for women with a high risk (20 percent or up) of breast cancer. Women with an intermediate breast cancer risk do not qualify for anything other than standard mammography, but they may also have a dense glandular breast tissue structure that negatively impacts the precision of mammographic examination. Women with more than 75 percent glandular breast tissue have a 4 to 5 times higher risk of breast cancer than women with little to no glandular tissue in their breasts. This results in a higher percentage of interval carcinomas and a poorer prognosis for any clinically diagnosed tumours.

Especially for young women with a BRCA1 or BRCA2 gene mutation and dense breasts, additional examinations through ultrasound could well be much more reliable than conventional mammography, with the

added advantage that no radiation is used.

Using the ACUSON S2000 ABVS, the radiology departments of the Radboud University Nijmegen Medical Centre (Roel Mus, Henkjan Huisman, Nico Karssemeijer) and the Jeroen Bosch Hospital in ‘s-Hertogenbosch (Matthieu Rutten, Mathijn de Jong, Ivo Dubelaar, Thomas Fassaert) will this fall start a clinical study among women who carry a BRCA gene mutation. In this study the current protocol (combined yearly mam-

mography + MRI) will be compared with an alternative protocol (biannual ABVS + yearly mammography + MRI). Also the results of automated breast volume ultrasound and mammography will be compared.

The aim is to prove that the use of automated breast volume scanning will detect more tumours than mammography, and that the incidence of interval carcinomas will decrease as the ABVS examination will take place every six months.



What is the ACUSON S2000 Automated Breast Volume Scanner (ABVS)

The ACUSON S2000 Automated Breast Volume Scanner (ABVS) is a highly advanced, multi-purpose ultrasound system ideally suited to comfortably image patients with radiographically-dense breast tissue or a history of breast disease. In less than 10 minutes, the automated system acquires full-field volumes of the breast, provides efficient and comprehensive analysis of the 3D data, and facilitates easy, semi-automated reporting. The ACUSON S2000 ABVS offers an innovative, mobile, in-suite design to accommodate virtually any environment.

Built on next-generation acoustic technologies, the ACUSON S2000 ABVS enables never-before-seen detail resolution and the ability to acquire the unique anatomical coronal plane not available using conventional ultrasound. In addition, the system supports advanced hand held, high resolution ultrasound capabilities for biopsy guidance, color Doppler imaging, and the latest sophisticated breast applications, including VirtualTouch™ and eSie Touch™ elasticity imaging, as well as fatty tissue imaging.

World Federation for Ultrasound in Medicine and Biology (WFUMB)

Connecting the World of Ultrasound

The 13th Congress of the World Federation for Ultrasound in Medicine and Biology (WFUMB) is the joint meeting of the 23rd Congress of the European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB) and the 35th joint meeting of the Austrian (ÖGUM), German (DEGUM) and Swiss (SGUM) Societies for Ultrasound in Medicine. Here, IMAGING Management brings you a round-up of the hot topics and predictions for the future of ultrasound technology.

Subharmonic Imaging (SHI)

Subharmonic imaging (SHI) is a modality where pulses are sent at one frequency while echoes are received at half that frequency. Gas microbubbles are used as vascular contrast agents to improve the imaging quality of diagnostic ultrasound. Due to the large impedance between the gas and the surrounding blood, these agents enhance the acoustic backscattering and produce enhancement of both Doppler flow signals and greyscale echogenicity up to 27 dB.

During his talk, Prof. Goldberg said that SHI is a useful additional method to common HI. The main difference between HI and SHI image quality is that the latter suppresses almost all tissue signals for improved tissue-to-contrast ratios but with a lack of anatomical landmarks, making orientation difficult. SHI is most useful where flow detection is more important than mere anatomy, for example in characterisation of breast lesions or other potential malign masses in the human body. Treatment monitoring is also an area where SHI is used as well as when tissue-echoes dominate, such as in intravascular imaging.

Currently Prof. Goldberg and his team are working on a four-year clinical trial of SHI in 450 women with breast lesions, so the successful completion of this trial is obviously one of their major goals. In this study the efficiency of 3D SHI will be investigated for the first time, which has previously only been done in animal studies.

Breast Ultrasound

Breast ultrasound was a hot topic at this year's congress. Asked about the indications for breast ultrasound, leading expert Prof. Mendelson points out that there are standard guidelines that give a very clear answer: "The main indications, and a more complete list is available in the May, 2011 ACR (American College of Radiology) Guideline for the Performance of the Breast Ultrasound Examination, including confirmation and characterisation of abnormalities observed or suspected on clinical or self-examination, mammography or other modalities such as 'second look' ultrasound for MRI-detected lesions and guidance of percutaneously-performed interventional procedures. Additionally, screening of women with dense fibroglandular tissue and elevated risk of breast cancer (with density itself a risk factor), and extent of disease evaluations, including the axillae in newly diagnosed breast cancer patients, were recently added."

According to Mendelson, breast ultrasound is the modality of choice in characterising, assessing and providing histological diagnoses of masses that require biopsy. Prof. Mendelson spoke about current hot topics in the field of breast ultrasound: "For detection, a very hot topic is how and how often to provide screening. Many versions of automated scanners are in development, and research in this area is active. Important workflow concerns affect utilisation of breast ultrasound, and

methods of efficient workstation review of 3D images are in development.'

Another hot topic is the specification of ultrasound above and beyond the morphologic characters of a mass, which in general allow many assessments to be made confidently, by elastography and its modalities. In future examinations elastography will probably be an additional support for assigning masses that have been found accidentally in whole breast screenings, helping to reduce the number of false positive biopsies without significant impact on sensitivity.

CEUS vs. MS-CT in Abdominal Traumata

CEUS enables visualisation of the vascular system and internal bleeding, even when contrast agents are only applied in small doses. Contrast agents consist of microbubbles that are not absorbed by the vascular system and can be captured for several minutes by specific ultrasound applications. According to presenter Dr. Schuler who spoke at the congress: 'CEUS works without any ionising radiation and with few side effects, and it can also be used in patients suffering from kidney dysfunction, thyroid disease or contrast agent allergy. In comparison to common ultrasound methods, CEUS requires additional software and specific ultrasound transferring devices.'

MS-CT devices use x-rays and contrast agents and are standard equipment in the



emergency unit of every major hospital. However MS-CT also has certain limitations, according to Dr. Schuler: "MS-CT is very useful to get a quick overview of the musculoskeletal system, lung, abdomen and brain/cranium but it also has the side effect of radiation exposure and is not suitable for patients with kidney dysfunction, thyroid disease, allergies, during pregnancy or in combination with the taking of certain drugs."

Both methods are very effective in imaging organ injuries, in which CEUS is even able to detect minor and active bleeding, while on the other hand the use of MS-CT brings advantages in the examination of the pancreas, spine and retroperitoneal musculature.

Ultrasound of Inflammatory Bowel Disease

Imaging of the abdomen plays a major role in detecting Inflammatory bowel disease (IBD) and in its surveillance. At the moment, the gold standard in diagnosing IBD is still colonoscopy, where morphology and biopsy provide information about the patient's condition. Ultrasound is also a very efficient way to detect IBD and is as accurate in terms of results as MR and CT.

Aside from being accurate in detecting the disease it without any ionizing radia-

tion and has no known side effects, but Dr. Wilson, speaking on this subject, also points out that: "Excess radiation exposure from overuse of CT scans is now a well recognised outcome in this population. Furthermore, while highly valuable, colonoscopy is invasive and no patient will tolerate anything other than occasional repeat examinations, emphasising the need for non-invasive and accurate imaging techniques. Ultrasound has excellent spatial resolution allowing for visualisation of all of the layers of the bowel wall."

The last three decades have seen dramatic improvement in the capabilities of ultrasound equipment. Current hot topics in ultrasound include elastography, performed with direct visualisation, as compared with other types of elastography performed with a surface push. This may play a potential role in the differentiation of a fibrotic from an inflammatory stricture in IBD. Furthermore, the use of volumetric techniques now allows us to scan in 3D and 4D and to show volumes of data rather than a simple 2D scan.

Tumour Assessment with CE-EUS

Endoscopic ultrasound (EUS) is an internal examination method that is performed close to the actual organ and allows higher imaging resolution than common ultra-

sound. Contrast enhanced endographic ultrasound (CE-EUS) is a further development of EUS, which uses special ultrasound contrast agents to make even the microvascular level visible to ultrasound imaging. Imaging at a microvascular level is particularly important in evaluating neoplasia due to the fact

Recent research in the field of contrast enhanced ultrasound concentrates on lymph node diagnosis, especially on optimising punctation indication for precise access to malign areas. Significantly, the development of lymph node-specific contrast agents could enhance the diagnosis of oesophagus, stomach and rectal tumours as in these cases the therapeutic approach is influenced by the level of lymph node infiltration. Development of new ultrasound contrast agents should also enhance imaging quality of lymph node tumours smaller than 3 - 5 mm, which are not sufficiently visible using other common imaging modalities, including PET.

According to Prof. Dietrich intense research is also currently being done on alternative uses of contrast agents: "Using contrast agents as a carrier for various substances will be a big topic in the future. Endosonografie is a perfect instrument to destroy microbubbles in the pancreatic area so that high dose medication is set free directly at the concerned organ.

» CONTINUES
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False Positive Results

Could the number be reduced?

False positives are an inherent part of any screening programme. The mammographic features of pre-clinical subtle cancers are, as mentioned above, often highly nonspecific, and it is often impossible to differentiate a malignancy from a benign condition. Consequently, the women have to be called back for diagnostic work-up. Benign lesions are diagnosed in most cases of assessment in screening programmes. It is, of course, a psychologic distress for the women to receive the message that something is suspicious on the mammograms. In addition to this stress, recalls are very costly due to the additional imaging including extra views, ultrasound, and MRI as well as needle biopsies if indicated.

The recall rates, i.e. the number of false positives, vary heavily among countries with mammography screening. The estimated cumulative risk of a false positive call-back for a woman having regular screening has been estimated to be more than 40 percent in the United States. In Norway, where they offer screening every second year from 50 to 69 years for a total of 10 screening rounds, the cumulative risk of false positive recalls are about 21 percent.

The much lower call-back rates in Europe as compared with the United States is partly explained by different medico-legal environments. In addition, however, the logistics and organisation of the screening programme most likely also play an important role for the different recall rates. Single reading is the standard in the U.S, whereas double reading with consensus (or arbitration) is commonly used in Europe according to the European guidelines. A main purpose of the consensus meetings is to increase the specificity, i.e. reduce the number of false positives.

Computer-aided detection (CAD) is often included in the U.S. but seldom used in Europe. CAD increases the cancer detection rate but also the number of false positives. In European screening programmes with double reading and consensus this side-effect would probably be kept at a minimum. Implementation of digital mammography has not reduced the number of false positives. On the contrary, full-field digital mammography has slightly increased the recall rate in several studies. Cancers diagnosed at short-term follow-up are classified as interval cancers in some screening programmes but not in others. Follow-up cases that do not prove to be malignant should be defined as false positives. The number of follow-up cases should be kept at a minimum.

Conclusions

Mammography screening has been one of the most controversial topics in healthcare during the last decades, and the controversies seem to be never-ending. Not all breast cancers diagnosed in mammographic screening will turn out to be lethal. Consequently, some women will be overtreated. However, most studies conclude that the benefits of mammographic screening in terms of lives saved significantly exceeds the harm of overdiagnosis. Nevertheless, all women attending mammographic screening should be informed not only about the proven reduction of mortality from screening but also about the potential harm of overdiagnosis and overtreatment. ■

For further reading contact our Managing Editor Dervla Gleeson at editorial@imagingmanagement.org

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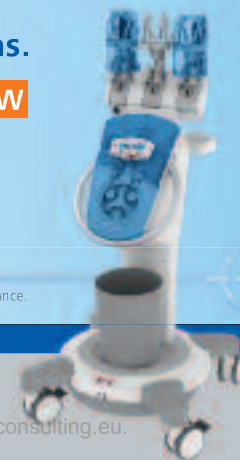
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RESPONDING TO U.S. GUIDELINES AGAINST ROUTINE SCREENING IN THE 40 – 49 AGE GROUP

The Case for Eastern North Carolina

Over the last two decades, convincing evidence has emerged that mammographic screening has contributed to a significant reduction in breast cancer mortality. Mammographic screening is especially important in the diagnosis of early stage breast cancer, which relies primarily on non-palpable mammographic abnormalities for detection. Age is a significant risk factor for developing breast cancer. The risk of developing breast cancer below the age of 40 in a normal risk population is very low, but increases in a linear fashion thereafter and is the basis for The National Comprehensive Cancer Network (NCCN) guidelines that suggest annual clinical breast examination, breast awareness and annual mammography beginning at age 40 in women of average risk.

New Guidelines Cause Controversy

In November of 2009, the United States Preventive Services Task Force (USPSTF) issued new breast cancer screening guidelines and recommended against routine screening mammography in women aged 40 to 49 years of age. This recommendation was not based upon new data disputing the benefit of screening mammography in this age group, but only “that there is a moderate certainty that the net benefit (of screening mammography in this age group) is small” when the metric utilised is the number needed to screen to save one life. Understandably, this generated considerable debate that resulted in an addendum that stated in part that the decision to screen should take into account “the patient’s values regarding specific benefits and harm”.

Evidence supports that women invited to participate in a regular programme of mammographic screening beginning at age 40 and continuing annually have a reduction in breast cancer mortality when compared to women who are not invited to participate in similar screening programmes. We consider this reduction in breast cancer mortality significant. Although the reduction in mortality increases during the 6th and 7th decade of life this reduction in breast cancer mortality is not insignificant in the younger age group (age 40 - 49 years).

Potential Harmful Effects of Screening

Mammographic screening has a number of potential harmful effects including the monetary cost to the patient and society, less tangible cost to the women such as false positives, unnecessary biopsies, and over diagnosis of a disease that is destined never to be clinically relevant, and finally the potential physical harm resulting from the radiation received from regular screening mammography. Discussions of the monetary and societal costs are beyond the scope of this article as these calculations are often very complex and the results can be quite disparate. However, these costs are implicit in the guidelines of the USPSTF recommendations.

To discourage screening based upon USPSTF recommendations in our environment in which the mortality from breast cancer continues to rise may cost society more considering the monetary cost of treating advanced breast cancer

The potential for physical harm based upon the radiation exposure received during routine screening is of concern. This is based upon the possibility that the radiation received from screening mammography may induce breast cancer. The induction of breast cancer by radiation is dependent on the age of the individual, the duration of exposure to ionizing radiation and the underlying risk of developing breast cancer. A comprehensive analysis of this issue supports a detection/induction ratio markedly in favour of screening mammography above age 40. Eastern North Carolina faces unique healthcare challenges. A largely rural part of the state, the twenty-nine counties that comprise that region of the state of North Carolina is the only region of the state in which mortality from breast cancer has continued to increase.



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Access to Healthcare a Problem

Access to healthcare remains a significant problem and the ability to provide technology to a rural population has resulted in a system in which much of the breast imaging is centred in the single urban centre of the region where there is an American College of Radiology (ACR) approved facility and is the hub of a group of 14 mammography sites

DOCTORS CALL FOR INDEPENDENT JUDICIAL REVIEW IN THE UK

Recently, Prof. Michael Baum professor emeritus of surgery at University College London, writing in the English media, (<http://www.guardian.co.uk/commentis-free/2011/aug/02/breast-cancer-screening>) noted that “(There are)... serious harmful consequences of screening associated with the over-diagnosis of breast cancer leading to an increase in the number of mastectomies.” He and a group of medical professionals are requesting an independent judicial review of data to assess the British government’s breast cancer screening programme, which they believe is unethical and potentially harmful. The group in question refers to the European study published in the BMJ in which researchers found that breast screening did not play a major part in the reduction of breast cancer mortality seen in recent years, rather attributing it to better treatment and improving health systems. The doctors want an independent judicial review of the information provided to women by the NHS in the form of information leaflets. Proponents of breast cancer screening, however, refute these claims by stating that adequate information is disseminated to attendees and that it does save lives.

Other Resources

- Watch a lecture by Prof. Baum (“Breast Screening: Some Inconvenient Truths”) on youtube: <http://www.youtube.com/watch?v=JxDnRMU-I7w>
- An overview is also available on the Cancer Active website: <http://www.canceractive.com/cancer-active-page-link.aspx?n=1420>
- The Nordic Cochrane Institute in Copenhagen has published a report downloadable from their website here: <http://www.cochrane.dk/screening/index-en.htm>

throughout eastern North Carolina. Imaging is performed in smaller communities and digitally transmitted to a breast imaging specialist for interpretation. To discourage screening based upon USPSTF recommendations in our environment in which the mortality from breast cancer continues to rise, in our opinion, is potentially counterproductive and may cost society more considering the monetary cost of treating advanced breast cancer.

Eastern North Carolina is the only region of the state in which mortality from breast cancer has continued to increase.

Our Guidelines for Cancer Screening

We screen three distinct populations: normal risk individuals, breast cancer survivors, and individuals at increased high risk for developing breast cancer based upon BRCA1/2 or other predictive models. We continue to advocate that individuals who are considered to be at average risk for developing breast cancer be invited to begin annual mammographic screening at age 40 and to continue annually for as long as a woman remains healthy. We encourage screening for breast cancer in apparently healthy populations by primary care providers of eastern North Carolina starting at age 40 and continuing annually as long as a woman is healthy, and referral is made to a breast centre in the case of abnormal mammographic and/or physical examination findings.

Women who are at increased risk for developing breast cancer warrant special attention. For this reason, we have a specialty High Risk Assessment Clinic at the Brody School of Medicine to evaluate and quantitate the risk of an inherited predisposition to breast and ovarian cancer based mainly on family history. Women identified to have a risk in excess of five percent of having a deleterious BRCA 1/2 mutation or a lifetime risk in excess of 20 percent of developing breast cancer are offered genetic testing as well as a more intense screening programme with the consideration of breast MRI alternating with annual mammography in those who elect not to have prophylactic surgery.

Survivors of breast cancer are followed in our breast centre with an initial mammogram, six months following completion of definitive radiation and then as appropriate, to assure stability of surveillance of mammographic abnormalities as recommended by the American Society of Clinical Oncology.

Steady Flow of Attendees

Since late 2008, we have observed a relatively steady number of women undergoing screening with some decrease in late 2009 and early 2010. From a high of approximately 1,600 screening mammograms in October of 2009 to a low of approximately 1,100 screening mammograms performed in December of 2009, we have observed a return to previous levels and now exceed pre-USPSTF recommendations for mammographic screening numbers in all age groups. The decrease was not age-associated as the number of screening mammograms in the 5th, 6th, and 7th decades of life all decreased in parallel and suggest that factors other than the USPSTF recommendations account for the variations observed.

Conclusions

Screening mammography is not a perfect breast cancer screening tool. Despite inherent limitations and costs of the technology, we consider the evidence that screening mammography saves lives to be powerful. We have not observed a change in practice in screening mammography in eastern North Carolina since the publications of the USPSTF recommendations of November 2009 and continue to advocate that average risk women be invited to participate in a mammographic screening programme starting at age 40. ■

A full list of references is available on request to the Managing Editor Dervla Gleeson at editorial@imagingmanagement.org

DOES CAD PROVIDE AN ALTERNATIVE TO DOUBLE READING?

What the CADET II Study Tells us About the Cost-Effectiveness of CAD

Can you briefly summarise the aims and conclusions of the CADET II study for our readers?

The aim of the CADET II study was to determine whether the performance (cancer detection rate and recall rate) of a single reader using CAD (SRCAD) could match that of the standard protocol in the UK NHS Breast Screening Programme (BSP), of double reading. Mammograms from over 28,000 women attending the screening mammography trial were double read and then read by another reader using CAD, and cancer detection and recall rates were compared. There was no significant difference in cancer detection rate (87.2 SRCAD vs 87.7 percent DR), although there was a small but significant increase in recall rate with SRCAD (3.9 percent vs 3.4 percent DR). This is still within the acceptable limits of the UK and other European screening programme guidelines. Overall the CADET II study demonstrated that SRCAD could be an alternative to DR.

Which parameters affected the model used to assess cost-effectiveness in CADET II and how?

In our economic model we showed that SRCAD would be

cost-increasing compared to DR in all sizes of screening centre because the cost of CAD equipment, staff training and the additional assessment costs associated with reading with CAD are greater than the saving in reading costs that would be made. Sensitivity analysis showed reading time and the reader type i.e. whether radiologist or radiographer, had the greatest effect on the cost-effectiveness of SRCAD compared with DR. In addition, the cost of the CAD equipment had a significant effect.

Studies evaluating CAD have mainly focused on the higher recall rates that reportedly arise with its use - why did you decide to focus on cost-effectiveness?

The results of the CADET study had shown the clinical effectiveness of SRCAD but before it could be considered for widespread implementation in the UK screening programme, evaluation of its cost-effectiveness compared to DR was required. We focused on cost effectiveness because the increase in recall rate using SRCAD leads to additional healthcare costs: for example, additional assessment clinics and diagnostic tests.

» CONTINUES ON PAGE 22



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The New Generation of Real-time Tissue Elastography

A Higher Class of Technology

In a satellite symposium sponsored by Hitachi Aloka Medical at the recent 13th World Congress of the Federation for Ultrasound in Medicine and Biology (WFUMB) in Vienna, Dr Kazutaka Nakashima from the Department of Breast and Thyroid Surgery in Kawasaki Medical School, Japan, gave a presentation on 'The New Generation of Real-time Tissue Elastography'.

Ultrasound is the most frequently used and most important imaging modality in clinical use for breast cancer patients, according to Dr Nakashima. 'At our institution, we use it for screening, diagnosis, indication and selection of patients for surgery, and evaluation of treatment. Additionally breast elastography is a very popular tool in Japan, especially Hitachi's "Real-time Tissue Elastography", the most well-known and reliable elastography programme that has been available for the last five years. Many Japanese physicians and radiologists have experience of, and know the usefulness of, incorporating breast elastography examinations in the daily clinical treatment. Dr Nakashima himself has been one of the key opinion leaders working with Hitachi in the development of Real-time Tissue Elastography

Two Popular Tools Aid Evaluation of Elastograms

Two popular tools for the evaluation of breast elastograms have been devel-

oped. The first, the elasticity score (also known as the Tsukuba Score after the university department where the pioneer of breast elastography, Prof Ueno, works) and the Strain Ratio (also called the Fat to Lesion Ratio). Clinical studies¹ have reported that these classifications can improve specificity in the diagnosis of breast masses. And, in a retrospective study at his institution, using a Strain Ratio cut-off value of 4.4, Dr Nakashima achieved a sensitivity of 0.81, specificity

"When the specimen was cut in the horizontal direction of the tumour spread, it was clear that the main mass and peritumoural spread had been easily recognised using 3D elastography."

of 0.96 and accuracy of 0.85 in the differentiation between benign and malignant breast tumours. And, as Dr Nakashima pointed out, there were many presentations made during the WFUMB meeting of studies using the elasticity score and the strain ratio.

New Generation of Ultrasound

During 2011, Dr Nakashima has worked with a new generation of ultrasound equipment developed by Hitachi Medical

Corporation, Japan, the HI VISION Ascendus. 'The new equipment gives us greater contrast and higher resolution imaging in elastography', he said. The greater contrast and higher resolution offers new options for elastography imaging, such as real-time 3D elastography. 'In fact, using the HI VISION Ascendus, we have seen an improvement in all of the ultrasound imaging modalities: B-mode, Doppler including the new FineFlow Doppler mode, and elastography'. In particular, he showed examples where the intra-tumoral architecture could be seen in the B-mode, and with the high



HI VISION Ascendus

resolution, high S/N ratio of the 2D elastography, colour differences are seen in hard tumours. 'It is important to see the difference in tumour architecture', he added.

With real-time 3D elastography, appreciation of the intra-tumoural architecture is even greater. Dr Nakashima showed some examples where a thin slice of softer tissue was seen through the centre of an otherwise completely hard lesion. From the histological specimen after surgery, this softer stripe was seen to correspond to haemorrhage made by the previous core needle biopsy. Another example showed a significant

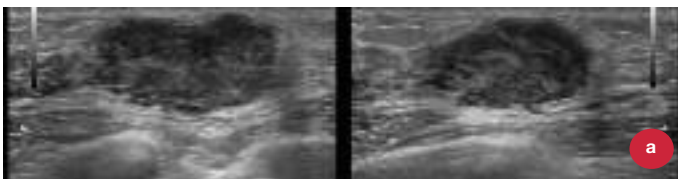
peri-tumoural hard band. When the specimen was cut in the horizontal direction of the tumour spread, it was clear that the main mass and peri-tumoural spread had been easily recognised using 3D elastography.

Elastography for Surgery Planning

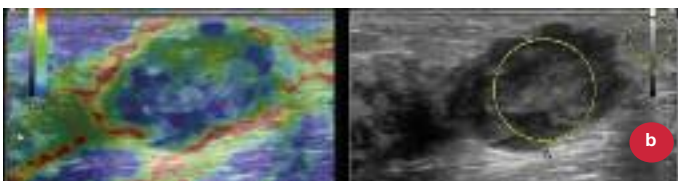
And finally, the value of elastography for planning surgery was demonstrated. If breast tumours, especially benign tumours like fibroadenoma, are to be resected, minimal surgical intervention will improve the cosmetic result after operation. By using elastography to evaluate the tumour expansion as accurately as

possible preoperatively, a minimum volume of breast tissue is resected to conserve the breast with excellent cosmetic results. 'It is very important for surgery to know the safe resectable line before operation', Dr Nakashima said. Elastography gives us good information for resection of breast tumours. Cosmetic appearance and conserving breast functions such as lactation and sensation are all possible when the resection line is as small as possible, he added.

1 Itoh A., Ueno E., Tohno E., et al. Breast disease: clinical application of US elastography for diagnosis. *Radiology* 2006;239:341-350

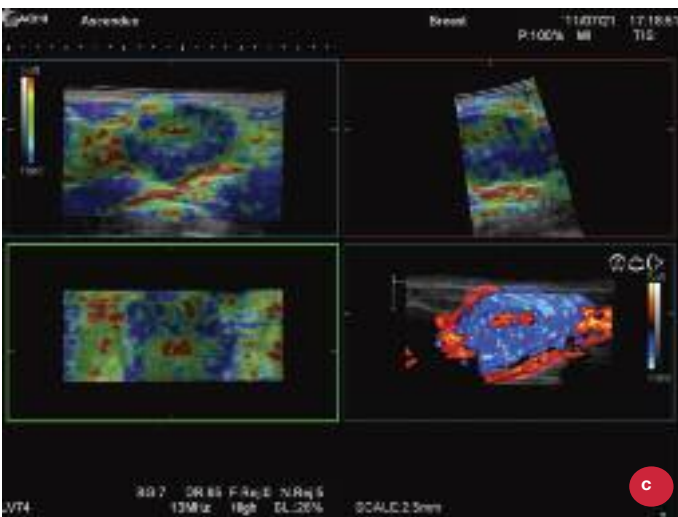


a. Heterogeneity inside the tumour is clearly seen with the B-mode



b. Corresponding colour differences are seen in the elastography mode

c. Using real-time 3D elastography, the softer stripe seen in the centre of the tumour corresponded to haemorrhage as confirmed by the histology specimen



d. Histology specimen



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What, in your opinion, is the general perception amongst radiologists on its effectiveness versus double reading at present?

The CADET II study was one of the first prospective studies conducted in the real-life setting of a screening programme and it demonstrated that SRCAD could be an alternative to DR. However, if you look at a couple of meta-analyses of CAD studies that have been published recently, the general consensus appears to be that DR, especially if used with some form of arbitration/consensus is superior to SRCAD. But it is difficult to generalise the results of CAD studies because of limitations and biases in the design of many of the published studies and also the fact that many of the early CAD studies were conducted in the U.S. Differences in the screening programme organisation between the U.S. and the EU make it difficult to interpret the impact that CAD may have on reader performance in the EU.

The main reason for radiologists being unconvinced about CAD is that they are concerned about the performance of CAD in terms of its relatively poor specificity i.e. there are approximately 1 - 2 false CAD marks per four-view case, which they find distracting and there is concern that if these false positive CAD marks are acted upon this could lead to additional recalls and associated costs. To address this, imaging scientists and commercial CAD vendors are constantly working to try to improve the specificity of the algorithms and make CAD marking more informative. In the UK many of the units used for screening are analogue and not digital mammography. It is difficult to implement CAD with a film/screen system.

Many EU countries cite a shortage of trained radiologists. Could this trend incentivise imaging departments to deploy CAD?

Yes it could. Now that screening programmes are moving over from film-based to digital mammography systems, it will be much easier to integrate CAD into workflow. There is no need for the additional step of digitising films and CAD marks can be displayed directly as an overlay on the digital images on the reviewing workstation. However, many departments are also training radiographers to be mammography readers and the use of radiographers in DR could be a more cost-effective solution to the shortage of specialist breast radiologists. This is why it is important to evaluate the cost-effectiveness of using CAD with different grades of readers.

You conclude that indeed, CAD is not cost-effective – can you summarise the reasons why and elucidate with some figures that demonstrate this?

The higher recall rate of single reading with CAD versus double reading (3.9 percent vs 3.4 percent) and the assessment cost (average cost estimated for 153 UK pounds per patient) were the main reason why CAD is cost ineffective even in high volume screening sites where economies of scale allow the lowering

One of the most startling findings, elaborated in detail in the report, is that “CAD is cost increasing for all sizes of screening unit.” As with most new technologies, prices generally come down some time following uptake: is greater affordability of the equipment something that would or should make CAD more attractive to buyers?

It is likely that large-scale introduction of CAD technology should allow for CAD vendors to offer more competitive prices and therefore make it more attractive to healthcare purchasers.

of the equipment cost per woman screened. According to sensitivity analyses results, if the assessment visit for all women had consisted only in an ultrasound, SRCAD would have been cost saving compared with double reading in both high and average screening units. This is impossible because according to latest NHS Breast Screening Programme data, 32 percent of assessment visits include a needle biopsy and an additional 2.2 percent of women are referred for an open biopsy. The only possibility for SRCAD to be cost effective is to improve CAD's performance and lower the difference in recall rates between SRCAD and SR. If the difference becomes as low as three percent SRCAD would be cost saving in high and average volume sites.

What does the study tell us about what further needs to be done to assess the cost performance and utility of CAD?

More accurate estimates of the cost of CAD equipment and upgrading need to be determined. The number of CAD servers and workstations required is dependent on the size of the screening centre. Also, if

CAD technology was to be used in a national screening programme then it is likely that bulk purchases could be negotiated with commercial suppliers. The estimation of healthcare costs should also take into consideration any increase in healthcare resource use arising from increased anxiety and stress associated with unnecessary recalls.

In view of the high false marker rate with CAD, the additional cost of involving an additional reader to arbitrate cases in which there is discordance between the human reader and CAD should also be evaluated. Arbitrating all discordant cases would clearly not be cost effective so appropriate reading training and QA with CAD should be introduced to minimise the need for arbitration.

Is the current streaming of students into mammography reading practice adequate?

More radiologists and radiographers are being trained in mammography reading. Reading standards continue to improve. This results in a reduced need for CAD.

Not all breast radiologists are going to hit the same, consistent level of accuracy every time. What is your opinion on the statement that CAD, even with its higher recall rate, is better at detecting cancers, and that increased costs should therefore be balanced against this consideration?

In screening mammography, readers need to look at large numbers of mammograms and only about six per 1,000 are cancer cases. This is a challenging task and it is recognised that there is considerable variation in performance between different readers and by the same reader on different occasions. This is partly due to individual perceptual variation but can be influenced by reader fatigue and distraction. CAD does not suffer from these human limitations so should be more consistent in its performance. However, even CAD does not have 100 percent sensitivity and specificity. Although CAD detects some cancers that the human reader has overlooked or misinterpreted there are also some cancers that the human reader(s) detect that are not marked by CAD. This was shown in CADET II study. ■

BREAST SCREENING: WHERE DID SKEPTICISM ORIGINATE?

This year, a BMJ paper* that aimed to compare trends in breast cancer mortality within three pairs of neighbouring European countries in relation to implementation of screening, cast a shadow on the efficacy of breast cancer screening programmes by investigating what factors other than screening might be attributable to the improved mortality rates. Critics of breast screening state that it can cause as much harm as it can good, and that new additions to the armamentarium such as tamoxifen and adjuvant chemotherapy may account for decreased mortality, as well as the fact that the programme focuses on early detection, but a smaller tumour can be a more aggressive one. Also, using data from, amongst others, the World Health Organisation, the paper in the BMJ stated that for those countries where women went largely unscreened, this decline in mortality was still evident. It also noted that the greatest reductions were for

the age bracket of 40 – 49, in which screening was not uniformly mandatory. “Deaths from breast cancer are decreasing in North America, Australia, and most Nordic and western European countries. After more than 20 years of intensive mammography screening in some of these countries, however, it is still difficult to determine how much of the observed reduction in mortality can be attributed to earlier detection of breast cancer or to improved management” state the paper’s authors.

Further Reading:

*Breast cancer mortality in neighbouring European countries with different levels of screening but similar access to treatment: trend analysis of WHO mortality Philippe Autier / Mathieu Boniol / Anna Gavin / Lars J. Vatten

This study reinforced that of an earlier one conducted in the U.S. in late 2009, when a group of government-funded independent experts decided to change their recom-

mendations. Instead of advising annual mammograms in all women age 40 and above, the U.S. Preventive Services Task Force (USPSTF) said women shouldn't routinely get screened until they hit 50, unless the patient had a genetic mutation (BRCA1, BRCA2) or known chest radiation exposure and those between 50 and 74 should only have mammograms every two years. Concern erupted that this would discourage women in this age group from taking part on breast screening programmes and that it might negatively impact reimbursement. Subsequently, a small study conducted by Davidson et al at the University of Massachusetts Medical School found that eight out of ten women felt that these new guidelines were unsafe, and would not put off screening as a result – in fact, it also showed that most of these individuals had an excessive estimation of their personal risk of developing the disease, which was felt to be attributable to the high level of attention given breast cancer by the media and various interest groups.

Digital Breast Tomosynthesis Technology

Foundation of a State-of-the-art Breast Unit

Cerrahpasa Medical Faculty at Istanbul University, Istanbul, Turkey

Breast imaging has long been a major focus of the radiology department at Cerrahpasa Medical Faculty, a top teaching hospital in Istanbul, Turkey, and one of 17 medical departments of Istanbul University. Three full-time radiologists and four full-time technicians, all dedicated breast imagers, perform 8,000 mammograms annually.

Last year, as part of the University's commitment to provide patients and students with access to leading-edge medical technology, Cerrahpasa Medical Faculty built a dedicated Breast Radiology Unit, investing in the latest technologies to detect and diagnose breast cancer at its earliest stages. "We have a

very modern facility," declares Professor Ayça Altug, M.D., Chairman of the Department of Radiology. "We are the first facility in Istanbul to implement digital imaging for a full-range of breast health services, from screening mammograms to diagnostic biopsies."

Working with Hologic, the radiology department installed leading-edge digital imaging technology, including a Selenia® Dimensions® breast tomosynthesis system, "Our facility is unique because we have all

new equipment and the most advanced technology," states Professor Altug.

The Mission to Find Cancer Earlier

Breast cancer is the most common type of cancer for women in Turkey, and it is estimated that 20,000 new cases of breast cancer are diagnosed each year. For Prof. Altug and her staff at the Medical Faculty, early detection is the key. "Our mission is to detect breast cancer at the earliest stage, using the innova-

"It is our expectation that breast tomosynthesis will be better than 2D mammography to find multifocal and multicentric foci in women with dense breast parenchyma"

tions in technology, to provide better treatment for patients and to reduce mortality," states Professor Altug. "We are very pleased to have tomosynthesis technology because it is better for the detection of small tumours, less than 1 cm, and microcalcifications, obscured by dense breast parenchyma, enabling us to detect more DCIS."

What Does Breast Tomosynthesis Do?

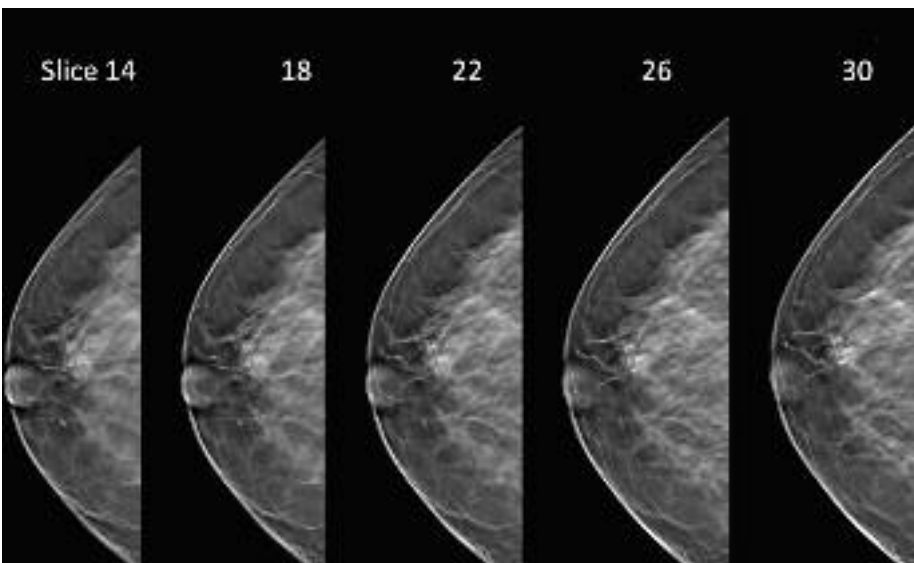
Digital breast tomosynthesis technology provides a clearer view of areas within the breast that are sometimes obscured by dense or overlapping tissue on a conventional 2D mammogram. Breast tomosynthesis is a three-dimensional imaging technology that involves acquiring images of a breast at multiple angles during a short scan. The individual images are then reconstructed into a series of thin, high-resolution slices to provide topography of



Professor Altug and her staff perform 8,000 mammograms annually at Cerrahpasa Medical Faculty, a top teaching hospital in Istanbul, Turkey.



According to Associate Professor Mehmet Halit Yilmaz, Director of Breast Imaging, "The earlier we detect the lesions, the more we save lives."



3D (tomosynthesis) images are acquired in a single compression, and the examination takes only seconds longer than a conventional 2D mammogram.

the anomaly – its size, its contours and its relationship with the surrounding breast tissue. The slices can be displayed individually or in a dynamic ciné mode. Tomosynthesis images are acquired in a single compression, and the examination takes only seconds longer than a conventional 2D digital mammogram.

Cerrahpasa Medical Faculty is using tomosynthesis to screen younger women

between the ages of 40 and 50, women with dense breasts, and high-risk women. The Breast Unit is also using tomosynthesis for diagnostic purposes. Since installing tomosynthesis three months ago, the Breast Unit has performed over 500 mammograms using the technology. "Initially, we plan to implement projects to determine the women who will benefit most from tomosynthesis," explains Professor Altug.

"It is our expectation that breast tomosynthesis will be better than 2D mammography to find multifocal and multicentric foci in women with dense breast parenchyma."

State-of-the-art Breast Imaging

The Breast Unit's comprehensive breast health services include breast ultrasound and MRI as well as interventional breast procedures. "Our new facility includes Hologic's MultiCare® Platinum prone breast biopsy table and Hologic vacuum-assisted breast biopsy equipment," says Professor Altug. "We perform all of the image-guided interventional breast procedures including stereotactic, MRI-guided, and ultrasound guided biopsies, and wire localizations.

"We chose Hologic because of the excellent image quality and the user friendliness of the systems"

"We chose Hologic because of the excellent image quality and the user friendliness of the systems," notes Professor Altug. "Hologic is helping us achieve our mission of detecting and diagnosing breast cancer at an early stage."

Using Technology, Detecting Earlier, Saving Life

Since the diagnosis of breast cancer is basically dependent on a comprehensive imaging system, its sensitivity, image quality, and user friendliness are critical. "In our clinical practice, detecting small lesions and obtaining biopsies of them are the main challenges. I think we perform better with Hologic" says Associate Professor Mehmet Halit Yilmaz, the Director of Breast Imaging. "The earlier we detect the lesions, the more we save lives."

The comments included in this publication are the opinions and personal stories of the individuals quoted and not necessarily those of Hologic.



AUTOMATING TISSUE-BASED BREAST CANCER DIAGNOSTICS

Digital Pathology Software to Improve Breast Cancer Diagnosis and Therapy



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Its reliance on biomarker evaluation for diagnosis and treatment decisions makes breast cancer care a good example of personalised medicine. In addition to breast cancer biomarkers such as the oestrogen/progesterone receptor and the Ki-67 proliferation marker, HER2 (Human Epidermal growth factor Receptor 2) has received particular attention in recent years. 20 - 30 percent of women with breast cancer test positive for the HER2 protein, associated with an especially aggressive breast cancer variant. HER2 positive patients usually respond poorly to conventional chemotherapy, but benefit from therapy with Herceptin®, a humanised HER2 antibody that costs on average approximately 100,000 dollars per patient. Because this approach does not help HER2 negative patients, doctors need to reliably detect and quantify the expression of this biomarker in breast cancer patients or else risk prescribing expensive and ineffective therapy.

Biomarker detection and analysis is the responsibility of a hospital's pathology department, which follows standardised protocols to score each sample as objectively as possible based on visual criteria. While the ability of pathologists to interpret histomorphological characteristics, such as whether a tissue is cancerous, is extremely reliable, human interpretation of quantitative image features appears more difficult. Measuring the number of cells positive for a specific biomarker and, even more so, visually quantifying the intensity of biomarker stains, may suffer from significant inter-observer variability. However, objective and accurate assessment, especially in case of the predictive biomarker HER2, is highly relevant because therapeutic decisions rely on the quantitative scoring result.

Therefore, pathologists and clinicians now cite a grow-

ing need for accurate biomarker quantification tools that can support treatment decisions. Employing software to automate image analysis of histological sections can enhance doctors' understanding of breast and other types of cancer by providing insights into functional and molecular genetic characterisation of tumours. Charité Berlin is working on such a project, which is designed to provide pathologists with access to reliable, objective and standardised information that can inform treatment decisions around breast cancer. This project also has implications beyond pathology into radiology as both fields rely on visual analysis to understand patient disease states.

Seeking to arm its physicians with the best possible information about their patients' health, the Institute of Pathology at the Charité began working with Definiens, a provider of image and data analysis technology, to develop a software solution for automated scoring procedures for breast cancer patients. Based on previous healthcare projects, Definiens has shown the capability to provide robust quantitative image analysis solutions. Both organisations focus on developing a prototype that could be integrated into the pathology department and ensure oncology teams receive reliable information about patient disease states.

Overcoming the Challenges of Conventional Image Analysis

As pointed out above, the analysis of stained sections can vary between pathologists, affecting the reliability of such scores. Automated scoring algorithms are subject to no such inconsistencies, but image analysis technology is constrained in other ways. Pixel-based approaches often cannot determine the morphological features important in a tissue section, and are thus of limited value for most histopathological applications. Definiens' approach, however, unlike other technologies, is designed to analyse structures within the sample, and can understand the relationship of tissue structure, cellular components and subcellular features. These features are particularly important for histological biomarker analyses because they are the basis not only for accurate quantification but also for the reliable discrimination between tumour and healthy tissue.

The computer-assisted diagnostics systems the physicians and scientists from Charité pathology and Definiens conceived

CHARITÉ BERLIN

Charité University Hospital is organised in 17 centres comprising 103 medical departments with over 3,200 beds located in four locations in Berlin. More than 3,700 scientists and physicians work at the Charité, covering a broad range of subspecialties in biomedical research and clinical medicine. The Charité Institute of Pathology was founded by Rudolf Virchow and is one of the largest pathology university departments in Europe.

integrates different histopathological modalities (similar to different imaging sequences in MRI), analysing the tissue morphology with conventional H&E (Hematoxylin and Eosin) staining; quantifying the protein markers ER (estrogen receptor), PR (progesterone receptor), Ki-67 (cell proliferation), and HER2 with immunohistochemistry; and assessing the HER2 (Human Epidermal growth factor Receptor 2) gene amplification status with SISH (Silver In Situ Hybridisation).

Together, this allows the software to correlate the different tissue features within their spatial context and derive reliable, reproducible scores. While the current scope of the prototype is for research purposes only, the goal is to offer pathologists a comprehensive and objective basis for therapy recommendation, improving breast cancer treatment by selecting the appropriate therapy for the individual patient.

Scoring Mechanism

The software is designed to compute scores based on a wide range of clinically significant variables, particularly morphology and multiplex biomarker expression. In practice, scoring of the tissue section images according to the established algorithms - Elston-Ellis for H&E, Allred for nuclear IHC markers and HercepTest for membrane — allows the pathologist to communicate with clear and well-documented recommendations for targeted therapy. With respect to HER2, cases with a low expression (scores of 0 and 1+) are not suitable for further investigation for inhibitory treatment, while a high HER2 expression (score 3+) is predictive of the efficacy of Herceptin therapy. Cases that score 2+ are followed up with a measurement of the amplification of the HER2 gene using SISH, and, in case of amplification, Herceptin therapy is recommended.

To develop and validate a software prototype that can present a simple numerical score to physicians, Charité Berlin provides Definiens with 150 samples. For each sample, seven sections are stained: one for H&E, one each immunohistochemically stained for biomarkers HER2, ER, PR and Ki67, and SISH analysis for HER2 and Chromosome 17 (Chr17). All these data are fed into a three-level hierarchical classifier. First, relevant features are extracted from the image data for each slide. The programme then determines a score for each modality examined. Finally, the individual scores are combined into a total score to be reviewed by the pathologist and presented to the attending physician. Pathologists manually score half the samples as reference points.

Interface Development

The new prototype works with many different platforms

because a pathologist's working environment is marked by a heterogeneous hardware and software environment. On the hardware side of the equation, slide scanners from Aperio, Leica, 3DHistech and Hamamatsu are common. A recently developed system from Philips promises even higher throughput and automation. The data management is often independent but connected to the hardware; companies such as Roche, Aperio and Nexus are the most common such data management providers in pathology labs.

To develop the software as an intuitive component of a pathologist's workflow, Charité Berlin and Definiens are paying special attention to the graphical user interface (GUI), implemented in a web browser with Web 2.0 technologies such as XHTML, Javascript and Ajax. This allows the pathologist to perform different jobs and access data and analysis with a variety of hardware (whether from a desktop, a laptop or a tablet) and operating systems (Microsoft Windows, Apple OS, Linux). The GUI is often similar, if not nearly identical, to radiology applications. The web-based GUI will also allow pathologists to perform remote work (e.g. telepathology) or to consult with other experts using the internet. The system may also be used for education purposes to train students for manual scoring and tissue examination.

Broader Implications

Collaboration between research and clinical disciplines enables physicians to draw upon new findings in predictive molecular pathology, where pathologists not only diagnose a certain disease but also provide molecular characterisation and recommend a particular therapy. In this regard, image analysis promises to provide insights into functional and molecular genetic mechanisms of tumours, and helps translate this knowledge into clinical practice. Furthermore, the software prototype provides a new, image analysis-based evaluation algorithm that considers a range of immunohistochemical factors in recommending treatment decisions. Given the need for more reliable, objective scoring regimens in pathology, it represents what Charité Berlin expects will be among the first in a new generation of image analysis programmes.

Such an image analysis approach can work similarly for radiology as for pathology. Given the convergence of the two fields, one can expect the development, implementation and benefits of new programmes to track Charité Berlin's experience with the breast cancer-oriented software thus far. In this case, software may well provide quality improvements that could augment physicians' clinical effectiveness and help patients receive the best

TECHNOLOGY HORIZONS: DIGITAL RADIOGRAPHY

Market Outlook and Trends



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The emergence of digital radiography has altered the face of radiography in the recent past. It has offered a new standard for digital x-ray image capture. DR technology has brought about a transition from film-based image capture to direct digital image capture that can be previewed immediately after exposure. This optimised workflow provided by DR is highly beneficial for end users particularly those with huge patient volumes. An estimated 70 percent of all imaging procedures are general radiography and therefore the transition to digital represents enormous market potential. Together with advancements in PACS, DR can help enable radiological departments realise improved patient throughput, optimised workflow and greater productivity.

Obstacles for Growth in DR Market

The European DR market has shown considerable growth in the recent past but not as much as predicted in the initial years after its conception in the market. There has been a significant decline in sales owing to economic factors that perceived DR as a luxury rather than a necessity. On the other hand DR systems still continue to face stiff competition from CR systems and upgrades as they are more economical and can be integrated into existing analog conventional systems making them a better choice for small hospital and private imaging and diagnostic centres with minimal budgets and lower patient volume. Although CR and DR complement each other in large hos-

Resurgence in DR unit sales is expected in the future with the implementation of digitisation becoming mandatory in certain regions of Europe

pitals, CR has become a commodity and is still preferred for low procedural volumes and general applications thereby negatively impacting DR sales. Another restraining factor for the growth of digital radiography is that end users believe that DR may not be as beneficial despite the advantages of optimised workflow and better throughput if they do not have high patient volumes. The high initial investments of DR cannot be justified if there are low patient volumes. Return on

investment is an important attribute that is evaluated by end users before a purchase to analyse their productivity in the long run.

Despite the tremendous advantages that DR has to offer such as optimised workflow, enhanced image quality and improved patient throughput a certain percentage of physicians and radiologists are still sceptical about the transition to digital. A few of them are of the notion that a number of technical aspects need to be learned in order to use the digital solutions and therefore are hesitant to adopt this technology thus, deterring them from buying DR systems.

DR Hitting its Stride in Large Institutes

On the other hand, larger hospitals and universities are adopting DR rapidly. The primary forces driving this adoption are the significant reduction in patient exposure to radiation, greater throughput, flexibility in image manipulation and enhanced diagnostic image quality.

The widespread increase in PACS installation owing to decline in its prices is also acting as an impetus for the growth of DR in Europe. The enhancement in the clinical value of PACS such as the ability to make digital images accessible anywhere through digital network is fuelling the growth of DR. Some vendors in Europe are also adopting a strategy of offering comprehensive packages comprising of PACS and DR systems making it more appealing to buyers who are looking to acquire an archiving system and also make the transition to digital at the same time.

Market Trends

Wireless, mobile and retrofit DR are being increasingly utilised and are likely to be a growing trend owing to their easy integration into existing conventional and CR systems, providing digital technology at lesser effort and inconvenience. Mobile and retrofit DR helps make the transition from CR to DR cost-effective and with less inconvenience. These mobile retrofit kits can be integrated into existing CR systems and help in upgrading them to DR technology and help to improve productivity and provide immediate image access.

Also making a big impact on the digital x-ray market are flat panel detectors (FPD). In particular, FPD devices are gaining prominence in room-based angiography owing to their

significant improvements in image quality, processing speed and dose-reduction. While the benefits of FPD have been proven to healthcare providers, the cost is a restraining factor preventing a faster shift to the technology. The high initial investments associated with FPD systems combined with recent capital expenditure freezes and hospital budgetary cutbacks have deterred product penetration. While hospital administrators are forced to decide whether the benefits of FPD DR System outweigh the initial purchasing costs. However with the decline in flat panel detector prices, the technology is expected to reach a wider customer base.

Certain DR vendors are also setting their sights on market expansion and are keen on venturing into developing markets or price conscious markets and hence are trying to make DR available to these markets through a concept of economic DR. These units are best suited for the price conscious Eastern European regions where DR is not in

Technology Trends

Since its inception in 1997 many developments have taken place in DR technology sector. Some of the most significant developments in DR technology have occurred, mostly in 2009. Some of these developments are still underway in Europe and expected to be introduced in the near future.

Portable FPDs: In the past, fixed DR detectors were restricted by the positioning limits of a vertical wall stand, table bucky, or programmable U-/C-arm. Portable FPDs have added a great deal of flexibility to DR systems, enabling DR to be used in a broader range of applications which require cross-table or bedside imaging. In some instances, portable FPDs provide dual-detector functionality at a lower cost, since only one detector is needed and can be moved between positions within a wall stand and table bucky. Standard cassette-sized portable FPDs enable easy integration of DR technology into existing analog or CR systems, which has helped make the transition to DR easier and less expensive for many end-users. Portable FPDs are also available in smaller and lighter sizes, making them convenient in field and mobile imaging applications.

Wireless Portable FPDs: The integration of wireless technology into portable FPDs has been one of the most significant technology advancements in DR. This enhancement has added even more flexibility to portable FPDs, which previously required the attachment of a tethered cable during imaging and image data transfer. In addition to the numerous advantages that this technology now provides, the integration of power and wireless data transmission capabilities into

portable DR panels is a significant engineering design feat.

Dual - Energy Imaging, Digital Tomosynthesis and Computer Aided Detection (CAD): These three major technological developments are looked upon as having potential to enhance the sensitivity of DR thereby boosting its diagnostic power making it more competitive than CT for chest imaging and diagnosis. Dual energy imaging digitally subtracts bone from lung soft tissue to reveal pulmonary nodules hidden behind ribs that are otherwise not clearly visible. On the other hand CAD software incorporated with DR enhances its sensitivity in detecting lung nodules and acts as a second reader aiding inexperienced radiologists to make accurate diagnosis. The addition of digital tomosynthesis features to DR provides a sense of depth and volume and is an improvement over conventional radiography as it provides 3D information and aids in pathology detection which otherwise might be a tedious task with 2D radiography. These three technological developments have great potential for DR in future once all clinical doubts surrounding these features are addressed

Dual Modality R/F Systems (DR/Fluoroscopy): The Dual DR and Fluoroscopy system which is a combination of a DR and Fluoroscopy is a recent technological advancement. This smart combination of radiography and fluoroscopy provides cost effective comprehensive clinical functionality. ■

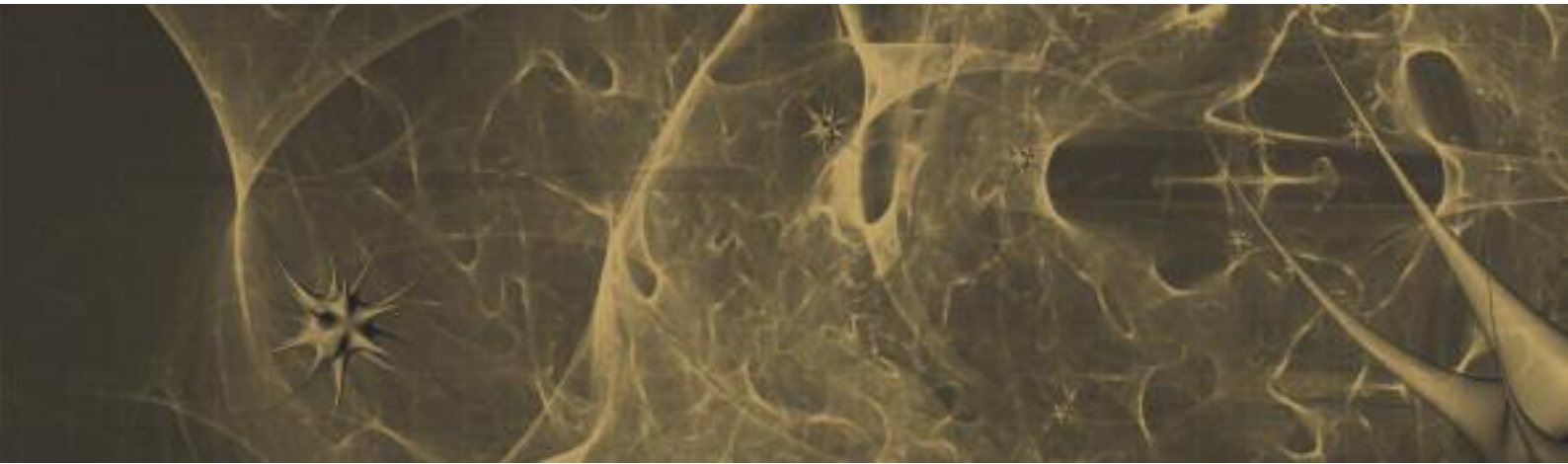
MARKET OUTLOOK FOR DR

Germany is the most industrialised country in Europe and is one of the largest DR markets. The Scandinavian countries are technically the most developed regions of Europe in terms of installation of DR. Most hospitals in the Scandinavian regions are already digitised and are in a phase of replacing CR with DR. The United Kingdom on the other hand is a potential DR market but has been rather moderate in terms of growth. Benelux, like the Scandinavian regions, has been one of the quickest in adopting DR. Spain and France have been slow markets owing to their low investing power. These regions comprise of smaller hospitals and private imaging centres that have shown keen interest in CR systems that fall in line with their budgets and needs.

Resurgence in DR unit sales is expected in the future with the implementation of digitisation becoming mandatory in certain regions of Europe. Hospitals and large universities that have delayed purchases owing to the unfavourable economic factors and minimal budgets are expected to purchase DR in the near future this may also be due to decline in PACS pricing as many hospitals are looking forward to purchase comprehensive packages of PACS and DR.

The Evolution OF MANAGEMENT

Review of MIR Annual Scientific Meeting,



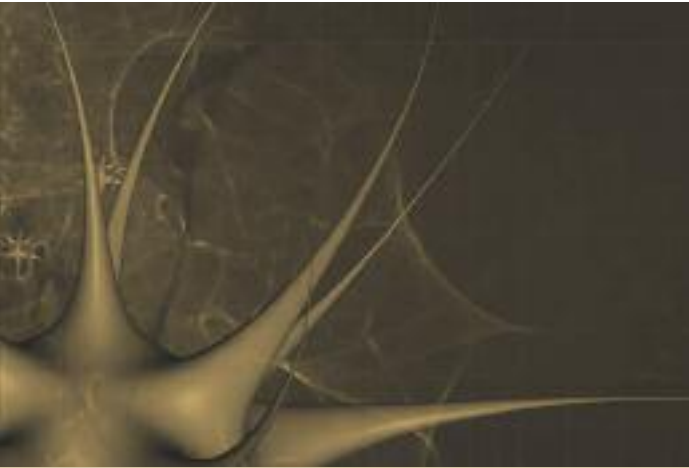
Reported by
Dervla Gleeson

Managing Editor

The lasting impression this year, left with attendees of the annual Management in Radiology (MIR) scientific meeting, is that both the organisation and the event itself, continue to grow into a highly focused event dedicated to raising awareness of management and healthcare economics topics, not just for radiologists, but for leaders in related domains of imaging-led healthcare. MIR is evolving: not only is there higher audience participation, and a more tightly-packed and varied schedule, but even more valuable information is shared as the congress draws its audience into post-session debates on each of the presented topics. In effect, MIR, as an organisation that presently offers three leadership-dedicated annual events, is clearly gaining ground.

IN RADIOLOGY (MIR)

Nice, France (Sept. 29 – 30, 2011)



Prof. Peter Mildenerger,
Chairman of Management
in Radiology

MIR Chairman, Prof. Peter Mildenerger (Mainz, DE) kicked off the meeting by drawing attention to the growing importance of strategic thinking and the notable evolution of radiology as a science, which were the flavours of both this year's meeting as well as the profession of radiology itself. Prof. Mildenerger also welcomed the inclusion, this year, of junior radiologists, who had spent the day preceding the congress receiving mentoring, interview coaching and career advice, and were also welcomed to the main congress itself. More and more, the next generation of imaging professionals are recognising the vital importance of learning management skills as early as possible: the old impression of radiologists as being management and leadership-shy is rapidly evaporating, and MIR is lighting their way.



Record High Attendance at
This Year's Edition

Prof. Yves Menu (Paris, FR) who acted this year as Chairman of the POC emphasised that the MIR congress is "... of interest to many people, not just radiologists, and that in its role as a sub-committee of the European Society of Radiology, it provides a focused platform for these topics, for the ESR, for the POC, and for participants".



Prof. Elisabeth Schouman-
Claes Speaks on
Benchmarking Results

Dr. Jane Adam & Prof. Rémy Demuth Chairing a Session



Session Highlights

The congress covered a range of useful sessions on topics from reporting, coding and finances, to imaging strategies, clinical decision support, architectural and organisational challenges, e-health, controversies in ultrasound, and also management issues in education and research. A new facet of the meeting was included during the second day of the congress, which included the presentation of abstracts for poster presentations. This innovation was designed to encourage the participation of researchers, including radiologists in training, and radiology managers. The best papers were presented in a special poster session under the topic of “Management Around the World” of whom the winners included Sophie Calmus, Gabriel Bartal, Martin Maurer, Béatrice Falise Mirat, Daniel Pintos dos Santos, Nadine Koff, Maren Ebert, Bernd May, Mansoor Fatehi.

Attendees Found the Sessions of Great Interest



Why is Management Important to Attendees?

As pointed out by MIR Chairman, Prof. Mildenberger, management is increasingly important in times of crisis. This was emphasised by presenter and attendee Prof. Rémy Demuth who stated that “*Simply put, management is an important part of our job.*” This was the overall viewpoint held by congress attendees, that particularly for medical imaging, management is one way to ensure ongoing high standards of professionalism, technological performance and renewed commitment to the patient.

The junior section of the MIR congress audience from the preceding day’s management meeting also benefitted from this focus. As the younger generation, they recognise that to advance in their careers, management is something that should be developed right from the beginning. Presenter and long-standing contributor to the MIR congress, Prof. Howard Galloway stated that he was “... *pleased to see the inclusion of young radiologists in the congress. It is very important to capitalise on the enthusiasm of young residents and ensure that they take part in management education.*”

Prof. Lorenzo Derchi with Dr. Sue Barter



Finally, second-time MIR attendee Dr. Sana Pasqualine stated “*Every time I attend MIR, I get something new. For example, I am attending an interview next week. As a radiologist, at the interview your practical skills are taken for granted, it’s very clear if you are a good radiologist or not. But now, your potential employer also wants to know things related to management, for example how you manage finances, what you are like as a colleague to work with, and your expectations of being in a position of management, on which you are expected to have an opinion.*” Clearly, while the larger more well-known annual radiology gatherings provide a certain smaller focus on management, there is a definite need for this congress, which provides a management-trained viewpoint.

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What's Next for MIR?

The dates and locations for next year's edition of the MIR Annual Scientific Meeting and related events are as follows:

- Management in Radiology **Annual Winter Course**, January 12 – 14, 2012, (Schladming, Austria), during which experienced trainers from "Inspire Change" will coach a select number of attendees on the following five key topics:

- :: Chairing National & International Meetings
- :: Advanced Presentation Skills
- :: Negotiating
- :: Dealing with difficult people
- :: Influencing

- Next year's **Annual Scientific Meeting** will be held in Genoa Italy from October 11 – 12, 2012, so save the date in your meeting calendar!

- The next edition of the **MIR Junior Course** will be held just prior to the Annual Scientific Meeting, on October 10, 2012, in Genoa, Italy. ■

Prof. Peter Mildemberger
& Prof. Elisabeth Schouman-
Claes



Junior Radiologists Were
Strongly Involved This Year



Young Radiologists Speak
With Prof. Elisabeth
Schouman-Claes



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AUDITING RADIOLOGY REPORTS

Using Audit Data for Rational Process Improvement



Dr. Howard Galloway

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The advent of teleradiology and the outsourcing of reporting have increased focus on the audit of radiology reports. However, thus far there has been little examination of the evidence that could underpin a rational approach to audit. Audit data as well as performance monitoring provide information that may be used to systematically improve the quality of radiology reporting.

Four major questions arise when considering how this might be achieved:

1. What are the reported rates of discrepancy and are they comparable, appropriate or meaningful?
2. Can acceptable performance levels be determined on the basis of what is reported in the literature?
3. What are the current methods of audit and what are the current classification systems?
4. What would the features of a system that could potentially inform evidence-based interventions be?

Studies Report on Discrepancy Rates

A large number of reported studies compare the performance of residents with specialists or specialists with sub-specialists, which do not reflect most common situations of peer review. In addition, studies from large teleradiology services rely on client sites to report discrepancies, which may not provide a true indication of discrepancy rates. The largest series of 124,870 cases reported by 10 radiologists from a U.S. teleradiology provider reports an average discordance rate of 1.0 percent, with body CT having the highest rate of 2.1 percent (Wong, 2005). This is the lowest rate reported in the literature but relies on client sites for over-reading.

Branstetter (2007) demonstrated a significant discordance rate between preliminary and final reports for senior radiologists in an emergency situation of 88 / 3,587 (2.5 percent) for CT and 3 / 253 (0.5 percent) for CR in a major trauma centre. This is similar to the ACR RadPeer self-reported rate from institutions and practices across the U.S. of 2.1 percent for major discrepancies across all modalities. Stevens (2008) summarised previous studies with a variety of selection criteria showing a major discrepancy rate from 0.5 to five percent with a mean of 1.79 percent. However, even among staff radiologists, there is substantial inter ob-

server variation (between 2.1 percent to 23 percent) in the interpretation of cross-sectional imaging studies

In terms of the level of discrepancy that might require remedial action, there is very little in the literature. Anecdotally, concerns about reporting performance are raised on the basis of individual cases rather than review of overall performance. One study that may provide an indication is that of Siegle (1998) who reported a review of 1,100 studies by 35 community radiologists over seven years showing a 4.4 percent mean rate of disagreement with three percent felt to be below standard of care.

The current audit process identifies discrepancies but does not provide sufficient information for specific process improvement.

From the reported rates, it would seem that a significant discrepancy rate of two - three percent for body CT would be an acceptable level of performance. What constitutes an unacceptable level of performance is less clear, although anecdotally, in some organisations levels of or above four percent on random sampling prompt a more systematic performance review.

Current Audit Process Insufficient

The current audit process identifies discrepancies but does not provide sufficient information for specific process improvement. Any current positive effect of audit is likely to be due to a non-specific manifestation of the Hawthorne effect where process improves only because it is being

watched. General studies demonstrate only small changes in doctor behaviour with the provision of various forms of feedback. Uniformly negative feedback has been found in many circumstances to produce a paradoxical effect with decreased motivation, disengagement and a resulting decrease in performance.

What systems may be used to classify discrepancies and what potential do they have to inform systematic quality improvement? There are three main ways of classifying discrepancy data. These are:

1. Clinical impact

This is the system most commonly used and is advised by the NHS. This system has potential utility particularly when liaising with clinicians and client departments and determining clinical follow-up action. Problems, however, include inconsistency and the difficulty of assessing the clinical impact from the request and radiological data alone. There are issues with peer review radiologists having sufficient expertise to reliably and consistently classify clinical impact. The most important problem is that it does not provide information about the possible cause of the discrepancy.

2. Peer assessment

The American College of Radiology RadPeer project uses a system based on the reviewing radiologists' opinion of the difficulty of the diagnosis. This shows that on random review radiologists concur with the original interpretation ~97 percent of cases. This has the value of incorporating a peer assessment of the difficulty of the case but does not provide more specific information to inform causal analysis of discrepancies.

3. Causal classifications

Unlike classification systems based on putative clinical impact, a classification based on proposed cause offers the opportunity to undertake targeted action for quality improvement.

Alternative Classification Systems

Renfrew (1992) proposed a classification system that tries to assign possible causes based on decision analysis methodology. This has consistently shown false negative errors and perceptual / cognitive factors to be the major component of discrepancies. More sophisticated variations on this theme have been used e.g. the Australian AIMS system, and are forming the basis of the proposed WHO classification. However, personal experience of attempting to apply these systems to radiology has shown that they are too complicated

for routine use. A simplified system based on Renfrew's paper classifying discrepancies into three broad categories as false positive, false negative or misattribution with further simple sub-classification is proposed.

Errors due to misattribution would be expected to be amenable to focused education or feedback from clinical outcomes. False positive errors likewise may represent failure to appreciate normal variations, which can be dealt with by education.

Mammography screening has demonstrated that feedback of operative results can inform the refinement of callback rates. False negative discrepancies are the most common. It is tempting to ascribe such errors to lack of care and attention. This, however, is not productive, as errors have been consistently reported to occur at a relatively constant rate over time and across different individuals. The majority of false negative discrepancies are apparently perceptual errors often in the setting of multiple abnormalities either related or unrelated.

Attempts to reduce false negative perceptual errors could focus on both systematic and individual factors. The work environment may contribute with poor lighting, cramped conditions and multiple distractions playing a role. Individual factors such as fatigue or eyesight illness may also play a role. Workload itself may be a major factor and there are surprisingly little data to correlate workload with discrepancy rates. One study showed that the discrepancy rate for body CT studies doubled faculty radiologists reported more than 20 studies a day but this was not statistically significant

Concluding Thoughts

The need for and inevitability of radiology reporting audit is now generally accepted. The challenge is to perform audit in a statistically valid manner and collect data that provides information that can potentially inform rational process improvement. Human factors are central in this and the effects of various forms of feedback and the need for radiologists to have professional and individual ownership of the process is vital if audit is to achieve the key goal of improving patient care. ■

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WHAT'S IN STORE FOR MOBILE HEALTH & TELEMEDICINE TECHNOLOGIES?

E-health Services Require Improved Network Infrastructure



Constantinos Pattichis is Director of the Department for Computer Sciences at Nicosia's University of Cyprus. He has a keen interest in the development of mobile health and e-emergency services both nationally and across the globe. Here, he shares his thoughts on the capabilities of mobile technologies, and discusses the need for improved infrastructure.

You were involved in several European-funded m-health and e-emergency projects – what has happened since these concluded?

Yes, I was involved with several e-health projects awarded via the EU European Regional Development Fund (INTERREG) to the University of Cyprus, in collaboration with the Ministry of Health of Cyprus, Nicosia General Hospital, Makarios Hospital, Pafos General Hospital, and Polis Chrysohous Hospital (including the rural medical centres at Kyperounta, and Pyrgos). These projects covered the development of an integrated platform for improving healthcare provision in the Mediterranean region and on mobile and robotised telemedicine for emergency vehicles, and monitoring of children with cardiac diseases funded by the Research Promotion Foundation of Cyprus. Unfortunately, although these services were successfully deployed and their need has been clearly demonstrated, they have not been placed in routine clinical practise, so that patients could truly benefit.

Is there any data assessing how cost-effective the use of m-health and e-emergency services are in comparison to traditional methods?

It is generally argued that m-health & e-emergency services are still largely undeveloped not only in Cyprus but in other EU countries as well. The success, experience, and benefits of clinical services in emergency telemedicine have only recently been published on a large scale of emergency cases by the telemedicine programme at the State University of New York at Buffalo School of Medicine, and the Erie County Medical Center (UB/ECMC). It was shown that the use of emergency telemedicine services could re-

sult in an approximate 15 percent decrease in the number of ambulance transports when it is added to the pre-hospital care provider's services, with an emphasis on younger subjects. However, more convincing studies are encouraged in order to promote the wider deployment of e-emergency systems and services.

How does remote diagnosis and care in emergency medicine systems benefit geographically isolated locations?

The use of remote diagnosis and care, and emergency telemedicine systems is of vital importance in Cyprus given that people living in remote locations on the island do not have access to specialised health services at a satisfactory level. As a result, inadequate health service provision and quality of life deterioration associated with the long distances that have to be travelled to reach specialised medical care, especially for the elderly, are greatly improved using robust telemedicine systems, enabling adequate medical access to remote habitants.

To this end, a unifying framework for an efficient end-to-end mobile-healthcare system for transmission of diagnostically robust medical ultrasound video has been developed within the framework of "Real-Time Wireless Transmission of Medical Video", funded by the Research Promotion Organisation of Cyprus. It is based on a spatially varying encoding scheme, where video slice quantisation parameters are varied as a function of diagnostic significance. Clinical criteria are first used for determining the regions of diagnostic interest. The regions are then used to specify video slices with independent coding control. Video slices can be automatically set based on segmentation algorithms or manually defined by the relevant

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Dervla Gleeson

Managing Editor

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medical expert. They are then encoded using a modified version of H.264/AVC Flexible Macroblock Ordering (FMO) technique that allows variable quality slice encoding and Redundant Slices (RS) for resilience over error prone transmission mediums.

Evaluation of the proposed scheme was performed on a representative collection of 10 ultrasound videos, nine of the carotid and one of the femoral arteries, for packet loss rates up to 30 percent. Extensive simulations incorporating three FMO encoding methods, different quantisation levels, display resolutions, frame rates, and different packet loss scenarios were investigated. Overall, a coarse to fine parameter optimisation was used for determining the minimum diagnostically acceptable source encoding parameters and corresponding bitrates for transmission over 3G (beyond) wireless networks.

Quality assessment was based on a new clinical rating system that provides for independent evaluations of the different parts of the video. Objective video quality assessment metrics were also employed and their correlation to the clinical quality assessment was derived. To this end, some objective quality assessment measures computed over the diagnostic ROI video slices gave very good correlations to Mean Opinion Scores (MOS). Here, MOS were computed by two medical experts.

Experimental results show that the proposed method achieves enhanced performance in noisy environments, while at the same time achieving significant bandwidth demands reductions, providing for transmission over 3G (and beyond) wireless networks. The proposed unified framework can be applied with minor modifications to other medical modalities.

What are the main challenges for the application of m-health in clinical practice?

The main challenges for the application of m-health in emergency healthcare systems and services can be grouped under communication systems, computer technology, biosignals and emerging technologies on the transmission of wireless digital images and video.

In many countries 3G (i.e. UMTS) and 3.5G (HSPA) mobile cellular networks are currently installed and operational, which provide typical upload bandwidth of up to 4Mbps (3G: 200-300kbps, 3.5G: 500kbps – 4Mbps) something that will enable the transmission of more information or example, continuous 12 leads of ECG when monitoring cardiac patients from a moving ambulance, as well as bandwidth-demanding real time medical video transmission for emergency telemedicine and remote diagnosis

and care. Depending on bandwidth availability, different quality, resolution and frame rate encoding may be considered to facilitate efficient system deployment. Towards this end, diagnostically relevant scalable video coding (SVC) may be employed to provide for different encodings that correspond to different bitrates, and therefore clinical capacity. Efficient encoding methods, incorporating error resilient implementation and error concealment mechanisms for recovering from transmission errors over aforementioned error-prone wireless channels, are also key to the success of emerging m-health systems for medical video transmission.

The use of such networks will give healthcare providers immediate high-speed access from anywhere in the area of a city

The diagnostic capacity of the transmitted medical video should be thoroughly evaluated by medical experts to investigate the effect of compression on medical video transmission. Traditional mean-square error measurements do not necessarily correspond to perceptual quality, and may correspond even less to diagnostic quality. As an example, image quality assessment over the near-regions of ultrasound video is not useful, while in general, users expect the highest quality in regions that are in the focus of the ultrasound beam. In addition, there will continue to be strong interest in region of interest (ROI) and object-based coding methods. The challenges associated with applying these methods require the development of effective segmentation methods.

Another important factor is the emergence of wireless metropolitan area networks (WMAN) in cities (e.g. WiMAX with tens of Mbps), something that will significantly improve communication in wireless healthcare systems operating within city boundaries. Fixed and mobile WiMAX are already deployed for that purpose, with some commercial applications already installed. The use of such networks will be very important because healthcare providers will have immediate and high-speed telemedicine access from anywhere in the area of a city.

The emergence of 4G technologies (Wireless MAN Advances and LTE-Advances) conforming to IMT-Advanced requirements, promise ubiquitous access to differing radio network technologies, thus offering, beyond extended coverage, the most effective connection mode

at the point of contact, even simultaneously using several wireless access technologies and seamlessly moving between them. 4G networks will facilitate even greater availability of bandwidths, lower latencies, enhanced mobility and quality of service support, enhanced service provision near the cell edge, security, and other cutting edge technologies, all of which are highly beneficial for future m-health systems and services development.

What other technological advances will aid more efficient remote healthcare?

The use of GPS (Global Positioning System), GIS (Geographical Information Systems) and intelligent traffic control systems has potential to improve healthcare services. For example, when a moving ambulance vehicle is trying to reach a patient using the fastest route, or when an ambulance carrying a patient is trying to get to the base hospital.

Modern portable computer systems have smaller size and weight but provide almost the same computational capabilities as non-portable computer systems making their use in wireless telemedicine systems highly applicable. Nowadays the introduction of portable devices like PDAs, smartphones,

netbooks and iPads is something that enables wireless telemedicine systems designers to create faster, better and smaller systems. However, there is still a need to develop compact devices with fast processing and power that are tuned in to the varied and demanding telemedicine applications.

Biosignal acquisition is another technological field that affects wireless telemedicine systems. The collection of biosignals such as ECG was till now performed using expensive devices which could only be handled and supported by medical personnel. Nowadays, very small devices can collect biosignals. They might be wearable, have the shape and weight of a necklace, etc. These devices will enable the use of wireless telemedicine systems almost anywhere and at less cost. Such devices can be used for home care purposes more easily than standard medical devices.

What are the most important infrastructures needed for m-health technologies to really make an impact in fields such as emergency services?

For medical wireless video transmission systems, the two most significant components include medical video compression technology and the wireless infrastructure that will

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be used for the transmission. Medical video compression needs to address some of the unique requirements associated with the intended diagnostic use. Efficient video compression systems can be built using current state-of-the-art video coding standards such as H.264/AVC, to provide for efficient (size-wise) real-time encoding. On the other hand, increasingly available bitrate through revolutionary wireless transmission channels realise communications previously only available to wired infrastructures, while coverage is extended practically across the globe with the latest mobile cellular and satellite systems.

H.264/AVC offers bitrate reductions up to 50 percent for equivalent perceptual quality compared to its predecessors, while currently developed H.265 aims to achieve similar reductions with respect to H.264, for an even improved coding efficiency.

The evolution of mobile telecommunication systems from 2G to 2.5G (iDEN, GPRS, EDGE) and subsequently to 3G (W-CDMA, CDMA2000, TD-CDMA), 3.5G (HSDPA and HSUPA, HSPA+), mobile WiMAX, and LTE systems, facilitates both an always-on model, as

well as the provision of faster data transfer rates and lower delays, thus enabling the development of more responsive telemedicine systems. More specifically, typical upload data rates range from:

- (i) GPRS: 40 - 50 kbps;
- (i) EDGE: 70 - 135 kbps;
- (iii) Evolved EDGE: 150 - 300 kbps (expected);
- (iv) UMTS: 200 - 300 kbps;
- (v) HSPA: 500 kbps - 2 Mbps, and
- (vi) HSPA+: 1 - 4 Mbps.

The 4G family of technologies targets improved uplink and downlink rates of hundreds of Mbps and 1Gbps respectively, increased coverage and throughput, enhanced mobility support (up to 350 km/h), reduced latencies less than five milliseconds, enhanced QoS provision, efficient spectrum usability and bandwidth scalability and security, with simple architectures in favour of the end user. The latter will enable the development of m-health systems and services that were previously unimagined. ■



Author
Yuri Prizemin

Parascript

VOTING IN CAD FOR MAMMOGRAPHY

Achieving Low False-Positive Rates for Greater Levels of Certainty

Computer-aided detection (CAD) uses software and computers to bring suspicious areas on a mammogram to the radiologist's attention. According to the American Cancer Society, early research suggests that CAD systems help radiologists diagnose more early-stage cancers than mammograms alone. But some doctors disagree about the accuracy of identifying cancers with CAD software. Some feel that CAD devices are not as effective as simply having a second radiologist review films or digital images (double reading), due to the occurrence of false positive identification of benign breast changes, deemed suspicious. However, single reading is already a primary screening method used in the United States and double reading is declining in Europe since fewer radiologists are entering the mammography field.

Despite this, many radiologists are dubious regarding CAD because of the occurrence of a high number of false-positive marks on CAD interpretations. The incidence of a large number of false-positive marks by a CAD system (with

current rates 5 - 10 times higher than those of radiologists) can significantly hinder its usefulness by distracting the interpreting radiologist. A significant reduction in false-positive rates is required in order for CAD to become comparable, performance-wise, to the opinion of a second radiologist.

CAD and False Positive Rates

It is possible to reduce the false positive rate and increase sensitivity, by combining the individual results of multiple engines and employing a voting mechanism that considers each. However, developing a voting scheme and algorithms to provide improvement for a particular combination of engines is a challenging task, requiring special aptitude and experience. The number of engines included in voting schema, their types, key expertise, accuracy of each engine are just a few factors that have to be considered in choosing

the right voting algorithm. In particular, it is very important to analyse whether or not the engines use similar approaches and whether they produce different or similar types of errors. Engines using similar approaches to recognition and producing similar types of errors are called non-orthogonal. Engines based on varying methodologies and, therefore, making different errors are referred to as 'orthogonal'. Voting schemes and algorithms are very different from non-orthogonal and orthogonal engines.

In any case, voting algorithms are uniquely created to homogenise results of particular engines, focus on individual engines' strengths, avoid their weaknesses, and suppress unimportant results. In some cases voting eliminates the results of an engine or algorithm altogether; in others it combines them with the results of others. Successful medical imaging technologies need to consider the strengths and weaknesses of particular engines, their peculiarities and individual characteristics and other factors. Employing non-optimal voting algorithms may not bring about an improvement of results and may even deliver poor performance.

The First Applications of Voting Methodology

The implementation of a powerful combination of engines using a number of fundamentally different algorithms and techniques was initially applied in the postal automation industry. A combination of a human-like holistic analysis, multiple neural networks and sophisticated statistical voting algorithms enabled a significant improvement in recognition rates and a decrease in error rates in mail processing.

These advancements in mail automation were first achieved in 1998, when the Remote Computer Reader (RCR) applied by the United States Postal Service recognised about 35 percent of machine printed and two percent of handwritten letter mail pieces. Thanks to the use of voting methodology modern systems recognise 93 percent of machine printed and about 88 percent of handwritten letter mail – or more than 90 percent cumulatively. Similarly, the application of multiple engines in a voting scheme for the banking and financial services industry raised the read rates in payment automation from 40 percent in 1997 to 80 percent at a one percent error rate today. The universality of these algorithms and methods makes them fully applicable to the medical imaging market.

Voting in Medical Imaging

Multiple, parallel recognition processes offer technological advances in medical imaging. Each image recognition process may identify areas of interest on the mammogram image

independently, without sharing information with other image recognition processes. Image recognition processes might also work together to identify different areas of interest. After image recognition processes individually identify areas of interest or objects on the mammogram image, the different areas can be compared to determine a confidence value related to the accuracy of the identifications. The comparison can be done using a voting process.

Comparing the results of multiple image recognition processes allows for the mitigation of the inherent faults of the image recognition process, thus leading to reduced false-positive and false-negative rates. Additionally, methods utilising multiple image recognition processes, rather than a single one, amicably lend themselves to multiple processor systems or networks. Thereby, they allow image recognition processes to be determined in parallel, increasing computational efficiency and spreading the workload across multiple processors. The result is fast and produces accurate actionable information.

The voting mechanism experience in other markets suggests that utilising multiple image recognition processes is the most efficient means by which superior performance can be delivered to the market. In fact, this same experience shows that not using such an approach rapidly becomes a competitive disadvantage to the supplier that does not offer it to the market once it becomes available and accepted. The reduction of false-positive readings achieved through voting methodology in medical imaging could ultimately result in decreased medical costs, emotional stress, follow-up examinations and recalls. It is only when CAD systems achieve sensitivity and false-positive rates approaching those of a radiologist that they will be embraced as a second opinion tool with no hesitation. ■

FACTS ON BREAST CANCER

The chance of developing invasive breast cancer is about 1 in 7 (13.4 percent). The National Cancer Institute estimates that there were 207,090 new cases detected and 39,840 women died of breast cancer in 2010. While in the past approximately only 75 percent of women diagnosed with breast cancer survived five years after detection, today nearly 90 percent of women diagnosed with breast cancer will survive their disease five years after detection. This increase in survival rates is largely attributed to advanced treatment methods and routine mammography screening, including CAD systems.

LUXEMBOURG EDITION

PROFESSIONAL CHALLENGES FOR RADIOLOGY

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Managing Editor

IMAGING Management spoke to President of the Luxembourg Society of Radiology, Dr. Rémy Demuth, about his take on the professional challenges experienced by radiologists in Luxembourg. Though professionally based in Luxembourg during his career, he is increasingly drawn to the European stage, recently as President of the radiology section of the Union Européenne des Medecins Spécialistes (UEMS / European Union of Medical Specialists). Here, we talk about his belief in the vital role played by multidisciplinary teamwork, the need for greater connection between the radiologist and their patient, and the possible growth of the private sector due to sluggish investment in public radiology services.

My interest in radiology was sparked by an early meeting with my future wife.

During my first year in medical studies at the Leopold-Franzens-Universität Innsbruck in Austria, a female co-student showed her cervical spine x-rays to the teacher after our anatomy course. As time passed my interest in radiology grew, and I entered postgraduate training in the radiological department of the University Hospital for Internal Medicine in Innsbruck. Happily, the young lady in question became my wife! This was the beginning of a lifelong interest in a profession that could not have suited me better: We cannot stand still in this specialty, where the speed of technical developments defines the term fast-paced. Thus the necessity of lifelong learning is a vocation that goes hand in hand with the practice of medical imaging, and it promotes a sort of dynamism that is inherent to the profession of radiologist.

Getting involved in radiology at a European level has proven how effective the right alliances can be in promoting change.

During the development of my career, I made new friends at a European level, with whom new ideas could become reality through joint action, and political fights could be successfully fought. As one success story, the “Alliance for MRI” initiative was successful in provoking changes to a European Directive. This was one example of effective lobbying, working directly towards patient care and for the future needs of a very important diagnostic tool. It also demonstrated that cooperation between different professional bodies such as the Union Européenne des Medecins Spécialistes (UEMS / European Union of

Medical Specialists) and the European Society of Radiology (ESR) can achieve high aims.

I work in Luxembourg's largest hospital structure, a merger of three local hospitals.

I work in the largest hospital structure in Luxembourg, the Centre Hospitalier Emile Mayrisch, which merged three local hospitals between 2004 and 2008, for a total of 640 beds, over 200 doctors and 1,700 employees, with a three-site location in southern Luxembourg. The radiology department delivers some 135,000 exams (24/24h -7/7 basis at two sites) a year. Included are some 15,000 MRI and 2,000 nuclear medicine exams.

Working as a radiologist in the healthcare system in Luxembourg means dealing mainly, if not exclusively, with clinical radiologic activity, as academic activity in medicine is rare in our specialty here. As the hospital environment changed greatly during the last decade following economic developments and needs, the flexibility of radiologists was an important condition. Subspecialisation is the new trend, but good qualifications in general radiology are essential for the on-duty part of our job.

The UEMS is Europe's oldest international professional medical union.

The work done by my predecessors in the UEMS has been impressive, and I hope to be a worthy successor, given the enormous development of the UEMS as the oldest European medical union. From its origins in 1958 by six founding member organisations (Belgium, France, Germany, Italy, Luxembourg and The Netherlands) it now represents more than 1.4 million medical specialists in 38 specialty sections

AUTHOR GUIDELINES

Content

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

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It is at the discretion of our editorial board to accept or refuse submissions. We will respond to submissions within four weeks of receipt. We reserve the right to revise the article or request the author to edit the contents, and to publish all texts in any EMC Consulting Group journal or related website, and to list them in online literature databases.

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

*Thank you,
The IMAGING Management Editorial Team*

coming from 30 national member organisations. The enormous work that has already been done is a very strong guarantee for the quality of medical care in Europe: the sections are defining the curricula of training, the European Accreditation Council for CME is accrediting meetings and other CME/CPD events according to high level criteria and consulting activities to the European Parliament and Commission are continuous processes.

For such an ambitious aim we need not only best knowledge acquisition, with first-class professional skills, but also the right professional mind, led by ethical convictions and social consciousness.

Luxembourg's small, local needs, do not lend themselves to a high level of subspecialisation.

The educational needs of young radiologists in training have to be met abroad as there is no medical training curriculum in Luxembourg. For the future development of subspecialisation we must acknowledge that with the localised population and level of clinical activity in Luxembourg, we cannot expect a complete high-level team of subspecialists in every hospital! No one could cover the expense of such a sophisticated service in a half-a-million inhabitant state. From the other point of view, those subspecialists could not live on their income. The second major problem is that the basic 24/24h on-duty rosters mean that each radiologist has to have excellent knowledge in general radiology.

Medical demography in Luxembourg translates to the same problems here as in most European countries; access to medical studies and, even more, to specialist training is getting more and more difficult, our students are facing greater access problems to the curricula, but nevertheless, radiology remains a very attractive medical specialty here for those who can find their way to clinical work.

Access to lifelong learning is a challenge for radiologists in a fast-paced technological profession, working in a small country.

In my opinion, the main challenges for radiology in Luxembourg are the rapid technological developments and thus the need for continued education and certification in a lifelong learning context. Equally, there is a corresponding financial challenge that exists in our healthcare

system: demographic changes leading to an aging and elderly population on a large scale will inevitably increase pressure on the system. So, the part of productive life years in proportion to the overall extended lifetime is shrinking at the same time, and if the legal and social framework does not change, the economic balance of the healthcare system will no longer be guaranteed.

Other challenges are similar to those that affect other European countries: investment in the latest technologies, learning vital management and economic skills to bring to our profession and interdisciplinary turf battles. Our presence near the patient should be improved, and the added value of a well-trained radiologist to the clinical pathways of many a disease should be more known. A real quality-based radiological performance with best patient and referrer contact and outcome will give us the best return-on-invest, ensuring our credibility and access to technology in the long-term.

For such an ambitious aim we need not only best knowledge acquisition, with first-class professional skills, but also the right professional mind, led by ethical convictions and social consciousness. There is neither time nor money for quantity-only centred radiological work, which would be very counterproductive in the long run!

Our cooperation with clinical colleagues has to be very well structured, in order to prevent time-consuming meetings with poor outcomes. The needed resources have to be guaranteed by those in charge to make multidisciplinary teams a very constructive and productive tool for all of the required participants. Without the right tools, demotivation would be a great danger, breaking down vitally needed dynamism.

TOP MANAGEMENT CHALLENGES FOR RADIOLOGY IN LUXEMBOURG

- Motivating colleagues to get involved in professional activities outside the department such as interdisciplinary team meetings, CME/CPD events, and responding to extended corporate and professional needs.
- Getting the right investment resources for long-term planning and timely integration of new technologies.
- Ensuring young radiologists in training in our country have access to ongoing education and clinical practice
- Staying up to date in an ever changing technological vista

Waiting lists are not a great burden in our country.

Fortunately our radiological modalities serve patients well. So, the waiting time for routine exams are very short, both for in- and outpatient schedules, even by European comparison. However, continuing investment remains a priority, as technological progress is much faster than our actual investment policy can afford. On this point our healthcare system absolutely needs an urgent evolution!

As the management of the modalities' uptimes is driven, or at least controlled by radiologists, and as we are working inside a public/private partnership, personal incentives are self-explanatory. On the other hand hospital staff have small incentives and responsibilities in the management of waiting lists, as their salary and job safety is not dependent on the customer.

In our relatively old-fashioned legislative framework medical activity is the privilege of the physician who has to fulfill legal requirements for qualification and registration

At the moment, radiology is largely provided for in the public sector but its shortcomings may usher in a new era of private services.

Until the present, radiological activity is exclusively performed within public or private hospitals, but concerning private, self-employed radiologists, the situation is somewhat particular in Luxembourg. Investment in expensive modalities is very regulated, and the shortcomings of the healthcare budget are not in favour of fast developments or reactions. Radiological services are at risk in the same measure as other cost-intensive clinical departments where shortages will represent a dramatic side effect.

Auditing is very widespread in Europe and this is a pattern repeated in our country.

Auditing is a very widespread aim of healthcare policy throughout Europe now, and it is even more fixed within European legal framework, as the cross-border Healthcare Directive (2011/24/EU) emphasises health technology assessment. National laws reflect the same development: As part of the hospital enterprise, the radiology department is under the same budgeting constraints. High quality control

and sound management are mandatory to generate maximum allocations. As we deal in general with fairly specific and predictable risks in clinical imaging (e.g. ionising and non-ionising radiation, diagnostic pharmaceutical products, etc.), the healthcare insurance and public health authorities have quite clear parameters to monitor.

The national society of radiology plays a strong role in education but each radiologist must take responsibility for his or her own skill level.

The "Société Luxembourgeoise de Radiologie" plays a role as promoter and provider of educational and training events. Our accreditation was recently extended in this area by the "Luxembourg Institute for Continuous Medical Training" (ILFMC). However, the responsibility lies with each individual to plan his or her own professional career and curriculum. The radiological society assists each member, by disseminating the most relevant information on educational events in the different surrounding countries, but also throughout Europe. As everyone has personal taste and preferences for this or that country-specific educational system or the language in which the events are held, our society tries to share the most complete possible agenda by means of our newly designed website.

Radiographers' autonomy is in general, fairly limited in Luxembourg, but radiologists have discretion as to which responsibilities they may take on.

In our relatively old-fashioned legislative framework medical activity is the privilege of the physician, who has to fulfil their legal requirements for qualification and registration. As medical activity is defined as "establishing a diagnosis" in current national law, a radiographer can only assist the radiologist or another physician, and to allow them the performance of a diagnostic procedure, or writing of a report would represent an illegal practice here. The individual level of personal professional expertise is very heterogeneous in our small country, with many clinical staff coming from abroad. In the main part, it is a very individual and personal decision to take for the radiologist in charge, how far he or she will allow each individual radiographer to take their own responsibilities. In my opinion, the biggest limiting factors for increased autonomy for radiographers are those personal mutual confidences and professional credibility that should develop when colleagues work together and establish trust. ■

KEY CONFERENCES & EVENTS

NOVEMBER 2011

27 – 02 RSNA 97th Scientific Assembly and Annual Meeting
The Scientific Assembly and Annual Meeting of the Radiological Society of North America (RSNA)
Chicago, USA
<http://rsna2011.rsna.org/>

DECEMBER 2011

04 – 06 Innovations in Cardiovascular Interventions
Tel Aviv, Israel
<http://www.icimeeting.com>

07 – 12 EUROECHO 2011
Budapest, Hungary
<http://www.escardio.org>

JANUARY 2012

12 – 14 MIR Winter Course
Schladming, Austria
www.mir-online.org

16 – 18 Bristol MRI 2012
Bristol, UK
<http://www.jcaseminars.com>

18 – 19 IT @ Networking 2012
Brussels, Belgium
www.itandnetworking.org

MARCH 2012

01 – 05 European Congress of Radiology (ECR) Annual Meeting
Vienna, Austria
www.myesr.org

JUNE 2012

12 – 15 ESGAR 2012
Edinburgh, UK
www.esgar.org

27 – 30 CARS 26th International Congress and Exhibition Joint Congress of CAR / ISCAS / CAD / CMI / EuroPACS
Pisa, Italy
<http://www.cars-int.org>

OCTOBER 2012

11 – 12 MIR Annual Scientific Meeting
Genoa, Italy
www.mir-online.org

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- **Benefits of Free Software in Public Health** by Luis Falcon; GNU SOLIDARIO, Spain
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