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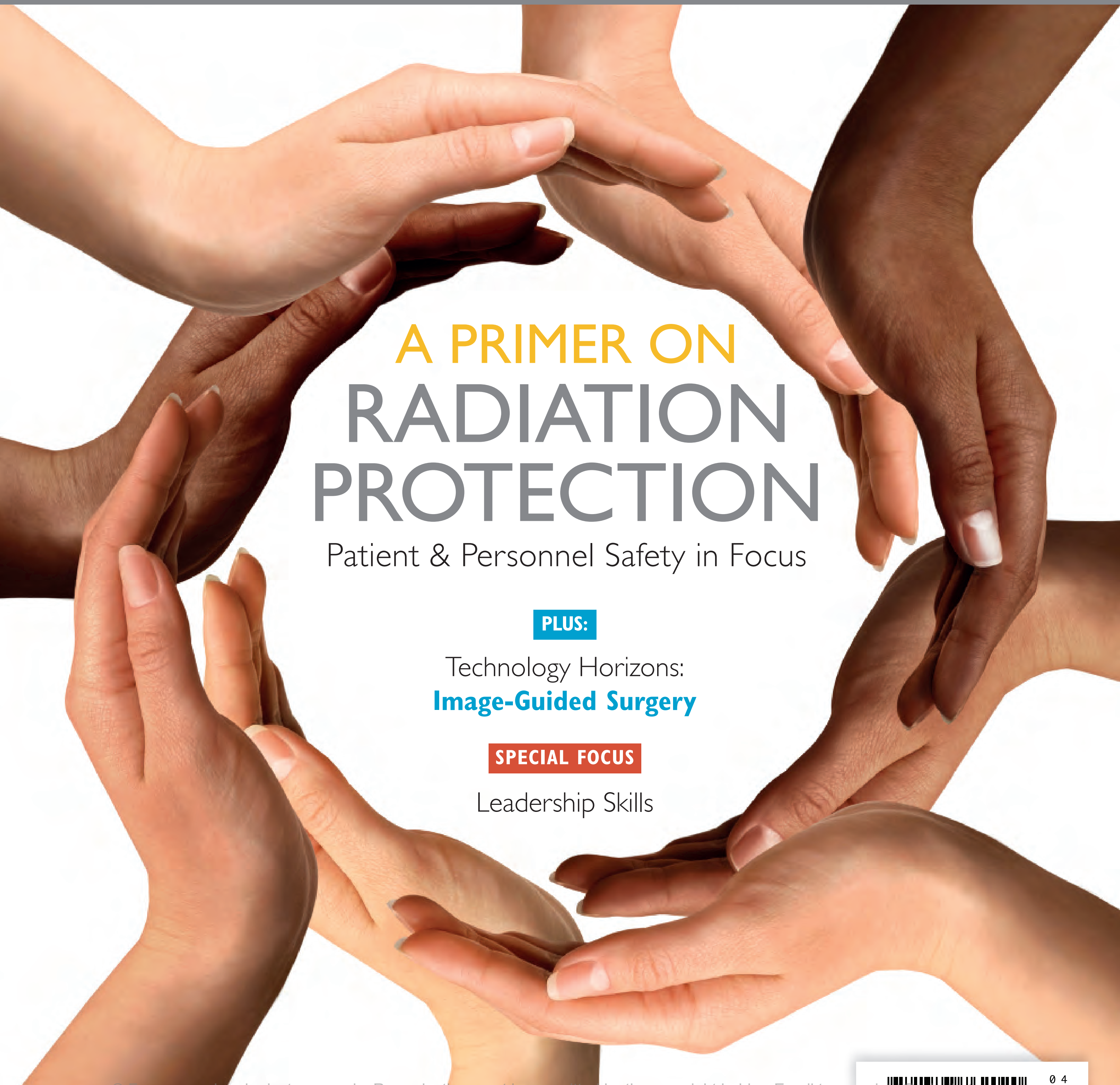

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A PRIMER **ON RADIATION SAFETY**

Prof. Iain McCall

Editor-in-Chief
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Dear reader,

In a recent issue, this journal addressed the reasons why radiologists could benefit from improved patient-radiologist communication, one of the main forces behind this being the drive to ensure greater patient information about the risks of medical imaging exams. As a follow-up to this, the cover story in this edition addresses the whys and hows of ensuring patient and also personnel safety in this context, since the two are inextricably linked.

Radiologists and radiologic technologists alike care about patient safety: of this there is no doubt. However, there will inevitably be gaps in knowledge regarding what exactly the correct dose of radiation should be, in which cases ought this be adapted, and when or how must this be communicated to patients. The ALARA edict encourages practitioners to keep radiation dose As Low As Reasonably Achievable, but what is being done to communicate to patients about the potential risks in seemingly innocuous exams, when those in charge of performing them may not be as clear or informed as one would hope? I suppose what we wish to emphasise in this cover story are the risks in presuming that ones knowledge is complete or ones patient communication flawless.

It is unfortunately not possible to comprehensively address the issue of managing radiologic risk in one cover story section. Nevertheless, we aim to hit the major points, including the viewpoint of a radiologic safety expert, a radiologic technologist who has previously published recommendations for her peers in promoting good practice, and an article that covers how Canada is sharing this responsibility for patient safety with general practitioners. Finally, we also include the viewpoint of the interventional radiologist, by Dr. Bartal and Prof. Haskal, two extremely authoritative writers who describe the method used in their department that works to reduce and manage exposure, not just measure and record it.

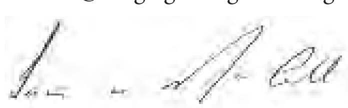
Our first contributor, Eugenio Picano, writes eloquently about radiologic risk communication in medicine: how it presently is and how it should be. He states that "Every radiological and nuclear medicine examination confers a low but definite long-term risk of cancer, but patients undergoing such exams often receive inaccurate or no information about these risks" and cites the American College of Radiology's (ACR) recent white paper, recommending that physicians "should work with patient advocacy organisations to more effectively communicate the potential radiation risks and health benefits of imaging procedures". Here you will read about the perceived gaps in current knowledge and a thorough look at attempts to set them right.

The approach outlined in Dr. Picano's paper has been formally endorsed by the International Atomic Energy Agency, that outlined in 2010 how informed consent is a fundamental requirement for all radiological procedures, and a main focus of the three A's strategy (i.e. Awareness, Audit and Appropriateness). Justification of each and every procedure is a key theme.

A further article focuses on the paediatric practitioner's view of radiation safety: Dr. Amber Gislason and colleagues emphasise that "Children are still growing, so their cells are rapidly dividing, making them more prone to DNA damage from radiation than adults". They draw attention to the Step Lightly campaign, an extension of its Image Gently predecessor, which urges practitioners to "child size" x-ray exam protocols, to step lightly on the pedal, and to consider other modalities rather than radiation based imaging.

Dose awareness and dose management are crucial areas of good management development policy and it is up to chairmen in the medical imaging department to set a strong and inarguable policy that filters from the top down. With this in mind, you will certainly find other useful papers published in IMAGING Management on complementary areas of patient safety and communication coming during this year and beyond.

To offer your feedback on any of the articles or topics discussed in this journal, please write to editorial@imagingmanagement.org.



Prof. Iain McCall

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A Primer on Radiation Protection: Patient & Personnel Safety in Focus

Not every imaging exam that is performed is an optimally safe one, for the patient or for personnel. Despite the existence of rigorous guidelines and an increase in the accountability being asked from medical practitioners, doubt remains about whether these parameters for optimised imaging exams are implemented in clinical practice. In other cases, whether due to the questionable application of a particular type of exam in a particular clinical case, or the dose of radiation not being expertly tailored, patients are at risk. In this cover story, we ask a range of experts to give their perspective on how to optimally protect imaging patients and personnel during risk-involved exams, and propose a protocol that you can implement to acquire high quality images without compromising safety.

> “
> EACH PATIENT SHOULD GET THE RIGHT IMAGING EXAM, AT THE RIGHT TIME, WITH THE RIGHT RADIATION DOSE

MEDRAPET PROJECT TO PROVIDE RADIATION PROTECTION EDUCATION

MEDRAPET (Medical Radiation Protection Education & Training) is the name of a new project that aims to provide radiation protection education in Europe under tender ENER/10/NUCL/SI2581148.The consortium partners are:

- ESR (European Society of Radiology)
- EFOMP (European Federation of Organisations for Medical Physicists)
- EFRS (European Federation of Radiographer Societies)
- ESTRO (European European Society for Therapeutic Radiology and Oncology)
- EANM (European Association of Nuclear Medicine)
- CIRSE (Cardiovascular and Interventional Radiological Society of Europe)

The 27 monthcontract, for was signed with the European Commission in Luxembourg on February 4. Attendees at the meeting included Augustin Janssens, European Commission, Head of Radiation Protection Unit; Remigiusz Baranczyk, European Commission, Radiation Protection Unit; Stefan Mundigl, European Commission, Radiation Protection Unit, and John Damilakis, ESR amongst others.

The project will focus on three main tasks:

- Working package 1: The conduction of an EU-wide study on radiation protection training of medical professionals in the EU Member States;
- Working package 2:The organisation of a European workshop on radiation protection training of medical professionals in the EU Member States, and
- Working package 3:The development of a European Guidance document on radiation protection training of medical professionals.

As a result of the European Guidance, the creation of a permanent multidisciplinary working party to draft and maintain European standard sets of competences at various levels for minimum radiation protection training and CPD required for all different groups of medical staff working with ionising radiation shall be envisaged.

The EFRS is leading working package 1. All EFRS member organisations will receive detailed information and will be involved in this project. An advisory group of EFRS radiographer experts is established to support the EFRS delegates in the three working groups. On February 5 the first meeting of working package 1 took place to plan the activities of this group until early 2012 and to discuss the outlines of the huge survey that will be run in the autumn of 2011 among all EU and EFTA countries, as well as those countries that are on the waiting list to join the EU.

COMMISSION TO EXTEND EURATOM BUDGET FOR NUCLEAR RESEARCH TO 2013

The Commission has adopted a proposal to extend the budget of the 2007 - 2011 Euratom Framework Programme, which funds nuclear research, to cover the years 2012 and 2013. This is a formal step necessary to bring the effective duration of the Euratom Framework Programme into line with the seven-year period of the main Seventh Framework Programme for Research (FP7), which ends in 2013.The proposal does not signify any change of policy and was already envisaged by the EU institutions when the two programmes were launched in 2007. Adoption of the proposal by the Council would allow the continuation of current research work, aimed notably at improving nuclear safety and radiation protection.

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MANAGEMENT IN RADIOLOGY

Annual Scientific Meeting & Junior Course 2011
September 29 – 30, Nice/FR

Management in Radiology (MIR), a subcommittee of the European Society of Radiology, has released details concerning the development of the scientific programme for their 2011 edition of the annual conference which takes place Thursday, September 29 to Friday, September 30 in Nice, France.

The congress provides essential healthcare management coverage not only to radiologists, but also to physicians and other healthcare workers in all medical disciplines, as well as to radiologic technologists, managers, nurses, informatics personnel and members of the medical industry. The scientific programme is available for download on www.mir-online.org, and is varied, interesting and highly pertinent to the problems and challenges of modern healthcare. There are lectures and discussions on requesting imaging studies, coding and budgeting, standards of reporting, location and management, e-health monitoring issues, ultrasound management, managing acute imaging services, and solutions to problems in imaging education and research – all of them offering plenty of opportunities for audience participation.

For the first time, the well-established MIR Imaging Management Junior Course will be combined with the Annual Scientific Meeting and therefore gives residents the chance to emphasise their knowledge on how to be prepared best for a consultant post. This special course – taking place just the day before the annual meeting, on September 28 – offers plenty of time for dialogue and questions. The meeting will be supported by the French Society of Radiology (SFR), and in this capacity be represented by Prof. Elisabeth Schouman-Claeys.

Abstract Submission

MIR is happy to receive your abstract for presentation at its Annual Scientific Meeting from September 29 - 30 in Nice, France until May 27 via e-mail to office@mir-online.org. The abstract should not exceed a maximum of 500 words, separated in "Purpose", "Methods & Materials", "Results" and "Conclusions".

www.mir-online.org

CARS

Register Soon for CARS Congress

The CARS congress with its associated journal has issued an open invitation to potential attendees of the annual congress to take place in Berlin from June 22 – 25. With a focus on research and development for computer-assisted systems and their applications in radiology and surgery, CARS has played a leading role in medical informatics for more than 25 years. It has a close collaboration with the ISCAS, EuroPACS, CAR, CAD and CMI societies. Following the long-term successful cooperation, they will jointly hold their annual meetings with the 25th CARS Congress in Berlin in 2011. 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.

www.cars-int.org

CIRSE

Call for Late-Breaking Abstracts!

CIRSE are urging stakeholders to present their latest research findings at the leading European meeting for interventional radiology, with a deadline of May 14, 2011. With more than 5,600 participants in 2010, the CIRSE annual meeting has become Europe's largest and most comprehensive forum for experts in image-guided minimally invasive therapies. CIRSE believes that this offers the best possible platform to present your research findings at CIRSE 2011. The organisation states that "We are looking for original abstracts of new experiments and clinical trials containing important late-breaking results, which were not yet ready at the regular abstract submission deadline". All abstracts must be submitted through the online CIRSE abstract submission system at www.cirse.org from May 4 to 14, 2011.

www.cirse.org

IHE-EUROPE

Connectathon Fast Approaching

With 450 million people covered by healthcare systems in 27 countries, Europe presents unique challenges for Integrating the Healthcare Enterprise (IHE). IHE-Europe creates a common ground and a shared goal of achieving a seamless flow of patient information.

The deadline for registering for the IHE Connectathon to take place in Pisa, Italy, is fast approaching. The IHE Connectathon is a landmark event for health information systems in Europe. During the five-day marathon more than 90 companies will continuously test the interoperability and connectivity of new products.

This year IHE Connectathon is attracting a record number of project managers, policy makers and other influential stakeholders from across Europe who are advancing health IT programs. With a full programme of daily round-tables and seminars on specific healthcare topics, IHE Connectathon 2011 in Pisa is the event not-to-be-missed.

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COMMUNICATION, CONSENT AND PATIENT SAFETY

Unlocking the Radiological Chamber of Secrets

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In theory, good medical practice implies knowledge of the doses and long-term risks of radiological and nuclear medicine testing, since awareness of risk is essential for tailoring the risk-benefit balance in ascertaining test appropriateness. In practice, extensive recent data show substantial unawareness of radiological doses and risks - not only on the part of patients, but of prescribing and practising doctors as well. Both specialists and non-specialists may not understand the difficult jargon of radiation protection, in which doses are expressed in various, often esoteric units (megaBecquerel, milliCuries, kilovolts, etc.), and simple information on doses and risks is difficult to find and hard to interpret.

Ineffective communication currently poses significant ethical problems, with high litigation potential. Informed consent is necessary to establish a respectful, ethical relationship between doctors and patients. It should be managed by following a process model, in which the patient actively participates in medical decision-making. Hence, informed consent becomes a vital component of the physician-patient communication and - from a legal perspective - an integral part of the medical act, being based on a continuous dialogue between patient and physician, called mutual monitoring.

A transparent, informative, honest consent form should spell out the type of examination and the exposure in effective dose (mSv), derived from reference values in guidelines or – better – from actual values from the department. The dose equivalent should also be expressed in number of chest radiographs and the risk of cancer as the number of extra cases in the exposed population, derived from the most recent and authoritative guidelines (e.g. BEIR VII Committee, 2006). Complete radiological informed consent is an important step in the direction indicated by the American College of Radiology's (ACR) recent white paper, recommending that physicians "should work with patient advocacy organisations to more effectively communicate the potential radiation risks and health benefits of imaging procedures". Forced to explain to the patient what they currently disregard, doctors will gently and painlessly learn what they should already know.

Every radiological and nuclear medicine examination confers a low but definite long-term risk of cancer, but patients undergoing such exams often receive inaccurate or no information about these risks. Too-detailed information on dose and risk may result in undue anxiety, but information "economical with the truth" may violate basic patients' rights (see Oviedo convention 1997) and law (97/43 Euratom Directive 1997). In fact, one of the three fundamental principles of the charter of medical professionalism in the new millennium is the principle of patient autonomy: "Physicians must empower their patients to make informed decisions about their treatment".

Patient Awareness of Radiological Risk

Informed consent for radiological examinations is often not sought, and when it is, patients are often not fully informed, even when facing considerable levels of radiation exposure and long-term risk. The risk of a 64-slice computed tomography coronary angiography can be as high as 1 in 100 in a young woman or in a child. In theory, the majority of paediatricians from the Greater Toronto Area in Canada, practising in a wide variety of hospital and clinical settings believe that a risk of 1 in 10,000 or more should be discussed with the child's parents. In reality, patients are not given information about the risks, benefits, and radiation dose for a CT scan, even when a considerably higher risk is involved.

In another study performed in the emergency department of a U.S. academic medical centre, adult patients who underwent diagnostic CT scans were surveyed. Only seven percent of patients reported that they were told about the risks of their CT scan, and all patients were unable to estimate the dose for one CT scan compared with that for one chest radiograph. Only three percent of patients believed that their lifetime risk for cancer was increased as a result of the CT scan. In another study performed in the nuclear medicine department of a leading academic centre in Italy, 79 percent of surveyed patients thought that the cardiac stress scintigraphy they had performed gave a radiation dose of < 1 chest x-ray instead of the true dose of 500 chest x-rays, and 40 percent thought that no cancer risk at all was present. Ironically, 71 percent of patients thought they received good-to-excellent information on the risks and benefits of the cardiac stress scintigraphy from their physician.

Physician's Awareness of Radiological Risk

Extensive recent data show substantial unawareness of radiological doses and risks, not only of patients but of prescribing and practising doctors as well. In theory, good medical practice warrants knowledge of the doses and long-term risks of these tests – which can be judiciously employed when they are most appropriate. The results of surveys recently performed on British physicians, Israeli orthopaedists, Italian cardiologists, Canadian paediatricians, and U.S. academic radiologists, show that the majority of doctors grossly underestimate the radiation doses (usually by up to 500 times) and corresponding cancer risks, for most commonly requested tests.

> "The argument is that radiologists are too busy to spend time obtaining informed consent and are anyway too wise to undertake inappropriate exams"

Emergency room physicians and radiologists alike are unable to provide accurate estimates of CT doses regardless of their experience level. In particular, among radiologists, five percent of respondents thought that a CT scan dose was less than one chest radiograph, and 56 percent estimated the CT scan dose between one and ten chest radiographs, with dramatic underestimation of the true dose (about 500 chest radiographs). Forty percent of paediatricians underestimate the dose of a pre- and post-contrast head CT by up to 100 times. A minority of doctors also suffer from what we might call imaging daltonism, i.e. the inability to separate green (non-ionising) from red (ionising) techniques. Five percent of British doctors do not realise that ultrasound does not use ionising radiation, and 10 percent do not realise that MRI does not use ionising radiation. Among Canadian paediatricians, four percent believed that ultrasound involves ionising radiation and 12 percent were not aware that scintigraphy scans do. Faced with this diffuse background level of radiological unawareness, inappropriate examinations may proliferate, to the profound detriment of society and patients.

Informed Consent: How it is

There are three possible ways to look at radiologic risk communication in medicine – no mention of risk, understatement of risks, and specific detailing of risk.

Strategy 1: "Don't say a word"

One philosophy is not to mention radiological risk. Even for procedures with high radiation dose, such as interventions under fluoroscopic control, there is no explicit or implicit mention of long-term risks. The risk exists and may be substantial, but it remains unheard (by the patient) and unspoken (by the doctor). The basic argument is that radiologists are too busy to spend time obtaining informed consent and anyway are too wise to undertake inappropriate examinations. Patients' legal right to information is eclipsed by the two forces of efficiency and a paternalistic, "expert knows best" vision of individual autonomy. The long-term nature of the risk, not its absolute amount, seems to be the excuse for disregarding informed consent.

Strategy 2: Understatement

In other aspects of radiological practice, obtaining written informed consent is part of standard practice. In this case, the issue of efficiency bias is not raised: a patient must give informed consent before contrast is injected. But what is the quality of the information given to patients? On the websites of scientific societies, in the information section for patients and in the informed consent forms to be signed by patients, we read statements such as "A nuclear medicine examination is safe, with an irradiation corresponding to a simple radiograph" or "almost always less than a common radiological examination". Both patients and clinicians might believe that a common radiological examination or a simple radiograph would be a chest x-ray, which is by far the simplest and most common radiological examination. In reality, however, the dose exposure in cardiology ranges from 500 chest x-rays for a sestamibi to 1,500 chest x-rays for a dual isotope cardiac stress scintigraphy. Such imprecise statements are probably intended to reassure patients, to avoid useless concern about an unavoidable risk. However, this attitude of one consent fits all for radiological examinations may mislead clinicians to underestimate the associated risks.

Strategy 3: Full disclosure

Some organisations, such as the U.S. National Institutes of Health (NIH), describe radiological risk in more straightforward terms, at least when the test is performed within a research project and with a radiation dose greater than 15 milliSieverts (corresponding to the average dose of 64-slice computed tomography coronary angiography): "Your scan involves exposure to radiation. Although it can vary from person to person, your whole body radiation exposure during each scan will be about 15 milliSieverts. This is about five times the average annual radiation exposure a person in the United States receives from natural background radiation. Although no harmful effects are expected, your long-term risks of harm from this degree of radiation exposure might be as high as one in 1,000. Harmful effects could include the development of cancer and genetic changes".

Informed Consent: How it Should be

Non-specialists (and sometimes specialists) often do not understand the difficult jargon of radiation protection. The pressures of an old-fashioned paternalistic view of medicine as well as a more modern efficientism act against the creation of a truly informed consent. The well-known permeability of medical opinion-leaders and media to industry and corporate interests can further modulate communication towards underestimating and obscurating risks. In an ideal consent process, the standard of risk communication already adopted for irradiation in research might be fruitfully followed for irradiation in clinical practice. The form - as a functional yet not exhaustive tool for the legal compliance to the correct implementation of a valid consent - should at least spell out the type of examination, the exposure in effective dose (mSv), the dose equivalent in number of chest radiographs, and the risk of cancer as number of extra cases in the exposed population. This minimal information constitutes the legal fundament to develop a wider dialogue, which is not only worthwhile but also beneficial within a process of informed consent both in the radiological area as well as in nuclear medicine.

Figure 1 underlines the linear relation between dose and risk and might be useful for passing information from doctors to patients and between doctors because the figure format complements the traditional table format (see table, p. 12) and the colour coding helps readers to understand risk levels. This simple evidence-based communication strategy, if used when obtaining informed consent, will raise the currently suboptimal level of radiological awareness among doctors and patients. Better knowledge of risks will help us to avoid the small individual risks that translate into substantial population risks. Consent forms would also help reduce pressure from patients for redundant and often useless examinations.

Common sense, deontological code, patients' rights, medical imaging guidelines, Euratom law - all coherently and concordantly suggest a responsible and informed use of ionising testing. Current practice clashes with these guidelines and laws. It will become more and more difficult to defend physicians ignoring doses and risks of exams with high radiation load, especially in the case of inappropriate examinations, which plague the current practice of medicine in every field. By law, there are strict limits for the general population (1 mSv per year) and for professionally exposed workers (20 mSv per year). Paradoxically a citizen, upon becoming a patient, loses his/her radiological rights and can receive literally hundreds of mSv of exposure without receiving any information and, in the case of inappropriate examinations, without any commensurate benefit. Perhaps it is time to change, and informed consent can help in this long-overdue turnaround from a culture of paternalism and over-diagnosis to a new culture of safety, prudence and appropriateness.

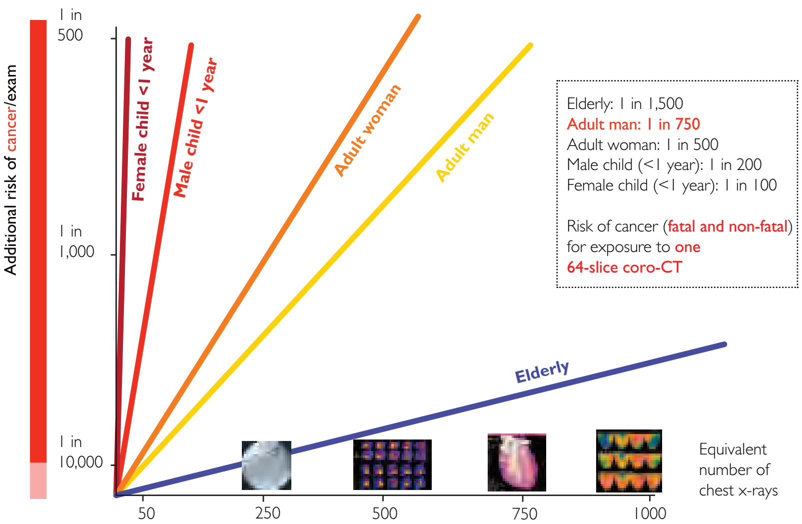
International Atomic Agency Endorses 2010 Approach

This approach has been now formally endorsed by the International Atomic Energy Agency, that in 2010 outlined how a truly informed consent is a fundamental requirement for all radiological procedures, and a key player of the three 'A's strategy (Awareness, Audit and Appropriateness) necessary to facilitate the justification process in radiological procedures. Along the same line, the recent landmark recommendations of Food and Drug Administration are aimed at optimising patient exposure to radiation from medical imaging exams, and thereby reducing related risks while maximising the benefits of these studies: "Each patient should get the right imaging exam, at the right time, with the right radiation dose".

A necessary step within this initiative is the need to increase patient awareness. The FDA "recognises the importance of empowering patients with information and tools to help them and their physicians manage their exposure to radiation from medical imaging". There is little doubt that the

Figure 1.

Dose (in x-axis, in equivalent dose in chest x-rays) and risks (in y-axis, calculated from BEIR VII) of commonly performed examinations .



Picano E, BMJ 9 October 2004, updated with **BEIR VII**, 2006

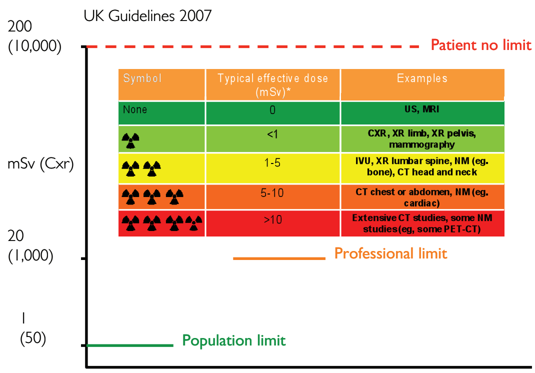


Figure 2:

Dose limits for the population (1 mSv per year, corresponding to the radiological dose of 50 chest x-rays) and for exposed workers (20 mSv per year, corresponding to 1,000 chest x-rays). Paradoxically, limits are nonexistent for exposed patients, who can receive cumulative dosages for a single pathology (for instance, coronary artery disease or renal colic) up to hundreds of mSv without any warning, awareness or information.

informed consent form is an essential tool to reach this still elusive target. It should be managed/implemented by means of following a "process" model, in which the patient actively participates in medical decision-making, alongside the diagnostic-therapeutic pathway. Hence, informed consent becomes a vital component of the physician-patient communication and - in a legal perspective - an integral part of the medical act, being based on a continuous dialogue among patient and physician, which is called mutual monitoring.

In our opinion, an effective radiological risk communication strategy should include:

- Sharing information with patients in a balanced way, listening to their concerns, encouraging them to ask questions, supporting their ability to make an informed decision;
- For exams involving high ionising radiation load (cancer risk 1/1,000-1/10,000): good documentation of the information process offering patient leaflets written in lay terms in suitable format, enriched with visual aids, with a consent form to be signed by the patient and informing physician;
- For exams involving low ionising radiation (cancer risk > 1/100,000): patient information posters in waiting rooms and public areas or other aids to enable informed decision-making without written consent.

Conclusion

Correct informed consent plays an essential role in the physician-patient relationship. A proper, complete, updated and comprehensive informed consent form should find a full implementation as part of a holistic process, in which the acceptance of the diagnostic and/or therapeutic act is the resultant outcome of three qualifying moments, logically and chronologically interlinked, as it follows:

- The correct and full communication about diagnostic and/or therapeutic information which - with regard to radiology and nuclear medicine - should focus on the dose equivalent in number of chest x-rays and the estimated risk of cancer as well;
- The act of ensuring that the patient has fully understood, the meanings and sense involved in that communication. This understanding could be increased by means of implementing tools and techniques such as video-registered feedback and teach back, as important components of a legally relevant process, and
- The final decision regarding the proposed diagnostic and/or therapeutic act.

Nobody is able to specifically endorse something if he/she does not achieve an adequate level of information and if he/she is not involved in both a communication and decision-making processes. Without the presence of these crucial components, whatever module of subscribed consent cannot be considered as valid within the juridical profile. This simple informed consent process and form policy will gently force the doctor to be more aware of what he/she does and the patient more aware of what he/she undergoes, and enabling both to make more responsible choices. ■

Investigation	Effective Dose (mSv)	Equivalent No. of Plain Chest Radiographs	Approximate Equivalent Period of Natural Background Radiation	Additional Lifetime Risk of Fatal and Non-Fatal Cancer*	RCR Symbolic Representation**
Plain PA chest radiograph	0.02	1	3 days	1:1,000,000	☢
Lung perfusion scintigraphy (Tc99m)	1	50	6 months	1:10,000	☢☢
CT chest (non contrast)	8	400	3.6 years	1: 1,200	☢☢☢
Perfusion cardiac Rest-stress Technetium 99m sestamibi scan	10	500	4 years	1:1,000	☢☢☢☢
MDCT cardiac (64- slice)	15	750	7 years	1:750	☢☢☢☢
Coronary stenting	20	1050	8 years	1:500	
Thallium-201 scan	41	2000	16 years	1:250	☢☢☢☢

Table 1. Dose/Risk Communication: The Royal College of Radiologists' (RCR) Approach

*These examples relate to a 50 year-old male. Multiply by 1.38 for women, by 4 for children under 1 year, and by 0.5 in an 80 year old male. ** ☢: <1 mSv : ☢☢ 1 – 5 mSv, : 5 – 10 mSv, ☢☢☢☢ : > 10 mSv. On the right side column, symbology proposed by Royal College of Radiology, 2007 (41).

RADIATION SAFETY AND THE **INTERVENTIONAL RADIOLOGIST**

Fundamental Rules of Patient & Personnel Safety

Developments in the applications for minimally invasive interventional procedures carry a parallel increase in the use of fluoroscopy and CT, both of which are associated with potentially excessive radiation exposure to patients and personnel. Interventional radiologists (IRs) use image guidance in each and every intervention. Most of the image guidance systems are based on ionising radiation, mainly fluoroscopy. IRs of all generations are thus natural leaders in the responsible use of radiation-based imaging tools. Here we explain some of the guiding principles fundamental to patient and personnel health protection.

IRs wield a double-edged sword in terms of ionising radiation, using it for imaging on one hand and for image guidance on another. IRs perform the whole spectrum of interventional procedures, comprising both vascular and nonvascular. Moreover IRs use imaging tools of all kinds. For example, ultrasound allows us to see virtually any access procedure and has become a must in IR labs. MR guidance is evolving for various interventions, especially in oncologic patients. CT-guided interventions are widely used and CT fluoroscopy with real time CT imaging is evolving. Patient and staff radiation protection are very much connected, as the main source of personnel exposure is the patient. In fluoroscopic image-guided interventions we are talking about intelligent dose management and not merely protection. We need a technology that will really reduce exposure, not just measure and record it.

Personnel radiation protection is very complex and comprises passive and active tools. Passive radiation protection represents the means provided with and by the angiography system. Passive protection tools are operator independent and must be applied in daily practice. Active radiation protection is about our behaviour and responsibility. Image-guided interventionists are obliged to be protected from ionising radiation using any available passive means, dose reduction methods, and by behavioral adjustment to the hostile setting of the angiography room. The active methods allow proper performance of the interventional procedures with the lowest radiation exposure possible for patients and staff.

Who Oversees Radiation Protection?

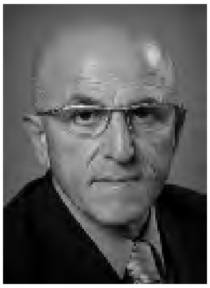
As a rule, the hospital authorities and governmental bodies control patient and personnel protection. It is mandatory that heads of IR services and heads of medical imaging departments carry an absolute responsibility to proper patient and staff dose management based on the ALARA (As Low As Reasonably Achievable) principles and the latest guidelines.

Recently, two joint guidelines emerged from both sides of the Atlantic: one for patient protection and another on personnel protection, published by the North American Society of Interventional Radiology (SIR) and the Cardiovascular Interventional Radiology Society of Europe (CIRSE) in both societies' journals (JVIR and CVIR). These guidelines provide a comprehensive overview that comprises detailed instructions on why and how to protect patients and IRs from occupational exposure. These should become an integral part of any IR fellowship programme as well as routine practice in IR labs.

Other Image-Guided Interventionalists & IRs Apply Same Guidelines

Since many non-radiologists (e.g. cardiologists, vascular surgeons) routinely practice endovascular interventions we have to make clear that the same basic principles of dose management apply to all parties involved. The difference is usually in the set-up. IRs perform interventions in dedicated rooms with dedicated equipment that includes a large image receptor as well as protective tools. Cardiologists use dedicated cardiac angiography systems with smaller size image receptors. In many hospitals, vascular surgeons perform combined surgical and endovascular interventions in the operating rooms using mobile C-arm fluoroscopy systems without any protective tools on the equipment.

Mobile C-arm fluoroscopy is widely used in operating rooms, but recently there is a "new kid in town", the hybrid room. This is a complete and very powerful angiography system used for complex procedures that comprise simultaneously open and endovascular techniques during same intervention on the same operating table. These rooms represent a real challenge for staff protection, as too many people are involved at the same time and the protective



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Tomosynthesis Is the Next Step in Breast Imaging

The Klinik Engeried in Berne, Switzerland, Uses Tomosynthesis As an Additional Tool to Improve Diagnosis

In a country known for its high standard of medical care, the private hospital, Klinik Engeried stands out for its pioneering use of new technologies to improve women's breast health. Located in Berne, Switzerland, the 86-bed Klinik Engeried is ranked among the leading private hospitals in central Switzerland for its center of excellence in women's health.

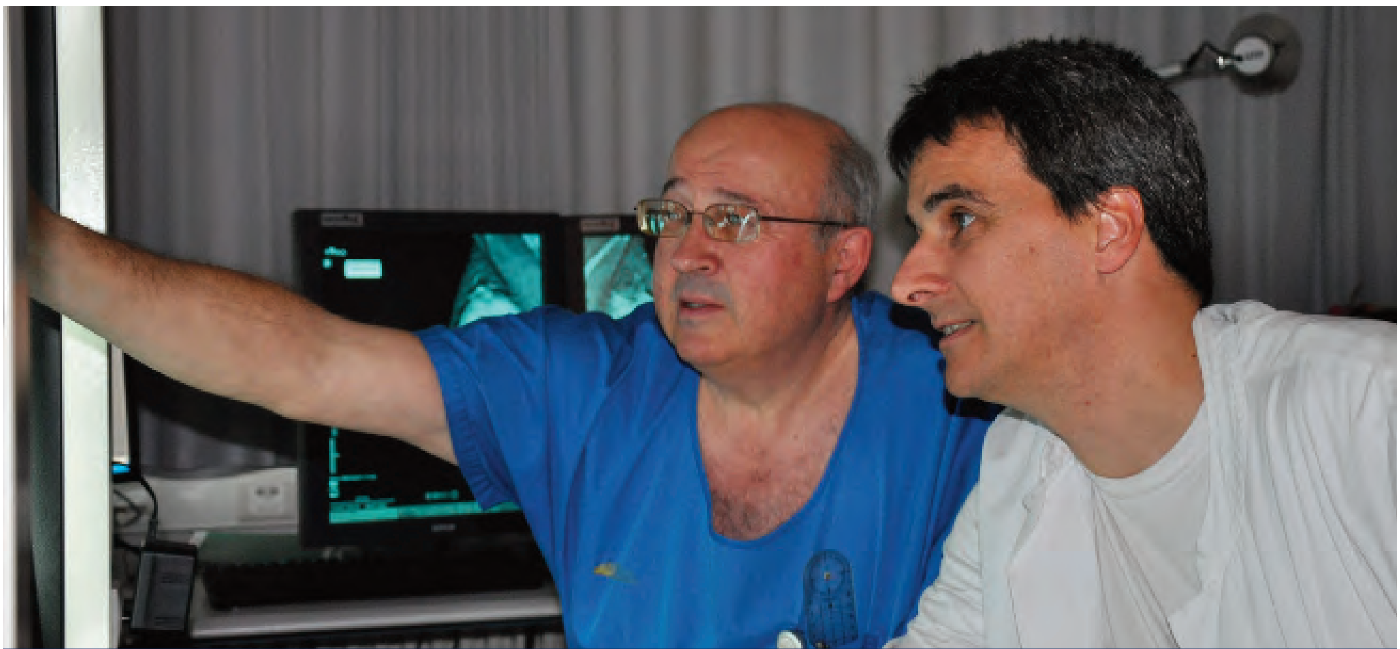
Thirteen years ago, Klinik Engeried installed one of the first digital mammography systems in the world and broke ground by offering all women routine digital mammograms. "We are different than other facilities in that we have been performing digital mammograms since 1999 when the technology was first introduced," states Dr. Peter Cerny, the radiologist responsible for bringing digital mammography to the hospital. "I was sure digital technology was the future of breast imaging, and Hologic was a step ahead in digital technology. Hologic images are good."

"If we need to see small or difficult to detect structural changes or if the breast is dense, we take additional images with tomosynthesis."

In 2008, the Klinik Engeried led the way again, with the installation of Hologic's Selenia® Dimensions® three-dimensional breast tomosynthesis system, becoming the first hospital in Switzerland and one of only a handful of hospitals in Europe offering this groundbreaking technology. "Tomosynthesis is the next step in breast imaging," continues Dr. Cerny. "It lets you see small and difficult to detect structural changes better, because there is less overlapping tissue. Each step in the evolution of technology makes you feel better diagnostically."

"Women come to our breast center because they see us a leader in technology," states Dr. Cerny. "We perform twice as many mammograms as other facilities in our province."

The hospital performs 8,000 mammograms annually and has performed more than 4,000 tomosynthesis breast examinations over the past two years.



Dr. Peter Cerny (left) introduced digital breast cancer screening at Klinik Engeried hospital in Switzerland thirteen years ago. Klinik Engeried was one of first sites in Europe to adopt the technology. In 2008 the hospital recorded another first when Klinik Engeried became the first site in Switzerland and one of the first sites in Europe to offer breast tomosynthesis screening.

Clearer Views Add Up To Better Diagnostics

Tomosynthesis provides the breast center with an additional tool to diagnose breast cancer in difficult cases. "Tomosynthesis provides the best opportunity to detect cancer in women with dense breast tissue or hormonal treatments, as well as younger women and women with a family history of breast cancer," states Dr. Cerny.

Technologists at Klinik Engeried routinely take four standard views for each patient using the Selenia system's two-dimensional technology. If the radiologist sees structural changes or if the findings are unclear, the technologist is asked to take additional pictures using the three dimensional capabilities of the Selenia Dimensions system. "If we need to see small or difficult to detect structural changes or if the breast is dense, we take additional images with tomosynthesis," explains Dr. Cerny. With tomosynthesis technology, an x-ray tube rotates around the breast, taking views of slices of the breast from numerous angles, enabling radiologists to see abnormalities that could be hidden by dense or overlapping tissue.

Tomosynthesis lets the busy breast center tailor its diagnostic tool to the patient. "We always look at the 2D images first to determine if we need to take 3D images," explains Dr. Cerny. "Digital mammography with the option of doing tomosynthesis is another step forward in diagnostics. You see things better. You detect more and you sleep better because you feel diagnostically more secure. Tomosynthesis is a very good tool for getting a better diagnosis in difficult cases."

A Different Diagnosis

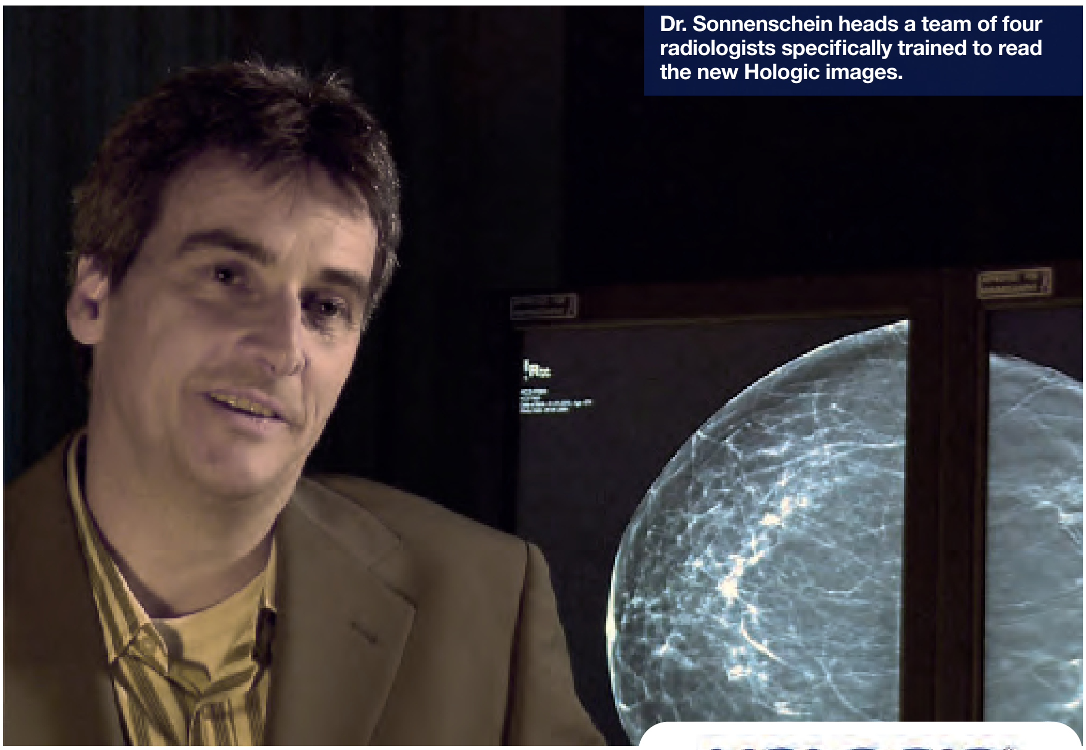
Dr. Cerny reports that tomosynthesis changes the categorization of BI-RADS categories quite often. "The ability to evaluate structural changes and evaluate the size and margins of an abnormality also reduces categorizations of the BI-RADS® 3 and 0, reducing the recall rate and, in our opinion, it seems to lead to a slightly higher cancer detection rate. Tomosynthesis images provide more information; you get additional picture information because tomosynthesis removes overlapping tissue."

"Digital mammography with the option of doing tomosynthesis is another step forward in diagnostics."

"We feel tomosynthesis has helped us find several cancers that would have been missed with two-dimensional imaging alone. We had some cancers we identified as BI-RADS 1 or 2, which are normally benign, and we changed the diagnosis to low or very high probability of malignancy because we were able to see more with tomosynthesis," states Dr. Cerny.

In the thirteen years since Dr. Cerny introduced digital mammography to the Klinik Engeried, the hospital's reputation and radiology department have grown. Today, Dr. Martin Sonnenschein heads the women's imaging team, overseeing four radiologists specifically trained to read women's breast mammograms. The busy breast clinic – integrated into the general radiology department – also performs more than 500 biopsies a year.

The hospital's goal is utmost patient satisfaction. "If you offer good quality and good service you attract more referrals and more patients," says Dr. Cerny. "We've been with Hologic since the beginning. The quality is good and Hologic provides great support."



Dr. Sonnenschein heads a team of four radiologists specifically trained to read the new Hologic images.

THE TEN COMMANDMENTS OF RADIATION PROTECTION

1. Obtain the required but not necessarily "best" diagnostic information;
2. Reduce fluoroscopy time and use low dose fluoroscopy modes;
3. Store relevant images from fluoroscopy and avoid unnecessary fluorography;
4. Reduce the number of DSA series and number of images in the series;
5. Avoid the most irradiating C-arm angulations;
6. The image detector should always be close to the patient;
7. Reduce scatter from the patient (collimate);
8. Shields on your body and eyes;
9. Shields between patient and yourself, and
10. Use magnification only if necessary.

IRs have to follow the toughest rule of all: Follow all 10 rules!

means are available in the best scenario only on one side of the operating table.

Rotational angiography with cone beam CT capabilities is available and is utilised extensively in neuro-interventions, oncologic interventions and in bleeding patients. Image acquisition in rotational angiography has a wide range of geometry and consequently significantly limits patient and staff protection and is difficult to validate.

Utilisation of pre-procedural noninvasive imaging, when applicable, saves valuable time in the IR room and reduces possible complications from diagnostic angiography. CT angiography (CTA) almost instantly provides an accurate diagnosis, an access map and a measurement tool in most cases. It is noninvasive and saves time as well as patient and personnel exposure. MR angiography (MRA) should be the preferred option when possible. The IR has to read CTA and MRA studies her/himself. It is also highly recommended to install and routinely use a dedicated PACS monitor in the IR lab for real time viewing and if possible processing the studies directly from the PACS system.

In our department we've found such a set-up extremely useful in daily practice. Such an attitude is invaluable in emergency set-ups, especially in bleeding trauma patients. CTA is more sensitive than angiography in location of the bleeding and can show the extraluminal pathology as well.

Basic Principles of Patient Protection

The following basic principles of proper radiation management of patients should be routinely used in any IR practice:

1. Obtain a thorough medical history to determine if the patient has had any previous radiation related procedures such as:
   - i. Radiation therapy
   - ii. Previous fluoroscopically-guided interventional procedure
2. If a previous radiation history exists:
   - i. Examine the patient for signs of skin changes related to radiation exposure
   - ii. Avoid further irradiation of any such area, if possible
3. Consider including the potential for skin injury in informed consent:
   - i. Essential for a large patient,
   - ii. If the procedure could be prolonged
   - iii. Counsel the patient about these and other risk patient specific factors (i.e. weakened skin from previous procedure, obesity, collagen vascular disease or diabetes)
   - iv. Ask the patients to examine themselves for several weeks for any skin changes or hair loss at the area of beam entry and to report any changes to you.
4. Review the patient's medical history for conditions that might increase radiation sensitivity.

Medical Simulators

One of the most challenging issues in radiation protection is adequate training depending on the level of dose associated with the procedures practiced. As most staff exposure is linked with scatter from the patient, the experienced operator will require the shortest fluoroscopy time with a smaller dose. Medical simulators are aimed at improving IR skills using IR lab equipment. Simulators proved to be an efficient and safe educating tool for fellows in training as they rehearse in a complete IR lab environment with no radiation and no possible complication. They provide tactile sensations of guidewires, balloons, stents, embolisation coils and more; as well as simulation and display of relevant fluoroscopic images with Cine, DSA and C-arm operation. Virtual reality endoluminal simulators create an interventional environment and are expected to significantly improve our skills and reduce complication rates and radiation exposure of patients and personnel.

Future Trends

- Real time dosimetry of the operator;
- Medical simulation training of staff;
- Routine planning of interventions using noninvasive imaging, and
- Dose management measures to become an integral part of every procedure.

Conclusions

Important variations in patient and staff dose values take place in IR suites. This very new technology is not a guarantee of low radiation risk. The image-guided interventionist has to have a deep knowledge of x-ray systems and good training in dose management. IRs have to be aware of the efficacy of the different passive and active RP methods and tools, as well as typical exposures for the available operational modes. ■

X-RAY BEAM OPTIMISATION FOR **PAEDIATRIC INTERVENTIONAL CARDIAC IMAGING**

Paediatric-Specific Concerns for Radiation Dose

In the cardiac catheterisation lab, image sequences of the heart are captured by a dynamic x-ray imaging system to allow real time visualisation of catheter movement within the vessels. An iodine-based contrast medium is often utilised to allow clear visualisation of blood flow through the arteries, ventricles, and valves of the heart. Cardiac image sequences must be captured with high spatial and temporal resolution to identify occlusions and other perturbations of blood flow within the heart against the visible background anatomy. Such procedures are used to diagnose and treat congenital heart disease in children; they are becoming increasingly complex and frequent. Echocardiography and Doppler ultrasound may also be utilised to obtain diagnostic information without the use of ionising radiation. However, real-time x-ray imaging is essential in order to perform these minimally-invasive interventional cardiac procedures.

The ALARA concept (keep radiation dose As Low As Reasonably Achievable) is paramount for all x-ray imaging modalities and patients, but it is especially important for paediatric patients with congenital heart disease. The majority of adult patients undergoing interventional cardiac procedures are at least middle aged, suffering from age or lifestyle related heart problems. Paediatric patients, on the other hand, usually have a congenital disease which requires multiple, lengthy interventional procedures over the course of their childhood.

Children are still growing, so their cells are rapidly dividing, making them more prone to DNA damage from radiation than adults. This higher radiosensitivity is demonstrated in figure 1, where a Sievert (Sv) is a unit of measurement for radiation dose. Combined with the longer mean life expectancy of children, this makes them vulnerable to long term stochastic effects of biological tissue damage from radiation such as long term chromosomal damage. In addition, paediatric anatomy shows that younger patients' vital organs are in closer proximity to each other than those of older patients. This closer proximity results in a higher radiation dose to vital organs near the area of interest, in this case the heart.

In 1978, a published study of blood samples before and after interventional cardiac procedures of infants and chil-

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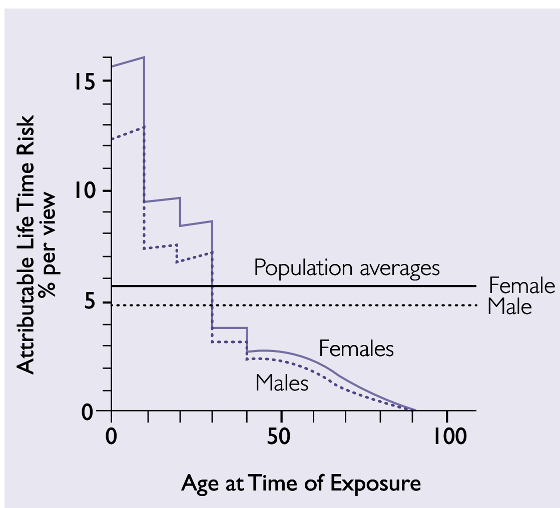

Figure 1.

Lifetime attributable risk of radiation- - induced cancer from a single small dose of radiation at various ages at the time of exposure. Radiosensitivity decreases dramatically with age. Estimates are based on a relative risk model as adapted from the International Commission on Radiological Protection.

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IT @ 2012 will recognise and promote outstanding healthcare IT and medical technology projects. 25 nominees from across Europe and beyond will compete in the *IT @ Networking Awards 2012* on January 18 – 19 2012. This high-level competition will see candidates go through two rounds of presentations in an effort to convince the expert audience and panel of judges why their solution deserves to win. If last year is anything to go by, attendees will not hold back in cross-examination of each presenter during the Q&A sessions before placing their vote for their favourite solutions.

WHY ATTEND THE IT @ NETWORKING AWARDS 2012?

This event will give you the possibility to expand your general and in-depth knowledge on IT solutions. Every presentation is strictly structured according to our presentation cri-

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teria. Such criteria allows for a cross-departmental understanding of each solution.

Uniquely, *IT @ 2012* requires all presenters to talk about the key problems they have encountered in creation or implementation. By highlighting honestly the problems and obstacles encountered, they provide the audience with an excellent tool for advancing similar issues in their own institutions.

IT and medical technology is of key importance to hospital management, especially considering the current financial constraints and increasing pressure our healthcare systems are faced with. Intelligent IT solutions increase cost-effectiveness, productivity and safety.

HOW IT WORKS

IT @ 2012 is a two-day event comprising two rounds of presentations. During the first day, 25 projects will be showcased in a Mindbyte presentation. Mindbytes are short and straight to the point. In just five minutes, each presenter will highlight the main advantages of their project and convince the audience they want to know more. After each presentation you, the expert audience, and our panel of judges will place their votes. The top nine presentations make it through to the second day of competition where they are given the opportunity to present their projects in detail. This Workbench presentation has an allocated time of 30 minutes followed by 15 minutes of cross-examination.

WHAT SETS US APART

What differentiates *IT @ 2012* from other congresses? The main difference lies in the element of competition. Yes, *IT @2012* features presentations from across the world. But these are presentations with a difference, competitors are presenting to win; they have a completely different mindset. Each presenter will do the best to secure the top prize, to persuade the audience and judges that their solution deserves to win. The Q&A sessions also take on a new dimension with presenters having the opportunity to cross-examine their competitors.

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IT @ 2012 will take place in the famous Theatre de Vaudeville, a most stimulating environment in the Gallerie de la Reine, the centre of Brussels.

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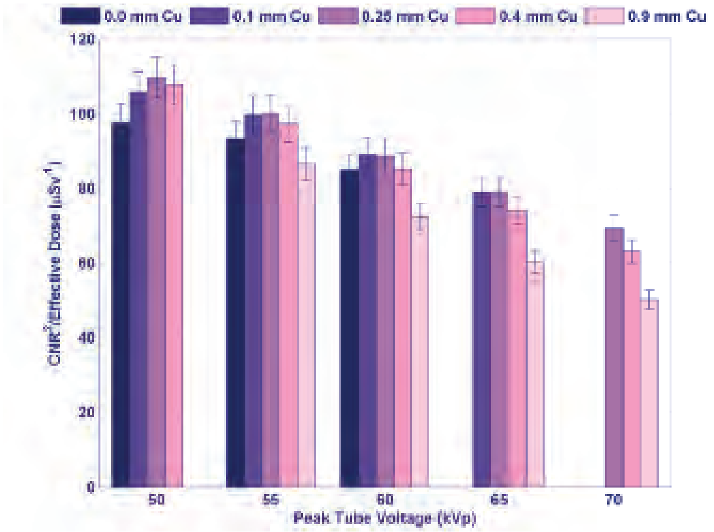

Figure 2.

8.5 cm phantom: Optimisation figure of merit for varying peak tube voltage and copper (Cu) thickness, with the anti- -scatter grid removed.

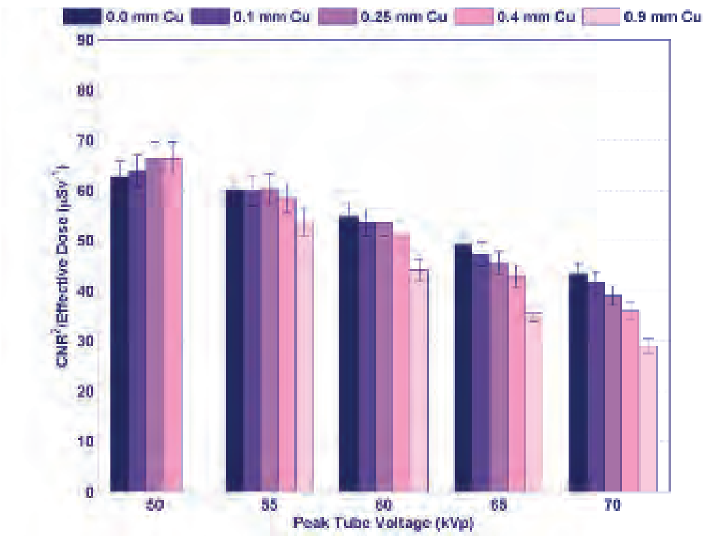

Figure 3.

12 cm phantom: Optimisation figure of merit for varying peak tube voltage and copper (Cu) thickness, with the anti- -scatter grid in place.

It may also be necessary to re-evaluate equipment or x-ray techniques used. In terms of the first stage, dose surveys for paediatric interventional x-ray procedures are being performed by medical physicists more in recent years, with results published in peer-reviewed journals "as a first step towards optimisation". Results vary in several capacities, mainly the type of dose measurements used. Some dose surveys retroactively collect procedure dose values, which had been reported by the x-ray system at the end of each procedure. Others use calculations based on x-ray parameters or precise, in-vivo dosimetry methods similar to those used in high energy radiotherapy procedures.

Published dose surveys often differ in methods used to quantify radiation dose. Dose area product (DAP) is reported by modern x-ray systems, measured with an ionisation chamber built into the x-ray system.

dren demonstrated post-procedure chromosome damage, suggesting long-term follow-up. Now, attention has gradually been brought to this matter, with Step Lightly, an extension of the Image Gently Campaign. Its message is to "child size" x-ray exam protocols, to step lightly on the pedal, and to consider other modalities rather than radiation based imaging. Participants of Step Lightly are predominantly in U.S. and Canada, but the campaign now has links with the International Atomic Energy Agency (IAEA) based in Vienna, Austria.

Dose Measurements

The literature often points to a specific solution in order to keep paediatric dose ALARA - evaluate radiation dose, implement dose reduction techniques, and monitor dose.

Skin dose is the patient entrance surface dose (ESD) including backscattered x-rays; it is the best risk indicator for erythema. Skin erythema is a deterministic effect of radiation, so there is a threshold dose value which determines its likelihood; this is a concern for adult cardiac x-ray imaging, where high beam energies are required to penetrate thick chests. At times, the patient entrance air kerma (ESD without backscatter) is documented. ESD and kerma may be calculated by equipment software, or measured by a physicist.

All of these dose measurements have the unit Gray (Gy). DAP is the most commonly reported dose measurement; it is useful for inter and intra-departmental comparisons of procedures dose, but without further calculations, it does not on its own directly provide information about deterministic or stochastic risks of radiation.

Effective dose, which has the unit Sievert (Sv), is an estimate of the stochastic risks of radiation. It includes different radiosensitivities of various biological tissues and age groups by implementing weighting factors in a calculation. Effective dose may not be directly measured; one of the above measurements must be converted to effective dose using established conversion factors. If sophisticated software such as PCXMC (STUK, Finland) is used to calculate effective dose, an organ dose breakdown is provided.

It is also worth noting that organ weighting factors are changed every few years to reflect new knowledge gained; this knowledge is built from examining atomic bomb survivors for long term effects of radiation. Effective dose is often outside the scope of published catheterisation lab dose surveys. However, it is the most important dose measurement concerning long term effects on paediatric patients with congenital heart disease.

Models Indicate Greater Understanding

Recent literature indicates an increasingly developing understanding of stochastic risks of radiation. Biologically motivated mathematical models have been built and Monte Carlo simulations performed to understand mechanisms of radiation-induced carcinogenesis. In one study, data from Biological Effects of Ionising Radiation (BEIR) VII helped determine the lifetime attributable risk of cancer associated with estimated radiation dose in children with complex congenital heart disease. A micronucleus assay was performed before and two hours after the interventional procedure; this was used as a biomarker of chromosomal damage and intermediate end point of carcinogenesis. Results demonstrated a need for radiation dose reduction in these children.

In addition to the various methods of quantifying radiation dose, there are a variety of dynamic x-ray imaging systems in use – image intensifier based, digital flat panel detector based, bi-plane, single plane, to name a few. Not only the x-ray detectors and system geometry differ, but x-ray tubes built over the last few decades vary greatly in power. Different manufacturers implement differing settings for paediatric imaging, some more child-specific than others. Some hospital departments have made alterations to x-ray systems to make the default settings more child-specific.

Such differences are often world region dependent; some regions prioritise impressive image quality whereas others are extremely conscious of patient dose. Many published dose surveys have identified the need to establish paediatric-specific diagnostic reference levels for interventional cardiac procedures. This would allow for a consistent comparison between heart centres.

Balancing Image Quality with Dose

The well-known trade-off or balance between image quality and radiation dose that exists for all x-ray imaging makes it difficult to optimise image quality with radiation dose. For children, fast heart rates require faster acquisition rates of image frames. If the frame speed is reduced in order to reduce radiation dose, the temporal resolution of the image sequence drops. This adds to the existing trade-off between image quality and radiation dose per frame.

X-ray parameters and geometric settings used on a given imaging system for a given diagnostic task differ in adult cardiac imaging from those used over the range of paediatric sizes. Smaller patients produce fewer scattered x-rays; they require less radiation in order to achieve suitable clinical image quality. The image quality to patient dose balance is hence different for paediatric cardiac x-ray imaging than for adults due to the broad range of smaller body sizes. There is a need for paediatric-specific optimisation of x-ray parameters.

Good practice in radiology will result in dose reduction, as implemented by radiography staff. Depending on staff training and the imaging system used, some examples are x-ray beam collimation, use of pulsed x-rays and of last im-

» CONTINUES ON PAGE 40

DOSE REDUCTION IN COMPUTED TOMOGRAPHY (CT)

AEC a Valuable Tool

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Professionals in the radiology department have to ensure that every examination is justified, optimised and tailored to the clinical question. Radiation dose optimisation is very important in CT examinations and factors affecting patients' radiation doses have been reviewed (please see "learning resources"). Various technical approaches have been introduced to reduce radiation dose and improve dose utilisation. Automatic exposure control (AEC) with tube current modulation (TCM) is an important technical feature that helps reduce the radiation dose required for diagnosis. AEC adjusts exposure to the patient's size, shape and composition. Properly used, AEC can typically decrease doses by 15 - 40 percent, compared with protocols with fixed milliampere (mA) levels. However, a potential drawback of AEC is the increased complexity.

The AEC system has three main functions:

1. Providing a means for defining the desired image quality/dose level (i.e. an input value);
2. Acquiring information about patient size, shape and composition;
3. Modulating the tube current based on the input value and acquired patient information.

With AEC, the traditional mA-selection has been replaced by an input value which is, unfortunately, manufacturer specific and refers to either mAs (reference effective mAs) or image quality (noise index, reference image or standard deviation).

AEC uses size and attenuation information from a scout image (and/or from a previous rotation) to adjust the tube current while scanning. Most often it is adjusted according to a patient's size at each:

i) Acquisition angle;
ii) Table position; or
iii) Both.

The tube current can also be adjusted to patient size in general or varied with cardiac phase, using ECG, independent of patient size and the angular position of the tube. New scanners are generally equipped with a combination of angular and z-axis TCM but, in older scanners, TCM is often only available in one direction (angular or z-axis).

Efficient AEC Use is Not Intuitive

AEC was introduced in CT scanners to decrease patient dose while maintaining appropriate image quality. However, knowing how to use AEC correctly and efficiently is essential for


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optimal effect. Efficient use of AEC requires knowing the TCM type available in the scanner and thorough understanding of all user-selectable parameters as well as the AEC input values.

The input value indicates the radiation exposure for an average sized patient; for a smaller patient, it will be less; for a larger patient, more. It is important to know how the radiation dose is affected by changing the input value. A convenient linear relationship exists between mAs (and reference effective mAs) and patient dose; increasing the mAs will cause a proportionally equal dose increase, but it is more complex for the image noise based input values, as the image noise is inversely proportional to the square of the tube current.

Optimise Protocols

In general, AEC systems promptly do what they are supposed to, and mA is adjusted accurately (within the predefined range) to patient size and shape. The input value is, however, user selectable and needs to be chosen wisely to acquire the expected dose reduction. AEC does not in any way change the need for appropriate selection of other parameters, e.g. beam energy, slice thickness and noise reduction filters. It is important to realise that altering parameters that affect image quality (e.g. kV, pitch and recon image thickness) may affect the mA as decided by the AEC, especially in scanners with image noise based AEC input values, because AEC aims at maintaining image quality. There is a considerable difference from one scanner to another. For example, reducing slice thickness (at constant AEC input value) leads to higher mA in one scanner but increased noise in another scanner. The same applies to changing the reconstruction algorithm for the first reconstruction.

The TCM modulates the tube current within a given range (e.g. 10 - 500mA), but patient diameter can vary greatly. In addition, the subject contrast increases with body size and, if size correction is not built-in to the AEC system, the AEC input value should be altered with regards to size. It is still of the utmost importance to create special paediatric protocols.

Implementation and Potential Pitfalls

AEC is probably best implemented under the supervision of an application specialist who is familiar with the exact scanner type. It is normal to encounter some problems but given the fact that the AEC is a mature technique now, most of the problems will probably be related to work procedures. Frustration may arise when noisy images appear but it is important to find the reason for the error, correct it and head towards the goal of utilising the benefits of AEC. Systematic errors may have gone unnoticed but result in TCM errors when AEC is used. CT design, in general, assumes that the patient is positioned in the centre of rotation; for an off-centred patient, size calculations on which the TCM is based will be incorrect. Note that a new scout image is needed to correct the TCM after correcting the position.

The indirect effects of other scan and reconstruction parameters on the exposure first came with the introduction of AEC and need to be realised to avoid unintentional dose increase. For example, if parameters are changed to decrease the dose, AEC may alter the mA to compensate. The fact that AEC differs between scanners may increase the risk of errors.

Possible reasons for sub-quality images when using AEC:

- Incorrect positioning or patient's position changed after scout acquisition;
- Low subject contrast in small patients;
- Narrow mA range or high image quality demands;
- High image quality demands may result in the mA being constantly at the maximum and the proposed constant image quality from one patient to another will not be achieved;
- Composition different from what the AEC assumes (e.g. relatively dense body areas, such as knees or large metal implants);
- Protocols are not standardised;
- Beam energy and tube angle when scout is acquired may affect the TCM;
- Sharp boundaries or incomplete coverage of the scout;

LEARNING RESOURCES

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- TCM adjacent to sharp boundaries may be incorrect, and/or,
- The scout has to cover the entire area scanned (including extra-rotations).

All the potential pitfalls are best avoided by well educated professionals. Modern equipment with excellent technical solutions will not ensure CT examination optimisation on its own. Sufficient training is essential.

Recommendations

- Study the AEC in your scanner/s
- Study how image noise and patient's dose are related
- Use AEC for all examinations of the trunk
- Create protocols for average, paediatric and obese patients
- Standardise procedures and look systematically for reasons for errors
- Observe the mA for individual patients and learn when adjustments are needed
- Read and react to scanner generated messages ■

This summary is based on the article Optimal Use of AEC in CT: A Literature Review by Jónína Guðjónsdóttir, Borgny Ween and Dag Rune Olsen from ASRT Radiologic Technology, March/April 2010, Vol. 81 (4) pp.309-317.

FAMILY DOCTORS AS GATEKEEPERS **TO MEDICAL IMAGING**

The Experience in Canada

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In recent years, Canadian governments have invested significantly to improve access to MRI and CT scans. As a result, both the number of scanners and number of exams performed in Canada have increased exponentially. The Health Council of Canada's recent report *Decisions, Decisions: Family Doctors as Gatekeepers to Prescription Drugs and Diagnostic Imaging in Canada* found that between 1990 and 2009, CT scanners in Canada more than doubled from 198 to 465. In that same period, MRI scanners increased more than tenfold from 19 to 266. Distribution of the scanners varies across the country. Ontario, Canada's most populous province, has the most CT scanners at 155, whereas the nation's territories have only two CT scanners altogether (one in Yukon and one in the Northwest Territories, zero in Nunavut).

Across Canada, the number of scans has also seen an increase. Compared to 2003, there has been a 58 percent increase in CT exams and a 100 percent increase in MRI exams. This translates into 121 CT scans and 41 MRI scans for every 1,000 Canadians in 2009. By comparison, in terms of access and use of MRI and CT scanners, Canada ranks lower than other 10 other OECD countries. For example, in 2009, Canada performed 121 CT scans per 1,000 population and the OECD average was 139 CT scans per 1,000 population; Canada performed 41 MRI scans per 1,000 population, whereas the OECD average was 49 MRI scans (see fig. 1, p. 40). Although there has been an increase in diagnostic imaging equipment and examinations, the number of radiologists essentially remained the same between 1992 and 2006.

Family physicians are the first point of contact with the healthcare system for many Canadians. As a result, their decisions, such as which drug to prescribe or diagnostic test to order, affect not only treatment and health outcomes, but how the health system as a whole is used.

The Role of the Family Physician

While the investment and resulting increase in scanners and examinations were intended to address the issue of access, there were implications for, and related concerns about, appropriate use of CT and MRI scans in Canada. Concerns were related to the fact that specialists have traditionally ordered the vast majority of MRI and CT scans, and given the access to these tests, the role of the family physician in this area was changing.

Compounded by factors such as the aging Canadian population, more people being diagnosed with chronic health conditions, and with the move away from hospital-based care toward community-based care, family physicians are faced with increasing demands on their time and skills. They are doing more than ever before – including the ordering of

» CONTINUES ON PAGE 41

*Unless otherwise noted, data/ statistics referenced in this piece were taken from the Health Council of Canada's report *Decisions, Decision: Family Doctors as Gatekeepers in the Use of Prescription Drugs and Diagnostic Imaging in Canada.* To download a copy, or for more information on the Health Council of Canada please visit www.healthcouncilcanada.ca

IMAGE GUIDED SURGERY

Offering Better Procedure Planning

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Introduction

Recent advances in image guided surgery (IGS) are changing the manner in which surgeons are able to execute difficult procedures, most specifically the minimal invasive ones. By building detailed, patient-specific models of anatomy, and augmenting those models with other pertinent information, such as functional properties, the surgeon can better plan the procedure to optimally extract target abnormal tissue while avoiding nearby critical structures. By registering these models with the actual patient position in the operating theatre, one can provide the surgeon with augmented reality visualisations, in which hidden tissue is displayed in exact alignment with a live view of the patient. By tracking surgical instruments relative to the patient and the registered model, real-time feedback is provided about the position of the instrument and its relationship to nearby tissue.Throughout its evolution, the computer has played a major role in IGS. Not only is the computer indispensable in displaying and manipulating medical images, it is ubiquitous in this branch of biomedical engineering, controlling the imaging equipment, reconstructing the images from raw data, tracking instruments, modelling tissue, evaluating surgical performance, controlling robots and facilitating the human-machine interface.

Why Image Guided Surgery?

Because of the precision that image-guided surgery technology provides, surgeons are able to create an exact, detailed plan for the surgery — where the best spot is to make the incision, the optimal path to the targeted area, and what critical structures must be avoided. The technology allows surgeons to view the human body — a dynamic, three-dimensional structure itself — in real-time 3D.The technology creates images that allow surgeons to see the abnormality, such as a brain tumour, and distinguish it from surrounding healthy tissue. It also enables them to manipulate the 3D view in real-time during surgery. The constant flow of information helps surgeons make minute adjustments to ensure they are treating the exact areas they need to treat.

The technology aids in shortening operating times, decreasing the size of the patient's incision, reducing the procedure's invasiveness — all of which can lead to better patient outcomes and faster recoveries. Image-guided surgery also provides new alternatives for patients with multiple medical problems, patients who may not be able to tolerate large, invasive surgeries, and patients whose conditions in the past would have been considered inoperable.

Market Overview

IGS systems combine various high-end technologies, such as navigation technologies, image acquisition and image processing in order to allow 3D visualisation of the human anatomy and the localisation of surgical instruments during minimally invasive surgeries. By synchronising preoperative images with real-time information during surgery, IGS systems provide surgeons with the precise location of objects within the body without actually seeing it with the naked eye. The systems normally consist of an image-processing work station and a tracking system. The imaging approaches used include optical techniques, such as computed tomography (CT), magnetic resonance imaging (MRI), fluoroscopy and ultrasound, while the tracking technologies normally in use are optical localisers and electromagnetic navigators. Optical localisers track infra-red rays emitted by light-emitting diodes (LEDs) located on the surgical instruments. Reflectors that are attached to the instruments reflect images to a camera, which is connected to the computer that analyses the images and tracks the LED as the surgeon moves.

The total revenues for the image-guided surgery market in western Europe was 214.6 million dollars in 2010. The market is expected to reach 285.0 million dollars in 2014, growing at a compound annual growth rate (CAGR) of 10.1 percent from 2008 to 2014. The revenues included in this research service are those generated from the sales of new systems. The market growth is mainly driven by the benefits for patients and healthcare providers offered by image-guided surgery, which enhance market acceptance. In addition, as more and more clinical evidence are available and surgeons gain additional experience with these systems, the adoption of image-guided surgery increases. This explains the increasing market growth in recent years. However, the growth is expected to become gradually slower in the following years because the image-guided surgery market in western Europe is becoming mature and is likely to experience saturation, especially in the field of neurosurgery, which is currently a major market segment.

Competitive Landscape

The leader of the IGS market in western Europe was BrainLAB AG, with an estimated 32.7 percent of the market in 2008. BrainLAB AG was followed by Medtronic Navigation Systems with 22.1 percent of the market. B Braun Melsungen and Stryker also occupied considerable amount of the market with 11.1 percent and 7.3 percent market share, respectively. BrainLAB AG enjoys very strong brand recognition in all clinical applications, partly due to the fact that historically the company was the first to offer image-guided surgical systems. As Medtronic, Inc. has a strong brand name in the medical device industry in general, Medtronic Navigation enjoys recognition in the IGS market. Although the company's market share in the orthopaedics segment has decreased during the last couple of years, it is an important competitor in the neurosurgical and the ENT market segments. B Braun Melsungen, Stryker and Amplitude SA are strong competitors in the orthopaedics market segment.

Applications Trends

Orthopaedics

Image-guided orthopaedic surgeries include knee and hip replacements, which are the primary applications for orthopedics IGS and additional applications, such as trauma and emergency interventions and ligament reconstruction. IGS for orthopaedic applications is well accepted in western Europe with the highest penetration rates in Germany, which is the major market for image-guided orthopaedic surgery systems. The amount of orthopaedic procedures done with IGS systems in Europe is constantly growing as market participants improve technologies and increase the value for patients, surgeons and hospitals. Although there is still a need for long-term clinical data in this field, surgeons are willing to perform image-guided orthopaedic surgeries, which reduce the chances for errors and complications in complex and simple procedures. Being the latest clinical segment within the IGS market, the IGS systems market for orthopaedic surgery was expected to grow significantly. In terms of product adoption and usage, the market indeed grew. However, most participants in this market segment do not charge their clients for the system, or charge for part of the cost, gaining their revenues from disposables. Therefore, in terms of revenues from sales of systems, the market has grown more moderately than expected. Nonetheless, the potential of the total orthopedic IGS market is relatively high as this market segment is still young and the usage of these systems is increasing.

Neurology and Neurosurgery

Historically, IGS systems were first introduced for use in neurosurgeries. During the years, these image-guided procedures that involve preoperative images and planning and intraoperative navigation became the standard of care for many neurosurgical procedures. Among the different IGS applications, cranial applications have gained the highest market penetration. Currently, the vast majority of neurosurgeons in western Europe use these systems. IGS systems provide neurosurgeons with the ability to increase surgery accuracy, reducing the high risks associated with neurosurgery, such as damaging healthy tissues and therefore, gained their credibility and are well accepted in the market. Although the current penetration of IGS for spinal applications is much lower, it is believed that the technological advancements allowing 3D imaging, faster registration and enhanced safety will instigate utilisation and support the growth of this market segment. Although already having a high penetration rate, the total neurosurgical IGS market is expected to keep growing as a result of introduction of new products, increasing prices, growing adoption of IGS for spinal applications and high replacement rates.

Ear, Nose and Throat

As ENT surgeries require navigating in small anatomical structures and cavities with limited visualisation, using image guidance in procedures like sinus surgery, cyst or polyp removal, reconstructive, ENT surgery, optic decompression and skull-base surgeries adds a significant value to them. Providing a 3D image of the patient's inner anatomy, IGS systems allow a much better visualisation than common 2D endoscopic procedures. By being less invasive and more precise than traditional ENT surgery, IGS improves outcomes and increase patients benefits by reducing the risk and allowing a shorter recovery time. As IGS systems for ENT applications become simpler and easier for use, more clinicians and hospitals understand its value and use these technologies. Although the acceptance of IGS among ENT surgeons is quite high, the total market for ENT surgeries is very limited compared to other market segments, such as neurosurgery or orthopaedics.

Emerging Applications of IGS

Sentinel Lymph Node Mapping

The first steps for translation of this technique to the clinic have been made in sentinel lymph node mapping. The sentinel lymph node is the first lymph node to which the lymphatic fluid coming from the tumour drains and in which tumour cells will first metastasise. Currently, lymphatic imaging is performed using dye-injection, nuclear imaging, CT, and

MRI, which each has their specific limitations regarding sensitivity, resolution, exposure to radioactivity, or practical use. NIR fluorescence imaging allows for high spatial and temporal resolution without ionising radiation, making it an easy-to-use and safe technique. With parallel imaging of visible and near-infrared light, the contrast agents can be traced to the sentinel lymph nodes in real-time, without affecting the visual appearance of the surgical field. Considering the recent clinical results using intraoperative NIR fluorescence cameras or portable NIR-imaging devices, sentinel lymph node mapping is one of the most promising clinical applications for NIR fluorescence imaging in the field of oncology.

Optical IGS

Intra-operative optical imaging camera systems are being developed resulting in the detection of a variety of tumours in mice during surgical procedures. In addition to intraoperative tumour detection, endoscopic systems are under development for diagnostic and surgical applications. In neurosurgery, the use of 5-aminolevulinic acid for detection of malignant gliomas by optical imaging techniques has been recently studied. The intra-operative use for fluorescence guidance has been described in a phase II trial as an effective adjunct in the surgery of recurrent malignant gliomas.

Technology Trends

Regulus Navigator

The Regulus Navigator has been shown to be an accurate, reliable and easy-to-use image-guided device during its clinical trials for any intra/extracranial procedure. The system has also been shown to be a cost effective alternative to significantly higher priced commercial image-guided systems. Technological advancements have revolutionised many areas of medicine. Image guided instrumentation promises to play a substantial role in these advancements for years to come. As we have mentioned, there are many technologies currently being used, or investigated for image guided surgery. Many of these will continue to be refined adding new applications for use such as in breast biopsies, cardiovascular surgery, increased use in Orthopaedics, ENT/Otolaryngology and many more areas of medicine. As the technology advances, so will the list of surgical instruments which can be attached to the image guided device, again allowing for further applications. The goal of developers is to interface virtually any and all instruments the surgeon may wish to use providing real-time visualization of the instrument tip in the actual surgical field.

Display Technology

The essence of an image-guided surgical system is its tracking device. However, an equally important component is the display; it must be capable of displaying the image in three-dimensions, either by presenting the observer with orthogonal planes that follow position of the tracked probe, or else display a representation of the probe within a three dimensional rendition of the patient image. To be an effective tool in the operating room (OR), it must be truly interactive.

Multi-Planar Image Display

Multi-planar image representation is as old as tomographic image acquisition, and even when the resolution of early systems was far from isotropic, vertical slices through the data were demonstrated to be useful in navigating through the images in three dimensions.

Three-Dimensional Displays

The traditional means of displaying medical images was an x-ray film on a view-box, and even with the advent of 3D imaging techniques like CT and MRI, until recently images were still viewed slice-by slice, either as films on a standard light-box, or on a computer display.

Stereoscopic Displays

Stereoscopic imaging is no longer in general use in diagnostic radiology, although there are some centres that still employ it routinely, while others use it on a sporadic basis. However, since the advent of three dimensional imaging modalities, there is an increased need to navigate through large data spaces quickly.

Head-Mounted displays

One of the greatest advantages of this approach is that it keeps the images that would normally be displayed on an inconveniently placed computer monitor, within the surgeon's field-of-view at all times. With this system, images from the preoperative studies are always in view. In addition, the real-time, video-based endoscopic images, being used for navigation within the ventricles for example, are always available to the surgeon without the need to turn away from the site of the operation.

Conclusion

Despite its current challenges with regard to setting up an apt OR infrastructure, image guided surgery is having a powerful influence on medicine today. With the computer as a valuable assistant to the physician, surgeries of the future are likely to be less invasive, shorter, less risky and more successful. ■

BUYER'S GUIDE
IMAGE GUIDED SURGERY SYSTEMS

BRAINLAB

Kolibri™

Simple Excellence with an Extremely Small Footprint

Kolibri™ meets today's clinical demand for an economical system that doesn't compromise functionality or performance. Its lightweight, mobile design allows the system to be used in multiple ORs with different navigation applications..

- Separate camera and touchscreen for OR mobility
- Rapid patient data transfer directly to Kolibri in the OR
- Combines planning and navigation capabilities in one platform
- Compatible with all Brainlab navigation software

VectorVision® flex

Small Size. Big Vision.

VectorVision® flex combines a small, ergonomic navigation platform with big-screen image viewing. Navigation can be controlled from the surgical field with the mobile platform or from the wall mounted, multi-touch Digital Lightbox display. Connected to the hospital's network, this image guided surgery platform provides instant access to patient and hospital data.

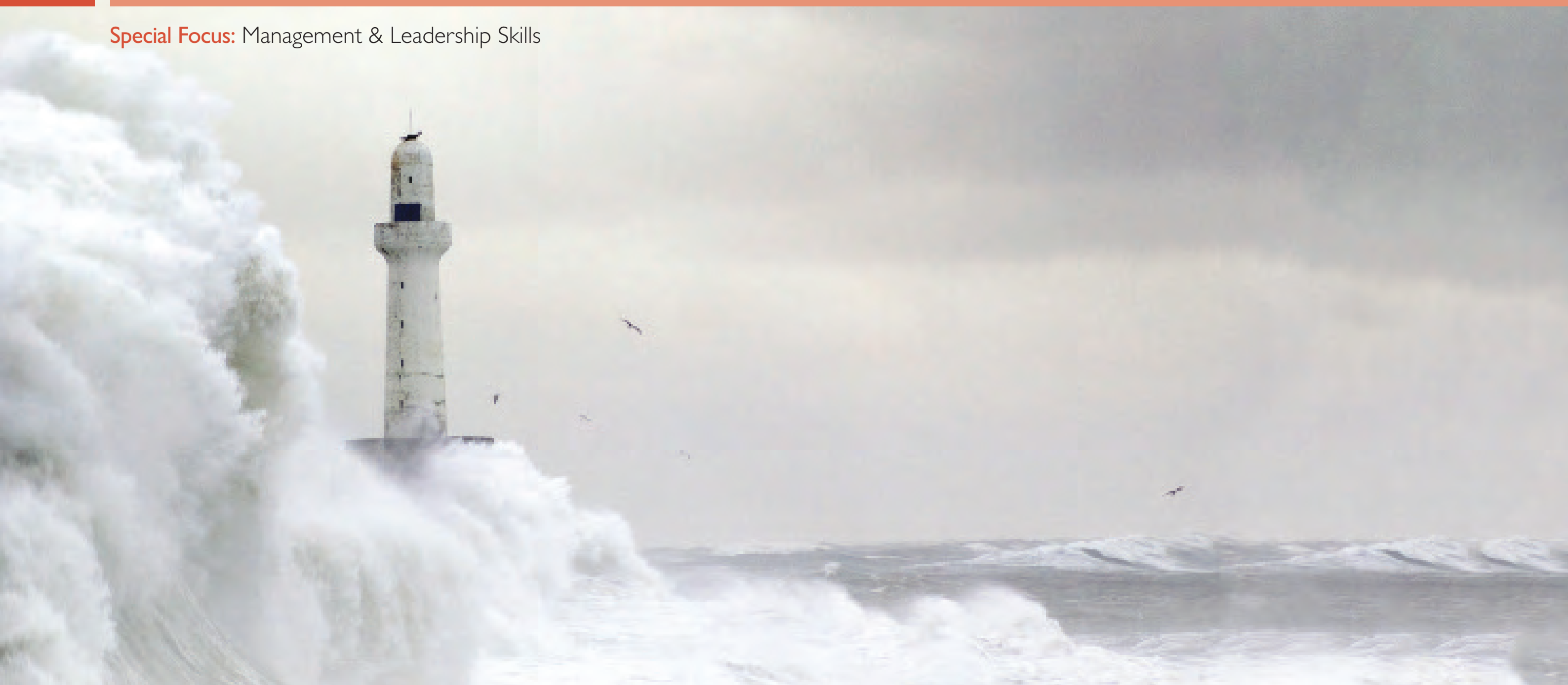
- Utilize 30" high-resolution viewing display as additional navigation monitor
- Access to PACS
- Access web-enabled HIS on Digital Lightbox
- Combines planning and navigation capabilities in one platform

VectorVision® sky

Maximum Efficiency in Space Usage

VectorVision® sky offers unparalleled navigation ergonomics and efficiency in a flexible, ceiling-mounted system. Connecting the hospital network to the surgeon's central control terminal, this image-guided surgery platform provides highly efficiency in OR space usage and site planning.

- Also available in combination with OR lights
- "Zero OR footprint" concept provided through direct mounting to the OR ceiling



DIALECTICS AND **LEADERSHIP**

Getting Ahead by Getting Along

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A cornerstone of leadership is the mastery of techniques for convincing people to pursue your vision. Sometimes, provided you imbue those who report to you with a sense of urgency and shared passion, your ministrations will be enthusiastically supported. But most of the time such unanimity of purpose is lacking. Some of those you direct will actively dispute you, while others will be passively aggressive. Still others will be diffident or confused about what you mean and what they should do. And among your staff there will inevitably be rivalries, petty jealousies yet also productive teamwork. So how do you manage such a variety of attitudes, questions, initiatives and complaints, each of which is, in either a small or large way, a test of your capabilities as an executive?

Dialectics: Inducing Respect & Harmony

There is a range of personal styles you can bring to the task, many of them ultimately deleterious to your success. You can be overbearing or standoffish, over-forgiving or hypercritical. But one approach I have found that more often than not engenders respect and augments harmony is to couch discussion in dialectic terms.

What is "dialectics"? I am not referring here to the term dialectic materialism, a tenet of Marxist ideology. Rather I use the word in an apolitical context, defined as a dialogue between two or more people who may hold differing views, yet wish to pursue truth by seeking agreement with one another. Dialectic must be strenuously distinguished from debate, which could be defined as a dialogue in which two or more people who hold differing views wish to persuade or prove the other wrong. Characteristically, if not always formally, a debate ends in a decision. There is a loser and a winner as decided by individuals deputised for the occasion. In a debate the object is victory, whereas in a dialectic interchange the object is accommodation, consensus and acknowledgement of the legitimacy of differing positions if not the establishment of agreement.

Applying Dialectics in the Department of Medical Imaging

Technique one: Distinguish between deliberate intention and accidental consequence

How does dialectics play out in the day-to-day work of a leader of a radiology department or any organisation for that matter? Let me give some examples. Consider the terms unfair and unfortunate: they are often used interchangeably by an aggrieved petitioner. A tendency is for a bad outcome to be designated as unfair. Therefore it is to be rectified by an exaction of some sort, often in the form of blame or the issuance of a penalty. But frequently what actually went wrong is a consequence of bad luck and not mean-spiritedness. In an unfortunate circumstance, the adverse consequence is not directly a result of purposive human activity or intention but of factors inherently beyond conscious direction or manipulation. Making such a distinction is crucial in reaching agreement or at least reducing tension. The role of the chairperson is to elucidate this distinction when discord is about to be sowed so that potential combatants seeking redress come to realise that an unpleasant condition or outcome is no one's fault even if it is everyone's concern. In this situation the dialectic interjection moves the dialogue forward, avoiding unnecessarily persistent or recurrent recriminations.

Technique two: Downplay destructive hyperbole

Another technique of dialectic correction concerns the management of metaphor. This imposition of responsive and responsible leadership is used to manage arguments specifically to downplay the destructive intrusion of hyperbole. How many of you have heard an event characterised as a "disaster" or a "nightmare" when in fact it was only an annoyance readily endured and often correctible and corrected. But if you allow the inflammatory metaphor to be accepted not as merely referential for narrative effect but as a representative articulation of truth, then all further deliberations will be based on its supposed veracity in defining the tenor of the discussion. Metaphor management is crucial for the focusing of ensuing exchanges because it encloses and delimits the terms of engagement. Reminding one that his or her use of such an arresting but invidious metaphor is a rhetorical extravagance that is inappropriate to form the basis of bargaining, will catch its articulator off guard. Almost always he or she will reluctantly but assuredly acknowledge that the hyperbolic reference is not a reflection of reality but instead just an emphatic statement of position. And by delegitimising the melodramatic metaphor, the discussion can proceed along a less contentious path. And by dampening the emotional byplay through an insistence on unembroidered claims, perhaps an understanding between the parties in dispute may be easier to achieve and a sense of congeniality more easily restored.

Technique three: Offer thoughtful responses rather than abrupt declarations

A third example of the gentle introduction of a dialectic modus operandi upon which structured understandings can be erected is the purposeful management of conversations in which you are the protagonist. It can be accomplished by a progression of tenses in your sequential responses. The choice of verb can be vital for a productive give and take between leader and staff. Often a chairperson will not be perceived to provide full attention or adequate time to respond to entreaties and suggestions either earnestly or deviously offered by trainees, faculty or staff. Some of these proposals may be truly innovative whereas others seem helpful but are really only self-serving and still others are just ridiculous. A temptation of the chairperson is to make definitive pronouncements on the spot, typically in a declarative mode. Mostly, such abruptness makes the leader seem to be brusquely dismissive or less often uncritically receptive. A frequent result is that when a proposal is given short shrift it discourages the petitioner unnecessarily and when approved hurriedly, careful thought is not given to an estimation of its unintended consequences. Physicians are typically very good at rapid decision-making with little information but often not very good when measured deliberation is called for so that a novel suggestion is given its due dispassionately. How can one avoid the pitfall of rash judgment using dialectics as an argumentative device?

First instead of declaring approval or rejection outright, cast your replies in the subjunctive tense. For example if you say: "If I do what you say, then what would happen?" is a more inviting and less threatening response than the categorical decree "No, I do not like it and that's that!" The proponent seeking your favour is not offended by the need to develop a concept further. Moreover, continued discussion might engender ideas neither of you had thought about initially. And if some merit is elucidated through these subjunctive musings, then it might be profitable to move to sentences rendered in the conditional sense. For instance the next step in the evaluation may be "This notion could result in such and such" or "We should consider its anticipated and hidden eventualities." And if the examination of the initial proposal is still promising, then hortatory statements are in order in which the effort for continued development of the idea is joined but still contingent on further activity. The key words now are "let us", as in "let us investigate it some more".

Careful Phrasing Means Greater Accord

Along such a path of tenses, an ultimate decision on merit may be delayed but the rhetorical paradigm is no longer so disconcerting or devastating as an outright rejection or as reckless as an immediate acceptance. Amity is maintained through this progressive analytic process navigated with the use of the key words such as "if then" followed by "could or would" and then by "let us". Under this schema, the chairperson becomes respected for his empathy, if not his eventual agreement. In this way the dialectic process helps you all get along and sometimes even get ahead.

Dialectics, of course, is not a panacea or even an anodyne for the pain of confrontation of staff with you or between employees under your charge with you as mediator. Yet it is often a good way to avoid the destructive effects of immediate discord and prolonged resentment. Moreover, it is an effective way to get your points across while leaving your ethos as leader intact or even enhanced. ■

THE IMPORTANCE OF **LEADERSHIP**

Differentiating Between Leadership & Management

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Leaders are those who do the right thing and managers are those who do things right, according to Warren Bennis, widely known as the progenitor of modern leadership concepts. Do we live and act like we know the difference between a leader and a manager? In everyday activities when urgent matters and routines dominate the agenda, most of us try to do things right, typically without reflecting much, not least because reflection, especially self-reflection, is not so popular in business worlds. For many, John Kotter made the first clear discrimination between leadership and management in the context of change management. In his opinion a manager is more likely an organisational administrator, whereas a leader has visions about where to arrive and how to get there. Management aims for perfect and optimised planning, organising and controlling. Leadership inspires, motivates and creates innovation, meaning and change.

People Want Coherent Leaders with Firm Personal Integrity

There are some basic qualities of good leadership most of us can relate to. In an ideal situation, a good leader is someone we trust, particularly in times of change. When we as followers are asked for commitment we also want to see a coherent leader with firm personal integrity. This simple reflection is very important when it comes to the question of how a leader can influence people to follow his/her vision or goal. If I am in a leading position, do colleagues, co-workers, team and staff members trust my expertise and habits? Or is it just business hierarchy, position and role that make followers obey? We all know about educational and organisational structures that sometimes generate individual careers, competition and rivalry. With this in mind, good leadership has to be concerned about the quality of reliability, commitment and trust as well as the quality of communication, cooperation and outcome.

1. Becoming a good leader needs reliability, commitment and trust

As team members and followers, we expect a good leader to be someone we can rely on. We want to see words and action to be congruent and an expression of the leader's own commitment. As a leader we have to be able to develop congruent and reliable leadership habits. If we demand commitment from others without acting appropriately ourselves, trust in our leadership will be weak. A direct result of reliable leadership habits and commitment is trust in the leader's decisions.

2. Becoming a good leader needs communication, cooperation and outcome

A good leader makes people feel their value by communication. Good leadership has nothing in common with anonymous functional communication. It gives the impression of being concerned with people and followers in everyday routines as well as performing organisational or functional tasks. This kind of related communication is needed when we want to influence our team and staff members effectively towards commitment and enhanced cooperation. It works through listening and asking questions not just by telling. People always perceive this communication habit positively because it generates valuation, appraisal, meaning and motivation. Meaningful communication always ends up in enhanced cooperativeness and outcome. Becoming a good leader is about developing people skills and communication habits that facilitate valuation, appraisal and meaning.

3. Becoming a good leader needs enhanced perception and reflection

Even though the need for leadership skills is deemed important, the challenge is how and when to reflect and establish effective habits when urgent issues dominate the agenda and cut off change processes. Therefore, to most of us, leadership means focusing on those we lead, not looking into the mirror of self- reflection. Understanding the importance of self-awareness and reflection is one thing, acquiring a leadership habit is another. Thus, becoming a good leader is not only a matter of information and knowledge, rather a matter of how we spend our time between acting as an individual contributor, manager of tasks and leader of people.

Nicole Truckenbrodt interviewed 52 leaders of top and middle management levels in different companies to evaluate their leadership skills in a self-assessment format. All the interviewed managers said that reflection skills are most essential to be a good leader but they don't have time for it. Also 100 percent of those interviewed mentioned that reflection skills only work effectively when there is some defined time provided on a regular basis to calm down their pace. They can't do that either. Another principle of good leadership deals with our perception according to the interviewed managers. Good perception skills should sense leadership tasks and challenges by listening carefully to team and staff members as well as recognising one's own internal reactions. Perception training can be an effective way of enhancing leadership skills. Most of those interviewed said they couldn't implement that either, because they are educated into an academic or business world where non-scientific subjects and soft skills are not taken seriously. This survey brings up questions of working place reality into the challenge of how to become a good leader.

Sir John Whitmore, an author and expert speaker on leadership, highlights these basic questions:

- What are we leading people towards?
- What are the obstacles in my/our organisational and personal reality?
- What are my real options to develop good leadership habits?
- When and where will I listen and talk to people?
- When can I find time to reflect on personal and organisational issues, like enhancing the courage to perceive and talk about our states of mind?

4. Developing good leadership habits means prioritisation

Understanding that acquiring good leadership habits requires training in awareness, perception, reflection and people skills, as well as willingness and time management to implement all this into daily routines we now face the necessity of prioritisation. According to Stephen Covey (1989), prioritisation means discriminating between urgent and important, non-urgent and non-important activities. For many of us, training and implementing these kinds of leadership habits into daily business life is neither urgent nor important. What if becoming a good leader really means identifying leadership skills as important, even on a par with urgent issues, so that organising its training and implementation takes place within a serious time management strategy?

Conclusion

Ideal leadership is based on reliability, commitment and trust, as well as meaningful communication to enhance cooperation and outcome. Managers and leaders themselves identify good leadership as being carried by perception, reflection and people skills. To train and implement this in terms of habits and routine we need commitment and time. Most of us feel the importance of leadership especially in times of change, whereas the achievement of becoming a good leader seems to be unrealistic within the context of time lacking and different prioritisations. ■

CLINICAL CARE THE KEY TO INTERVENTIONAL **RADIOLOGY'S FUTURE**

Leveraging an Under-Utilised Resource

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Interventional radiology has evolved into an indispensible branch of modern medicine, offering a growing number of minimally invasive procedures in a broad range of therapeutic areas. This reach has been the discipline's strength as well as its Achilles heel; with no specific disease state, organ system, or patient group to exclusively call its own, IR often struggles for recognition while other specialties threaten to take on the procedures it has pioneered. However, in the changing world of medicine the organisation of patient care is no longer constrained within the classic collegial divisions, but depends upon interdisciplinary collaboration and the pooling of various competencies and expertise.

In 2009 a milestone was reached on the journey to recognition in Europe. Interventional radiology gained UEMS (European Union of Medical Specialists) subspecialty status within the division of radiology. This is a clear message to medical colleagues, patients and hospital administrators alike that IR, as a unique discipline, is here to stay, and that the most appropriate experts to carry out IR procedures are appropriately trained and credentialed doctors. Even so, in increasingly competitive and cost-constrained times, IR must position itself wisely for the future if it is to be an equal member of the medical family. Through constant discovery of novel procedures and technical innovation IR enables many new treatments with fewer complications, shorter hospital stays, faster recovery, improved patient comfort, and lower costs.

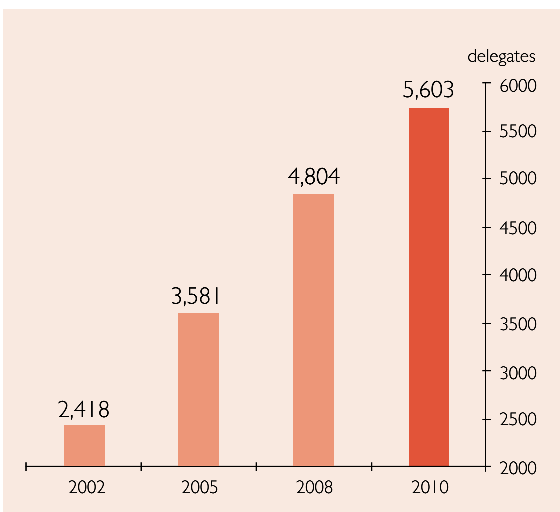

Figure 1.

CIRSE Congress attendance: one indicator for the positive development of IR in Europe is the strength and growth of its annual congress

Given these advantages, it is surprising to see IR existing in many hospitals as an under-utilised resource, performing a one-dimensional technical role providing procedures at the request of referring physicians. More and more IRs are actively changing this situation, however, proving their professional worth by playing a collaborative role in clinical patient care and raising awareness of what they have to offer.

Laying the Groundwork

In supporting the cause of IR, the work of national and supra-national organisations is vital in ensuring an environment exists in which individual IRs can excel in their specialty. A first step is its universal recognition and it is with this in mind that CIRSE and SIR collaborated on the publication of the 'Global Statement Defining Interventional Radiology'. Endorsed by 42 professional societies in 39 countries, the Statement was published concurrently in CVIR (Cardiovascular and Interventional Radiology) and JVIR (Journal of Vascular and Interventional Radiology), and provides a unified and accurate picture of IR, as distinct from other specialties and subspecialties.

As well as defining the clinical scope and required training for the discipline, the clinical practitioner status of those who belong to it is strongly asserted, to counter the detrimental view that IRs are nothing more than technical experts. The statement informs health authorities and political decision makers of the resources IR requires to provide proper clinical interventional care as a complete clinical practicing specialty in the context of multidisciplinary collaboration.

Another significant achievement has been UEMS recognition of IR as a defined medical subspecialty. As well as being an excellent way of raising IR in the consciousness of influential European policy makers, subspecialty status will catalyse the Europe-wide standardisation of IR training through syllabus development, to make specialised training pathways a reality and guarantee dedicated time for clinical practice during speciality training.

Furthermore, it has become vital for the future growth of IR that medical students at the undergraduate level gain more exposure to the specialty. This is essential, not only to guarantee a steady recruitment stream but also to raise awareness and make a positive impression on the referring doctors of tomorrow. It is disappointing that when IR procedures are taught in schools of medicine, it is often by non-interventionalists. Given the increasing reliance on imaging to teach anatomy, as well as the existing inclusion of radiology in undergraduate curricula, the opportunity is ripe for IRs to become more engaged in teaching what is no longer a set of novelties, but an essential part of modern medicine.

A further benefit of UEMS recognition is that the organisation will accredit examinations and assessments. It has already endorsed the European Board of Interventional Radiology (EBIR), which is an international hallmark of excellence in IR, certifying expertise and validating training. This qualification indicates that those who have attained it are highly competent in performing interventional procedures effectively and to the required standards of safety. The EBIR is administered by CIRSE and endorsed by ESR, two organisations that are also strongly supporting further scientific research in the field through involvement in the European Institute for Biomedical Imaging Research (EIBIR).

> "The imaging skills necessary to perform IR procedures are housed within diagnostic radiology and will continue to be so"

All of these steps will support IR in education and training, as well as teaching and research: the foundations upon which a clinical specialty is built. The final requirement of a true medical specialty is professionalism in clinical practice that has been promoted by CIRSE with the publication of 'Clinical Practice in Interventional Radiology'. This reference manual explains how to set up a clinical IR practice and details the resources required to do so, with a view to providing complete care for patients.

An Indispensable Part of the Clinical Pathway

The factors above have created the structures and support for IRs to excel within their own local working environments. The time has come when it is no longer enough for an IR to see the referred patient only on the day of the intervention. Indeed, patients as well as referring physicians expect more than just technical procedure provision, and want to be sure that the specialist to whom they refer takes responsibility for full clinical care. Patients who undergo an IR procedure should be seen by the IR for initial evaluation, including consideration of options prior to obtaining informed consent, work-up, therapy, and follow-up. This policy of longitudinal care is normal practice for other specialties so is essential to full professional recognition from all sides.

IRs should make themselves visible: writing on patient charts during ward rounds, offering a 24-hour service and communicating with primary care doctors upon patient discharge are all crucial in this regard. Primary care should also be engaged through attendance at meetings and continuing education events, where IRs can present their specialty. In this way referrals are gained, as personal contacts are made and primary care doctors are assured that full clinical care is provided for those patients they refer to IR. Such development of clinical practice requires the full support of diagnostic radiologists as well as chairs of radiology departments. The imaging skills necessary to perform IR procedures are housed within diagnostic radiology and will continue to be so, making harmony between colleagues in the interventional and diagnostic branches vital.

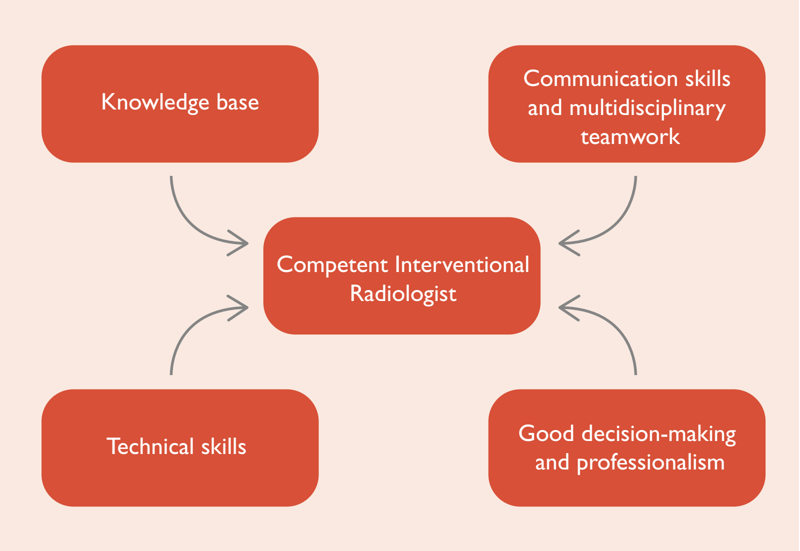

Figure 2.

Requisites for competence in interventional radiology

Greater Access Required

Despite an enthusiasm for clinical practice and a strong will for change, the number of IRs that have access to outpatients and control over dedicated beds is still too small. Even IRs that actively seek to establish a clinical practice may find obstacles in their way, especially when faced with hospital management tasked with efficient allocation of limited resources. This inertia may be compounded further through extra-disciplinary suspicion or concern over a rising source of competition.

In bidding for clinical practice resources IRs should highlight the financial benefits, in that IR adds well-reimbursed and complex interventional procedures, as well as sophisticated ancillary imaging work, to the group case-load. In terms of the wider healthcare market, a clinical IR practice positions a hospital for growth in the expanding area of minimally invasive procedures. IR is also a traditional source of innovation and progress in the clinic, and is highly marketable as a cutting-edge field of medicine.

Many IR procedures are unique alternatives to other more invasive surgical procedures, have great clinical value, and are preferred by patients. These interventions are now integral to modern medicine and in the face of rising patient demand must be offered as part of a complete clinical care package delivered by IR. Good patient-doctor relationships are based on trust that is established through full patient contact and clinical care. This is vital to risk management: in the case of a patient who knows and trusts their doctor, litigation is less likely to follow any complications that might arise from an intervention.

IRs are the ideal specialists with the complete skill set necessary for image-guided minimally invasive interventions and are just as qualified to provide the associated clinical care. Thanks to their own good work and the continuing support of their professional organisations IRs can be proud to make themselves heard in striving towards a bright future, not only for their own specialty but also for wider professional collaboration and improved patient care. ■

BENEFITS OF PET-CT VERSUS OTHER DIAGNOSTIC METHODS

Standardisation Brings Cost and Time Savings

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PET/CT is an established clinical tool that is particularly valuable for cancer-related diagnosis, including both initial diagnosis and follow-up examinations. There are other procedures, like CT/MRT, bone scan, or mediastinoscopy, all of which are also costly. Given the fact that PET/CT is widely used anyway, the question arises whether it is medically responsible and financially favourable to focus solely on PET/CT examinations.

A study on 120 cases of lung cancer has shown that patients are properly restaged during follow-up examinations with PET/CT which sufficiently legitimises this procedure in medical terms. PET/CT can thus replace a combination of the three other procedures, which saves money and spares the patient from needless exams. The impact of switching from a case by case decision on which procedure(s) to use, to only relying on PET/CT entails both direct and indirect effects. A direct effect, for example, is the immediate cost or time comparison between PET/CT and any other examination method. An indirect effect is, for example, the altered restaging for patients. Both groups of effects are discussed in this paper in detail.

Direct Effects

The two most obvious direct effects of using PET/CT instead of other diagnostic methods are the difference in outcome and the difference in cost. With respect to lung cancer, PET/CT basically delivers an output of the same quality compared to CT/MRT, bone scan, or mediastinoscopy. Thus the results of all methods shall be treated as equally useful for follow-up examinations.

The study shows however, that the likelihood of upstaging (follow-up results in an operation rather than no operation) increased by 16 percent in the sample. This immediately changes the result of the examination in terms of quality. Assuming that patients weren't upstaged mistakenly, this implies PET/CT is more effective. Hence, treatment quality increases. Thus, PET/CT becomes valuable in terms of exposing the patient to less follow-up examinations and the physician being able to react earlier.

In terms of the cost, one simply regards the cost per examination of one method or another. PET/CT is cheaper than mediastinoscopy but more expensive than bone scan and CT/MRT. However, early upstaging implies:

(a) Less follow-up examinations, which in turn yields immediate savings, and
(b) This might result in chemotherapy treatment rather than surgery which would mean cost savings of about 40 percent per case.

The study further showed that about 8 percent of the patients could be downstaged earlier when using PET/CT. This implies not only more certainty for the patient, but also savings in further follow-ups and the potential for unnecessary treatment.

Indirect Effects

A second view reveals that the choice of examination method also influences the cost per examination. There are indirect effects of the decision over what method to use on the cost structure of all the examination processes. If management decides to only use one rather than three examination methods, so called economies of scale can be realised. Increased standardisation and routine helps staff to decrease process time and handle cases more effectively. For example, the time-intensive step of deciding on the appropriate method and eventually revising this decision can be left out.

Using only one method also implies that only one type of device has to be in place. The utilisation of this device can be maximised by concentrating all examinations on this device. Note that this argument doesn't hold, if other devices are fully utilised anyway. Maintenance and related costs decrease as well, as specialisation effects rise. This can be sourcing-related in terms of a help-desk, for example, or material-related in the case of the use of a tracer. As more patients are scheduled per day, management might be able to use tracers reserved for cancelled examinations elsewhere and thus avoid the cost of having tracers expire.

Further economies of scale may incur in the diagonsis routine, as physicians become more specialised and the output (report) naturally more standardised. This in turn also benefits the treating physician.

Conclusion

In conclusion, focusing on PET/CT is clinically favourable in terms of patient convenience and financially favourable in terms of cost savings. It further entails economies of scale by focusing on that one procedure, e.g. decreased marginal costs and enhanced operational efficiency due to routine. Based upon these insights it seems advisable to reconsider further diagnostic sequences for economic reasons. Not only on a stand-alone basis, but also for how they interact. On a holistic basis alone, synergies both in terms of financial impact and patient distress can be identified and capitalised on. ■

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age hold, reduction of frame rate when feasible, and removal of anti-scatter grid for younger children. When optimising a cardiac catheterisation lab for paediatrics, these are the first steps in dose reduction. Good radiological practice should always be exercised.

Optimising X-ray Beam Energy

For further optimisation, imaging systems utilise x-ray beam spectral filtration such as copper, in varying amounts. Copper reduces ESD whilst causing a slight reduction in image quality. A collection of published paediatric optimisation studies demonstrates no consensus regarding the correct amount of copper to use. Many optimisation studies also suggest alteration of x-ray peak tube voltage; some recommend raising it while others recommend lowering it. The peak tube voltage and spectral beam filtration together define the x-ray beam energy. There is a complex relationship between beam energy and patient size, and their effects on both image quality and dose. Examining both peak tube voltage and spectral beam filtration is necessary in order to optimise x-ray beam energy for patient size, to achieve the best image quality to dose balance for a particular patient size.

X-ray tube voltage is set by the automatic dose rate control (ADRC) of the imaging equipment, in response to the amount of copper spectral filtration present. Radiographic factors are automatically selected by the ADRC when the foot pedal is engaged, for fast easy use by clinicians. This closed loop operating mechanism makes it impossible for physicists to investigate the optimisation effects of peak tube voltage and of copper beam filtration independently.

The Leeds X-ray Imaging Research Group (The University of Leeds, UK) conducted an experiment in which the ADRC was surpassed to explore optimal x-ray beam energy for three different paediatric patient sizes. Peak tube voltage and copper beam spectra were varied in a controlled manner to observe optimisation effects of x-ray beam energy with respect to imaging iodine. The study was conducted on a flat panel imaging system, but due to the nature of the investigation, results were system-independent, and addressed general x-ray principles.

Image sequences of 8.5, 12, and 16 cm thick phantoms were used to approximate x-ray attenuation of typical paediatric patient chest sizes. Peak tube voltage, tube current and x-ray pulse duration were set manually by over-riding the system's ADRC mechanisms. Image contrast to noise ratio (CNR) and effective dose were determined to calculate the optimisation figure of merit (FOM), CNR2/effective dose. Full details of the experiment can be found in Gislason et al. (Medical Physics, 2010). Results are shown in figures 2 – 4; it is clear that for thicker copper filtration, lower peak tube voltage was favoured. Regardless of the filtration, lower peak tube voltage was generally favoured, more so for thinner phantoms. Where higher peak tube voltage was used, thinner (or no) copper filtration was favoured. The study concluded that in terms of beam energy, for iodine contrast agent based x-ray imaging, the image quality to effective dose balance can be improved by adding 0.25-0.4 mm copper filtration to the x-ray beam while maintaining a peak tube voltage of 50 kVp, depending on patient size. These results are in agreement with a Monte Carlo simulation study completed in 1999.

In addition to good radiological practice, for optimisation of image quality to dose in paediatric cardiac x-ray imaging, the x-ray beam energy should be adjusted for patient size. Actual peak tube voltage and spectral filtration used will depend on the x-ray tube and its inherent limitations. If this concept is not already implemented, for some imaging systems, adjustment may involve re-programming ADRC settings, which may require the hospital medical physicist and/or field service engineer. Every extra effort made will help reduce the chance of paediatric patients with congenital heart disease developing radiation-induced cancer later in life. ■

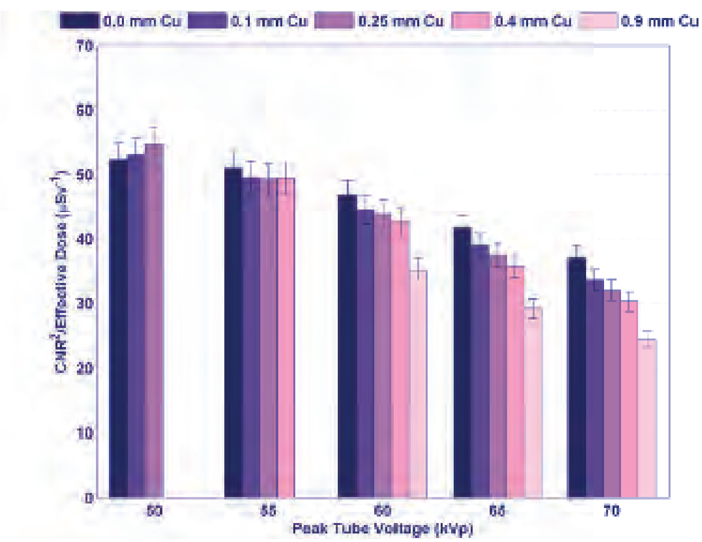

Figure 4.

16 cm phantom: Optimisation figure of merit for varying peak tube voltage and copper (Cu) thickness, with the anti- -scatter grid in place.

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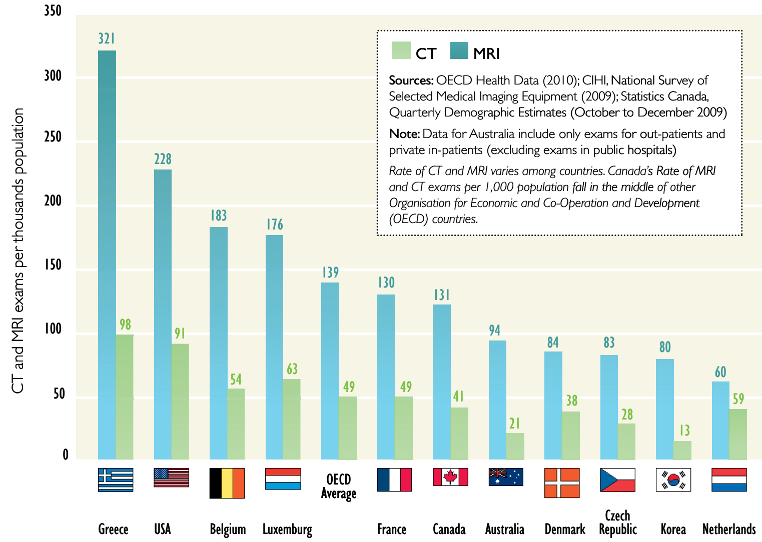

Figure 1.

Variations of Rates of CT & MRI Scans Per Countries (cited in Health Council Canada, 2010 p. 30)

more advanced diagnostic imaging services – and as such act as gatekeepers for these types of health services. Today, physicians are ordering more high-cost examinations (CT and MRI) than they have in the past. According to the Canadian Association of Radiologists (CAR 2010), the operating costs for diagnostic imaging in Canada now exceeds an estimated 2.2 billion Canadian dollars annually.

Overuse of Diagnostic Imaging

Research points to overuse of diagnostic imaging in Canada (Health Council of Canada 2010). For example, as many as 30 percent of CT scans and other imaging procedures are inappropriate or contribute no useful information. Further, less than two percent of CT scans for headaches found abnormalities (Health Council of Canada 2010). Moreover, about five percent of imaging workload consists of duplicated tests because the original has been lost or is not available (Health Council of Canada 2010).

By simply reducing the number of unnecessary tests by 10 percent, Canada could realise cost savings of 220 million Canadian dollars in healthcare expenditures (CAR 2010). It could also lead to a reduction in wait times for such procedures and improve patient safety in some areas by decreasing the number of patients being exposed to unnecessary radiation (CT scans only).

Tools for Decision-Making

For family doctors, their patients' health and safety are the primary focus of healthcare decision-making. These decisions affect the use of and spending on healthcare services including diagnostic imaging. A number of tools exist to help physicians with their choices. Clinical practice guidelines are a useful resource available to assist family physicians. They inform providers about appropriate care and help reduce inappropriate variations in care. In 2005, the CAR published Diagnostic Imaging Referral Guidelines: A Guide for Physicians. They are currently working on an updated version slated for release in early 2011.

Electronic health information systems like electronic medical records and electronic health records will facilitate the use of health technology such as evidence-based clinical practice guidelines. Canada is working towards developing a comprehensive electronic medical and health record system. The use of electronic decision-support systems is rare among Canada's family physicians. Some results from 2009 indicate that 56 percent of family doctors used electronic billing and 43 percent used computers to schedule appointments. However, only 13 percent per cent issued prompts about potential drug interactions or reminders for recommended patient care (Health Council of Canada 2010).

Technology Heralds the Future

Jurisdictions in Canada are investing in technology that facilitates the sharing of diagnostic images among radiologists, family physicians, and specialists. For example, the Picture Archiving and Communications System (PACS) connects all hospitals in a province, giving patients and providers easy access to the benefits of diagnostic imaging. PACS allows healthcare providers to view CT and MRI scan images (among others) no matter where they are, giving providers more timely information. PACS has an estimated 90 percent user rate among Canadian radiologists. Doctors using PACS found they saved 30 - 90 minutes a week along with a reduced number of patient transfers between facilities (Health Council of Canada 2010).

Conclusions

To assist family physicians with their decision-making and improve appropriate use of diagnostic imaging, Canada must make significant improvements in support systems to deliver more effective and efficient care. But before we make investments in new diagnostic imaging and other technologies, it is imperative to assess our current services and apply rigorous health technology assessment to ensure the most cost-effective and safe care. Without taking time to evaluate our current use of diagnostic services and the many factors that influence it, we will continue to perpetuate the cycle of inappropriate use and at times overuse – causing patient safety concerns as well as incurring unnecessary costs to our healthcare system. ■

RADIOLOGY IN CYPRUS

Professional Challenges

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CAREER **HIGHLIGHTS**

Each member of my family has been involved in the practice of medicine: Late father as a cardiologist and my mother as a microbiologist while my brother is a gynaecologist and sister a paediatric endocrinologist. After being accepted at the Athens Medical School I served in the army for two years then took up my studies. In 1978, I graduated medical school, got married and began a specialisation in radiology. At that time I was working in two hospitals in Athens, one in the morning and one in the afternoon and evening. In 1986, I decided to return to Cyprus to start my own private practice, and I was appointed as part-time director of the radiology department of the military hospital. This has continued until now. In 1986, I was a founding member of the Radiology Society of Cyprus and in 1988 I was elected President of the Society. In 1989, the Society was accepted as a full member of the European Association of Radiology (EAR, now ESR). I have been reelected President every three years since and currently hold the position.

In my department, I deal with conventional radiology, mammography, DEXA, panoramic & cephalometric exams, as well as 3D. Last year, a younger colleague joined the dept. and performs all ultrasound examinations. We also do ultrasound-guided core biopsies as well as stereotactic (ATEC SUROS) biopsies. The office uses CR for general radiology and direct digital for mammography and dental imaging. Thank God, everything is working very well.

Public Versus Private Radiology

In the Republic of Cyprus, both the private and public sectors for healthcare are completely separate. *The public sector* includes hospitals, outpatient department and rural health centres. They employ many radiologists and offer radiographers quite rewarding salaries and other benefits. I don't know how Cyprus compares in this respect to other European countries, but we reward our employees better than Greece and Eastern Europe. These institutes are equipped with general radiology, ultrasound, mammography, DEXA and CT with one MRI situated at Nicosia General Hospital. *The private sector* includes large clinics, private hospitals, private offices (like mine) and diagnostic centres where, again, the same range of imaging exams are performed – however, the private sector has many more CT and MRI units.

These private centres pose no competition for the public sector since the public sector offers services that cover almost 75 percent of the population, mostly for free – how can you compete with that? Also, the public sector now has big waiting lists of up to ten months for most of the modalities, and only rarely are services bought from the private sector. Private patients usually pay themselves or have private medical insurance coverage, although there are some medical funds, set up by, for example, the national electricity authority, telephone company, labour syndicates, etc. Teleradiology is performed in Cyprus with centres abroad on a "second opinion" basis.

Education & Training

Unfortunately, academic radiology is not that well developed here, since Cyprus does not have a medical school at the university and until the present moment, specialisation is not offered in the government hospitals. However, the Cypriot radiology society in collaboration with the medical association and local medical associations and other related societies, and also individual centres and public hospitals organise lectures on different subjects, by inviting speakers from abroad. The Society of Radiology also organised, in partnership with the Greek society, three Cypriot – Hellenic Congresses (2002, 2006, 2010) which were quite successful. In addition, many Cypriot radiologists attend foreign congresses like the European Congress of Radiology (ECR) and the annual RSNA.

Professional Challenges

In the public sector, I would say the leading professional challenge is the huge volume of work that awaits us as well as the extended waiting lists for imaging exams. Another hot point is the under-established communication and coordination between surgeons and interventional radiologists. In the private sector, the main problems are that we cannot find radiographers because the language – Greek – is not widespread, and when you are the only radiologists on staff you cannot easily drop your workload or to attend all the training and congresses you would like. ■

HOT TOPICS **IN MEDICAL IMAGING IN CYPRUS**

Remote Ultrasound for Ambulatory Patients

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Managing Editor

What kind of background does Cyprus have in tele-health?

Telemedicine is evolving in Cyprus, with some forms of telemedicine in common practice in many fields of medicine throughout the country. Our aim is to incorporate telemedicine in everyday practice in Cyprus, especially as the whole island is covered with state of art telecommunications. Health technology projects already implemented in Cyprus include the following:

- RIS/PACS internet gateway system;
- Wireless emergency orthopaedics telemedicine system between Nicosia hospital & rural health centres;
- Mediterranean OTELO tele-echography project, MARTE I, MARTE II and MARTE III projects;
- Echonet ultrasound network;
- Orthopaedic Teleconsultation Paraskevaidion (CY) & Shriner´s Hospital (USA) project;
- Telepathology network (TELEGYN);
- Emergency telemedicine (ambulance & emergency - 112) project;
- Oncology radiation therapy and radiation diagnostics (TELEPLAN and VIRTUOSO);
- Collaborative virtual medical team for home care of cancer patients (DITIS);
- Teleconsultation and teleradiology between medical centres in Cyprus in viewing and reporting cases and interactive participation of radiologists during the examinations.

Tell us about your collaboration with the University of Bourges, France, using robots to perform tele-echography.

Our collaboration with the University of Bourges/France began in 2003 as part of the OTELO project which involved satellite connection between Cyprus, France and Spain. My role was as physician operating the robot while specialists in two other countries performed the exam. It was repeated in 2005 with the MARTE I remote examination of patients in the rural hospital of Kyperounta by expert doctors in the radiology department of Nicosia General Hospital (2005) and in 2007 MARTE-II, the remote examination of volunteer patients on a cruise ship in the Mediterranean sea by expert doctors from Nicosia General Hospital and Bourges Hospital in France, using satellite communication (2007).

After the first two phases of the MARTE-I and MARTE-II projects both teams decided to continue their cooperation via the MARTE-III research programme. The cooperation between French and Cypriot researchers, expert doctors, partner organisations and sponsors was, from start to finish, of a very high standard. The project's lead organisations were the Cyprus University of Technology (CUT) and the University of Orleans (IUT), Bourges, France, with the University of Cyprus. The project started on January 1, 2008 and was completed on the April 30, 2010. The project was funded by the Cyprus Research Promotion Foundation (ΙΠΕ) under the auspices of the "Programme of Bilateral Protocols for Research and Technological Development" between Cyprus and France.

The MARTE-III project involved applied research in the field of mobile robotic tele-echography. The general aim of the project was to treat emergency patients in a moving ambulance, by the performance of remote ultrasound exams from a central hospital, by clinical radiologist experts in cooperation with the paramedics in the ambulance. The expert doctor examines the patient directly using the MARTE system based on wireless telecommunications. In many cases, the expert concludes that the patient is not at all a patient, or the problem with his health is not so serious. So the MARTE system may act in many cases as a 'carrier of good news' and help streamline otherwise urgent workflow.

The MARTE I project was organised in collaboration between the University of Cyprus, the Higher Technical Institute of Cyprus and the University of Bourges and Nicosia General Hospital. My role in the project was to use a victim probe and conduct a teleradiological examination from Nicosia General Hospital in a patient settled at Kyperounta Medical Centre based in a rural area outside Nicosia. MARTE II in 2008 was similar and the patient was based on a ship outside the country and in 2010, MARTE III involved a patient based on a moving ambulance; in both projects I performed the ultrasound exam through a robot based in Nicosia General Hospital.

Figure 1:

Photos from MARTE III

Tell us about the system that MARTE III uses. What were the requirements for its architecture & configuration?

The system consists of:

1) A specially equipped medical workstation on the expert's side, situated in the medical centre from where the expert doctor remotely performs tele-echographic exams and gives advice to the medical/paramedical staff in the ambulance for the support and treatment of the patient. The expert station in the medical centre (central hospital) consists of:
   (i) The fictive probe and its accessories,
   (ii) The computer, which is connected to the fictive probe, and
   (iii) Teleconferencing equipment (camera, microphone, screen, loudspeaker), through which there is optical and acoustic communication between the central hospital and the ambulance.
2) The specially equipped mobile workstation (on the patient's side in the ambulance) is used by medical/paramedical staff in the ambulance. This mobile workstation consists of:
   (i) The robot;
   (ii) The real probe, which is 'held' by the robot;
   (iii) The computer, which is connected with the robot and controls it;
   (iv) The teleconferencing equipment (camera, microphone, screen, loudspeaker), and
   (v) The ultrasound device.

The motion of the fictive probe is transferred via the network which is formed by the expert's computer, the terrestrial and satellite link.

"The aim of the project is to pre-examine emergency patients in a moving ambulance, using remote ultrasound exams viewed at a central hospital by clinical radiologists in cooperation with the paramedics in the ambulance"

(3) The system also includes the computer of the robot in the ambulance;
(4) The robot, and
(5) The real probe (which is applied to the patient).

The ultrasound applied to the patient is transmitted via the network formed by:
(1) The teleconferencing system in the ambulance;
(2) The satellite and terrestrial networks, and

(3) The screen of the teleconferencing system on the expert's side (central hospital) where it appears on the screen of the teleconferencing system, for the expert doctor to be able to make the examination as if he were next to the patient.

How are image acquisition, transmission and processing set up?

The methodology that was applied was the following: At the beginning an analysis of the various aspects of the project was performed so as to define the specifications and needs for equipment and software. Preliminary experiments were then performed using the vehicular satellite antenna, installation of the mobile unit in the ambulance, installation of the expert site unit in the central hospital (CUT telemedicine laboratory), connection of both systems and testing of the whole arrangement. Then the software was written according to the specifications and design of the new and improved model robot, called Melody. Then the mobile workstation was installed in the ambulance as well as the installation of the necessary equipment in the central hospital, and connection between the two units and testing of the operation of the system made as a whole. Then the software was designed and finally the integrated experiment of examining volunteer patients in the moving ambulance was performed successfully from the telemedicine lab of CUT, which was acting as the central hospital.

Samples of the experiment's results were used for analysis of the ultrasound images and videos recorded during the experiments, giving emphasis on the quality of the transmitted images and videos. The main outcome, the successful operation of the system as a whole, with reception of high quality ultrasound images via satellite links, was achieved with excellent results.

How does tele-echography compare to traditional methods in accuracy and image quality?

The tele-echography system is not the same as traditional ultrasound. The major drawback is the lack of free movement of the probe on the patient's body, which using the robot can only be done in an X/Y axis plane. This limits the ability of the physician to check specific areas compared to the traditional method; however the areas of interest can be reached and diagnosed. The interruption of transmission in some cases during the examination also limits the accuracy of the method in the same time frame as traditional means. Image quality is slightly decreased for technical transmission and acquisition purposes, however it has continuously improved and now compares to the standards of traditional ultrasound machines. Overall the examining physician, if trained, can establish a general diagnosis using these systems, covering most of the scenarios under interest.

Is this new digital means of diagnosis cost-effective compared to traditional methods?

This means of diagnosis involves certain extra costs that are not needed for traditional ultrasound exams. Currently the robot system costs approximately 50,000 euros for experiments, while a basic ultrasound machine and the transmission system are also needed at the patient location and the basics (victim probe, etc.) in the diagnostic centre where the examination will be performed. In these terms, tele-echography seems not to be cost-effective; however the consideration of the particular circumstances of the use of these methods is imperative since under certain scenarios teleradiology is the only mean of establishing a basic urgent diagnosis and moreover the transfer of every such patient to specialised centres is not only impossible at certain times (e.g. as in the case of ship passengers) but costly as well, as is the cost of hiring expert radiologists in centres located in distant areas.

How is the patient's consent being obtained, and how is their digital privacy being protected?

The patient's consent is a major legal issue in the field, and in our projects was obtained after the remote examining physician informed the patient via teleconference and the patient signed his/her consent form in the presence of an assistant or other physician based at the patient's location (this was only required in the "MARTE I" project where real patients took part at Kyperounta rural medical centre). The patient's privacy is protected as in other medical examinations firstly with the presence of authorised personnel in both places involved in the examination. The digital data are encrypted and protected throughout their transmission.

At this time they are not saved in a system such as PACS but in the future they will be protected with same means as digital CT or other imaging exams stored in PACS, in an encrypted form that needs the authorisation code of professionals in order to be viewed.

Are physicians and patients happy and confident with this remote method?

Physicians seem to be satisfied with this method, and confident that besides various issues in its implementation it is continuously improved and will hopefully reach the standards of traditional practice. Patients are sometimes hesitant about the accuracy of the method, but are willing to participate and are finally happy with the results, especially in those emergency scenarios tested through some of our projects. ■

HITACHI

Hitachi Launches Latest Addition

As the latest addition to the HI VISION series of ultrasound systems the HI VISION Ascendus benefits from modalities such as Hitachi Real-time Tissue Elastography (HI-RTE) for imaging tissue stiffness, and dynamic Contrast Harmonic Imaging (dCHI) technology, that enhances visualisation of tissue microvasculature after the injection of an ultrasound contrast agent. Features that are part of the standard package offered with the HI VISION Ascendus support new technologies and enable it to display 4D real-time tissue elastography images where volume data is captured in real time and the information on tissue stiffness is transformed into images by means of high-speed signal processing.

PHILIPS

Zurich Hospital Selects Philips Hybrid OR Solution

Philips announced the opening of the world's first Hybrid OR with FlexMove – a ceiling-mounted option for the Allura Xper X-ray system, designed to optimise workflow in Hybrid Ors – at the University Hospital Zurich (Universitäts Spital Zürich, USZ), Switzerland. A Hybrid OR is the integration of a surgical operating room with an advanced x-ray imaging system. This enables cardiovascular surgeons as well as interventionalists, to perform minimally invasive procedures. Further launches of FlexMove are planned later this year in Belgium, Germany, North America and the Republic of Ireland.

CARESTREAM

U.S. Hospital Inks Seven Year Order for Cloud-Based Carestream RIS/PACS

Winthrop-University Hospital, Mineola, N.Y., signed a seven-year, multi-million-dollar order for cloud-based RIS/PACS and vendor-neutral archiving services from Carestream Health. Carestream's e-health services deliver full RIS/PACS functionality for image review, storage and distribution throughout the enterprise including delivering advanced reading tools to on-site or remote radiologists. Cloud-based archiving of patient data and imaging studies is also included.

"Based on a thorough evaluation, we elected to purchase cloud-based services instead of a traditional RIS/PACS on-site installation. This service model is attractive because it offers affordable and predictable operating expenses, an uptime guarantee of 99.9%, and the ability to obtain ongoing technology refreshment from one of the world's leading healthcare IT providers," said Enrico Perez, BS, RT, CRA, Administrative Director, Winthrop-University Hospital's Department of Radiology.

Winthrop-University Hospital is a 591-bed university-affiliated medical centre and state-designated Regional Trauma Center. The hospital selected Carestream Health as its e-health services provider because of its proven track record of worldwide implementations.

HOLOGIC

Hologic Selenia 2D Awarded EUREF Certification

Hologic announced its Selenia Dimensions digital mammography system in two dimensional (2D) mode has been awarded "EUREF Type Test" certification by the European Reference Organisation (EUREF) Council for Quality Assured Breast Screening and Diagnostic Services. Only three products have received EUREF approval to date, of which two are Hologic systems - namely, our Selenia digital mammography system and now Selenia Dimensions, its newest breast cancer screening and diagnosis technology. The mission of the non-profit EUREF council is to raise standards by bringing together, at the European level, the best examples of quality control in mammography screening from regional and national breast cancer screening programs. EUREF mammographic type test certification ensures hospitals and imaging centres that the Hologic Selenia Dimensions system in 2D mode has passed a rigorous series of physics and clinical tests demonstrating the system meets the image quality, radiation exposure, and stability standards set by EUREF for screening and diagnostic mammography equipment.

AGFA

Luxembourg Hospital Selects AGFA HYDMedia

Agfa HealthCare announces today that the hospitals of the François-Elisabeth Foundation (FFE) in Luxembourg will replace their existing hospital information system (HIS) and document management system (DMS) with Agfa HealthCare systems. The Hôpital Kirchberg, the Clinique Privée Dr. E. Bohler - both in the Kirchberg area of Luxembourg City - and the Clinique Sainte-Marie in Esch-sur-Alzette will put Agfa HealthCare's HYDMedia digital archiving system into service by spring 2011. By mid 2014, the phased implementation of the ORBIS HIS will take place: applications supporting processes and documentation for medicine and nursing, for communicating services and physician reports, for operating room management, for pharmacy, and materials handling will be introduced step by step.

SIEMENS

UK Hospital Installs Siemens MAMMOMAT Inspiration

Southend University Hospital NHS Foundation Trust has installed two MAMMOMAT Inspiration™ Full Field Digital mammography systems with Stereotactic Biopsy from Siemens Healthcare. The systems will help expand digital imaging capabilities and improve services in line with the Cancer Reform Strategy (CRS). The Inspirations will be used for symptomatic breast examinations and will streamline workflow by offering guidewire insertion and biopsy on the same unit.

The stereotactic biopsy system guides the operator intuitively through the entire procedure. The tube angulation is controlled directly from the workstation and after selecting the target, the needle-holder moves automatically to the right position. This reduces work steps and speeds up the procedure without compromising on diagnostic confidence.

"Having installed two MAMMOMAT Inspiration systems, we now have biopsy capabilities in all rooms, whereas previously this could only be done in one," said Kim Baird, Superintendent Radiographer at Southend University Hospital NHS Foundation Trust.

The systems are fully integrated to the PACS, ensuring that all digital images can be sent and received from centres outside of the Breast Unit. It is hoped the enhanced connectivity will also improve efficiency by eliminating the time lost retrieving and displaying film-based images.

KEY CONFERENCES & EVENTS

MAY

3 – 8 **43rd International Diagnostic Course Davos**
Davos, Switzerland
www.idkd.org

27 – 30 **GEST 2011 Europe – Global Embolization Symposium & Technologies**
Paris, France
www.gest2011.eu

28 – 5 **74th Annual Scientific Meeting: Canadian Association of Radiologists**
Montreal, Canada
www.car.ca

30 – 4 **2011 Annual Meeting of the American Radium Society**
Palm Beach, Florida, US
www.americanradiumsociety.org

JUNE

6 – 8 **UKRC 2011**
Manchester, UK
www.ukrc.org.uk

9 – 11 **Swiss Radiological Congress 2011**
Interlaken, Switzerland
www.radiologiekongress.ch

22 – 25 **CARS International Congress 2011**
Berlin, Germany
www.cars-int.or

SEPTEMBER

10 – 14 **Annual Meeting of CIRSE (Cardiovascular and Interventional Radiology Society of Europe)**
Berlin, Germany
www.cirse.org

9 – 30 **Annual Scientific Congress: Management in Radiology (MIR)**
Nice, France
www.mir-online.org

OCTOBER

15 – 19 **European Association of Nuclear Medicine (EANM) Annual Congress**
Birmingham, United Kingdom
www.eanm.org

NOVEMBER

16 – 19 **MEDICA 2011**
Dusseldorf, Germany
www.medica.de

27 – 2 Dec. **RSNA**
97TH Scientific Assembly & Annual Meeting
Chicago, USA
www.rsna2011.rsna.org

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