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We are grateful to Judith A. W. Webb, M.D., London for revising our English
“2011 was a good year for our department”.

This statement surfaced as a comment from a member of our staff during the recent regional leadership evaluation programme – and has echoed in my mind since. After four challenging years of implementing ‘The hospital plan in the Capital Region’ during a global financial crisis, such a statement has considerable significance. The comment was prompted by the ‘change of guards’ in May 2011 when chief radiographer Preben Thomassen became co-head of the department with me.

Presenting the 8th annual report of the Department of Diagnostic Radiology, Copenhagen University Hospital Herlev, therefore gives me particular pleasure, as it marks the beginning of a promising new era.

With the movement of the Departments of Paediatrics from Glostrup and Gentofte Hospitals to Herlev Hospital during 2011, the planned changes in the clinical profile of our department are complete. We now cover all medical specialities except ear/throat/nose and brain surgery and have increased on-call services considerably throughout the hospital. Our workload increased by 11% in 2011.

Because of the creativity and commitment of our competent staff, the changing and increasing demands for radiological services have been met in large part by rationalisation of services, and only minor investment on new staff and equipment has been necessary.
The challenge will be to maintain our impressive results and to establish balanced and sustainable working conditions which support our staff. We will need to strive continually to achieve an optimal balance between workload, quality and the working environment. This provides a challenging but welcome opportunity for good leadership, which can make a difference by setting goals and direction and by providing suitable strategies.

We have started to design and plan radiology services for the ‘New Herlev Hospital 2017’ – an inspiring and creative process looking to our more distant future. To guide our efforts in the near future, the department has established two ‘beacons’ – ‘Quality in all we do – involving patients when possible’ and ‘Research and innovation put to practice’.

In 2011, Herlev Hospital was accredited by Joint Commission International. This has inspired us to intensify our focus on quality issues which have high clinical impact. We will invest in pursuing core values such as correct and operational imaging analyses, high quality images at low radiation doses and safe and timely communication practices.

Our department has been granted a new high-end CT scanner which will be installed in the summer of 2012. This will allow us to increase the quality of our imaging service, not only for paediatric-, cardiac- and oncologic imaging, but across the whole clinical spectrum. We also aim to reduce waiting lists for this expanding imaging modality.

Improving work flow and technology while involving and empowering patients in their scan procedures and implementing the results in clinical practice are strong focuses of innovation in our department. Our vision is to establish an ‘innovation cell’ for CT scanning in the department where room, time and technology are ready to support and execute innovative efforts for the Capital Region in collaboration with a private company willing to invest in such a partnership.

The scientific publications and citations from our research team have again put the department in the top rank among the departments of radiology in the Capital Region in 2011. Our ambition in research and development is to continue the direction of growth and expansion described in this report by establishing and maintaining fruitful collaboration with internal and external research and funding partners.

The staff of our department deserve immense praise for the impressive results achieved in the past year, of which we can all be proud. Such results were possible only because of their perseverance, professionalism and – above all – cooperation.

2011 was a good year for our department.
In May 2011, I started as chief radiographer in the Department of Diagnostic Radiology at Herlev Hospital, so I can reflect from a new perspective on the department’s current status and challenges.

In 2007, Denmark was divided into five regions, with resultant great changes in hospital planning. Herlev Hospital became one of the four hospitals in the Capital Region given the status of district or emergency hospital. Many departments and specialities have moved to Herlev, so the hospital has expanded its therapeutic capacity without, at first, expanding the existing building stock. This expansion has not only brought more patients but has also brought new specialities, such as paediatrics and neurology, and this has given many challenges for radiology, professionally and in terms of capacity. The increased number of radiological examinations have made it necessary to optimize procedures, while maintaining high professional standards. To achieve this, continuous training of our staff and top quality equipment are necessary and we must also focus on research, development and innovation.

I was looking forward to working in the department management team with head of department Michel Nemery, and my expectations have been fulfilled. Our collaboration is built on mutual trust and respect and we share the departmental vision of leadership based on dialogue and on a clear set of values. Our high quality and workload are achieved because of the job satisfaction and contentment of our very competent staff. Together with our management team our aim is that: “The Department of Diagnostic Radiology at Herlev Hospital should be the best department for patients and staff”.

Herlev Hospital is planning an extension of approximately 60,000 square metres in area with a new women-children’s hospital and a common emergency department ‘New Herlev Hospital 2017’. Radiology is a vital element in this expansion, and we are already working with architects and the clinical departments involved to plan this new part of the hospital.

“Don’t make predictions, particularly about the future”, the Danish multi-artist Robert Storm Petersen (1882-1949) said, and we meet the same challenge in planning the new Herlev Hospital. Even with a relatively short five-year time frame, we can expect great changes in the examinations and treatments the hospital offers, and probably especially in the technology we are going to use. Innovation is a key concept, but how do we go beyond our regular working day and become really innovative thinkers? Our answer is that we use the department’s established focus on quality, research, development and innovation. We need to inspire and challenge ourselves to think outside the box.
Over the past 11 years, the number of examinations performed in the Department of Diagnostic Radiology has been monitored using the same method. This allows comparison over the years 2001 to 2011. Our total workload has increased by 11% from 2010 to 2011.

CT scanning has increased by more than 16% compared to last year and by 117% since 2007, the first year of ‘the hospital plan in the Capital Region’, with a constant number of CT scanners available (5 in total, three 64-slice scanners and two 16-slice scanners). We are therefore very pleased that the department has been granted a supplementary new high-end CT scanner to be installed in the summer of 2012. This will allow us to perform a technology supported leap of quality and ability in paediatric-, cardiac- and oncologic imaging. CT scanning now accounts for 25% of our total examinations and because the amounts of data per examination continue to increase steeply, this is very challenging for our radiologists. The new CT scanner will be operated by new colleagues.
The number of MRI examinations performed peaked in 2010, after 10 years of continuous increase, and decreased by 4% in 2011. This was due to the changing clinical profile of Herlev Hospital, the available resources, which included an outdated MR scanner (0.6 Tesla), and the fact that radiologists were working at the limit of their capabilities. In 2011, we started scanning children under general anaesthesia – a time consuming multispeciality procedure – and we have increased our MR imaging service for Herlev Hospital’s new Department of Neurology significantly at the expense of relatively fast and easy scans of knees and spines from the primary sector. Quality improvement in collaboration with the spinal surgeons at Glostrup Hospital has resulted in improved image quality and provided acceptable and safe surgery planning, but at the expense of workload figures, since our oldest MR scanner needs longer scan times to deliver acceptable results. Herlev Hospital’s MR centre has six operating MRI systems – one newly upgraded 3 Tesla, three 1.5 Tesla and two open scanners of 0.6 and 1 Tesla.

The number of conventional radiographs performed continues to be fairly stable – although 2011 was a record year as we reached 80,000 examinations for the first time. This is, in part, explained by the increase in emergency examinations caused by the changes in Herlev Hospital’s clinical profile.
The demand for medical imaging continues to increase—as do the complexity and the amounts of data generated. In a time of limited resources, we need to find new ways to deliver the service. Innovation in work processes and image analyses, from the time when patients arrive in our care to the time when image analysis reports are sent to referring physicians, will provide the correct, and urgently needed, answer to these challenges in the years to come.

The table clearly illustrates that

1. Non-ionizing imaging modalities are preferred in patients below 50 years of age, and particularly in those below 30, who are the most susceptible to the harmful effects of ionizing radiation.

2. The overwhelming majority of examinations are done in patients between 60 and 80 years of age.
2011 has been a very busy year. As a result of ‘The hospital plan in the Capital Region’ the Department of Paediatrics from Glostrup Hospital and a part from Gentofte Hospital were moved to Herlev Hospital. The neonatal unit had already moved in 2010, and in 2011 the rest of the department arrived. It has been a great challenge for the Department of Diagnostic Radiology to serve the new paediatric department, but it has also been very exciting, preparing to welcome our new very young patients.

To prepare for the changes, a group of doctors and radiographers with special interest and experience in paediatric radiology, and with experience in conventional radiography, CT, ultrasound and MRI was established. The Department of Diagnostic Radiology has sections with special expertise in ultrasound, oncology, and musculoskeletal and abdominal radiology. Paediatric radiology covers all of these, and it was therefore important to include experts from the different sections. We now have a small dedicated group of doctors and radiographers across the teams which will improve our service to the Department of Paediatrics.

Before receiving patients from the Department of Paediatrics, we had to prepare many study guidelines and instructions and make arrangements to cooperate with different departments, such as the Department of Anaesthesia. Most children need to be sedated when they are having an MRI scan, because they must lie still during the examination. We now have very good collaboration with the Anaesthetic Department staff, and they are familiar with the precautions that necessary when examining children in the MRI scanner.

We were excited to welcome the Department of Paediatrics. The emergency department for children received the first patients in early April 2011 and during the spring and summer the rest of the Department of Paediatrics moved to Herlev Hospital. We were ready for our new patients and keen to establish a good relationship with the nurses and doctors of the Department of Paediatrics. We intend to provide an excellent service by helping in the quick and efficient workup of the children based on international standards of good care.
We now have daily conferences with doctors from the Department of Paediatrics and also special neuropaediatric conferences. We carry out many examinations every day, especially ultrasound and MRI, as these examinations do not use ionizing radiation, but also conventional radiography. The most common X-ray examinations are chest X-rays. We always use the principle of ‘ALARA’, i.e. ‘As Low As Reasonably Achievable’. This indicates that the lowest radiation dose acceptable should be used, and this is in part achieved by using examinations not involving ionizing radiation, if they can provide the same diagnostic information without major inconvenience or risk.

It has been a great change having children among our patients in the department and we have had to get used to the different symptoms and diseases with which children present. We have enjoyed the challenge and are still getting accustomed to the very young patients and their parents.

Ultrasound examination of a child.
Facts:

1: The Department of Paediatrics consists of different units at Herlev Hospital:

- Emergency department for children on the 3rd floor
- Paediatric units on the 10th and the 20th floors
- Neonatal unit on the 10th floor
- Paediatric outpatient clinic at ‘Arkaden’ and on the 3rd floor

2: The Department of Paediatrics has many different specialized areas:

- Neurology
- Endocrinology and diabetes
- Kidney and urinary disorders
- Gastrointestinal disorders
- Lung diseases including asthma
- Neonatal unit – for premature infants and sick newborns
- Unit for children with socially conditioned diseases

Our trademark for paediatric radiology – a happy giraffe.

MRI examination of a child.
Over the past three to four years, a new CT scan reconstruction method, called ‘iterative reconstruction’, has been introduced.

Since CT scanning began, reconstruction by ‘filtered back-projection’ has been used. In summary, this means that opposing signals collected in the detector system in a CT scanner are calculated and filtered using a specific calculation method based on the signal collected in the same area in the patient in two opposing positions. The degree to which these signals are weakened depends on the tissue through which the X-rays pass. Dense tissues, such as bone, weaken the X-ray beam more and so a weaker signal reaches the detector system. This provides less information to form the final CT image, resulting in ‘noise’ in the image. Noise impairs image quality and in the worst cases, if weakening of the beam and patient size are not considered may make an examination non-diagnostic. To reduce the noise radiation generated, the amount and ‘hardness’ of the X-rays must be adjusted for patient size and for the tissue being imaged, and this means that radiation dose has to be increased.

Currently, around the world there is a major focus on decreasing the radiation dose used during CT scans. The new iterative reconstruction method is revolutionary both in terms of dose reduction and image quality. ‘Iterative’ implies repetition and the reconstruction method repeats calculations of the weakened signals many times to strengthen them and so to minimise the noise. The more the noise can be reduced using repeated calculations, the more the radiation dose can be reduced. While the principle of the method is simple, these high level calculation methods need immense computing power and so a very powerful image reconstruction computer is needed.

In October 2011, we upgraded our three 64-channel multislice CT scanners so that we could use iterative reconstruction, so reducing the radiation dose to our patients.

On our Philips CT scanners this method is called ‘iDose’. iDose can be used in three different ways:
1. Dose reduction and iterative reduction equivalent to dose reduction, which means maintaining the same image quality as before but with a lower dose.
2. Dose reduction and iterative reconstruction to give a better image quality than previously.
3. Keeping the dose in existing low dose protocols, and using iterative reconstruction to improve image quality.

iDose can be used at seven different levels: level 1 produces a 20% dose reduction, level 2 a 30% dose reduction, level 3 a 40% dose reduction etc.

Initially we included five of our CT procedures in iDose and reduced the dose in stages.
It is very important for the radiologist to be involved in assessing image quality at all times and to judge at which level to finish image reconstruction and dose reduction. The CT images appear less noisy than before, meaning that they have a ‘softer’ appearance. The eye needs to get used to this change while making sure that the dose is not reduced too much, which would cause data loss in the images. Over a three month period, we have tested iDose with all our scan procedures. We are now at the stage where we are still very aware of image quality and see the possibilities for using the method to reduce radiation dose further.

Currently, we have reduced the radiation dose by 40% in the majority of our CT scan procedures and in the remainder we have reduced the radiation dose by 20 and 30%. In CT scans of children, iDose allows us to use a very low radiation dose and to apply iterative reconstruction to improve image quality.

For some CT procedures, such as examinations of bones or very small blood vessels, we previously used a higher radiation dose to achieve sharp, high resolution images. With the introduction of iDose, we can now, based on raw data, reconstruct less noisy images and so improve image quality without the same increase in radiation dose.

In addition to our upgrade to iDose, we also obtained the latest version in dose modulation. Absorption of X-rays in the area to be scanned is assessed on a preliminary image, and the X-rays used for the actual scan can then be modulated much better. As well as reducing the radiation dose, this improves and standardizes image quality.

In addition to the software upgrade, our image reconstruction computer was replaced by a larger and more powerful one so that although very advanced calculations have to be made with the data collected, we do not have a longer waiting time for the final reconstruction of the images. The introduction of iDose has not reduced our workflow.

The introduction of iDose on our three 64-slice CT scanners has provided a dramatic reduction in radiation dose for our patients. In addition, we can use this new tool to work with the scanned raw data to improve image quality retrospectively.

We intend to continue our work with iDose because of the great benefits it provides to our patients.
Teaching Non-Medics: Educational Outreach to Engineering and Physics Students

In the past three years, the research group in the Department of Diagnostic Radiology has made an effort to attract students with a non-medical background to the department. Most of the research performed in the department is clinical and defined by the interests of medical PhD students or department consultants. While this is entirely appropriate, in order to get the most out of the imaging modalities and to explore their possibilities further, it is expedient to involve people whose focus goes beyond the clinical aspects of imaging.

We are therefore collaborating with the Technical University of Denmark, DTU, to provide access for their students to imaging equipment, and so far we have had three groups of students in clinical practice as part of their curriculum in the relatively new engineering degree in Medicine & Technology. During their eight-day sojourn they receive a fairly broad introduction to the various aspects of the department, CT, MRI, US and even interventional radiology, and it is a pleasure to see how eager both doctors and radiographers are to share their knowledge and enthusiasm.

In addition, through a collaborative swap with the Departments of Oncology and Clinical Physiology, we can offer our lucky visitors first-hand introductions to radiation therapy with attendant imaging and PET/CT scans. All in all, this is a quite comprehensive trip through modern medical imaging, and the students have expressed great satisfaction. DTU also offers a graduate course in MRI which includes scanning exercises, and we have been happy to act as one of the ‘exercise nodes’ from almost the start of the course.

Beyond that, students from both DTU and University of Copenhagen have started to discover MRI as a relevant tool in pharmacy, biology, physics and engineering, and recently members of the research group have acted as supervisors, midwives and scanning technicians for projects leading to bachelor and master degrees in imaging and pharmacology. The outreach has been an unequivocal success, and we hope to continue in the same way to attract many more of these talented students.
An International Quality Stamp

In November 2011, Herlev Hospital – and thus Department of Diagnostic Radiology – was accredited by Joint Commission International (JCI).

In our department, quality development is an ongoing process, which guarantees the professional quality of our core services and also the safety of our patients and staff. The quality stamp from JCI supports our good work in which we place a special focus on quality throughout the course of examination, enhanced safety and staff skills, and indicates that we, as part of Herlev Hospital, have a high professional standard at an international level.

The accreditation process was extensive. Our current guidelines were reviewed, and many new guidelines were prepared to achieve consistent working procedures that meet JCI’s patient safety requirements and standards with the same high quality in all departments. This led to new initiatives such as a new practical and theoretical programme that ensures regular training of staff in fire fighting and cardiopulmonary resuscitation, and emphasises risk procedures and optimization of patient care.

The accreditation visit was very educational and helped to identify where there was room for improvement in areas which we might not notice in our everyday work. The emphasis on “Good practice” was motivating and provided inspiration for future quality development.

Topics in the Department of Diagnostic Radiology

As a part of the cross-disciplinary initiatives at Herlev Hospital, the Department of Diagnostic Radiology focused on a number of topics in the department.

We have intensified our focus on safety for patients and staff. Among other things we have established a training course in MRI safety for porters, service staff, Anaesthetic Department personnel etc. The course is offered monthly and is compulsory for any personnel who work in the MRI section.

We have implemented a ‘Safe invasive radiology’ programme which is a radiological adaptation of the ‘Safe surgery’ programme. We now have a standard checklist for interventional procedures to help preventing errors, and to ensure that the appropriate preparatory work-up is done and that a summary of the procedure and recommended aftercare is available.

Monitoring the time from the request until the report for a chosen procedure is available is another initiative. Through our Radiology Information System (RIS), we can extract data on particular procedures that record how long it takes for a report to be available. We use these data to ensure the fastest report times possible for critical procedures and prompt replies for routine procedures.

Our Work Continues

Our work on quality and patient safety is in continual development. There is always work to be done to improve and optimize processes. Examples are the use of a comprehensive risk management framework as a tool to reduce adverse events, improving the quality of the data we collect and use in our audits and improving our management of personnel and of the skills of medical staff.

Our next quality check is in May 2012, when Herlev Hospital will have another accreditation visit. The standards in the Danish Healthcare Quality Programme (DDKM) is the basis for this evaluation.

- Accreditation is a process by which an independent institution evaluates whether the hospital lives up to a set of prepared criteria (standards) which aim to improve patient safety and the quality of patient treatment.
- JCI’s programme consists of 6 international patient safety goals, 323 standards and slightly less than 1000 measurable elements by which the hospital is evaluated.
- Accreditation is granted for a period of three years, after which the hospital must re-apply for certification and must demonstrate further improvement and optimization of processes.
On 30 September 2011, the Department of Diagnostic Radiology staff gathered for our annual study day, organised by the department's work environment group. We were going to hear about and discuss how to break our bad habits, how to handle stress in the workplace and how to introduce humour into our working life.

The first guest speaker, Torben Wiese, who calls himself ‘habit breaker’ focused on the idea of achieving our goals, and considered three main points. First, he encouraged us to identify our bad habits. By using the expression ‘Bend the fish while it’s fresh’, taken from an African saying, he emphasised that we should change bad habits before they become too deep-rooted. We need to break the habits or they will stand in the way of our goals.

Secondly, behaving like a manager and taking responsibility for your own and other people’s work are important. Acting like a leader prevents us from just going with the flow and instead makes us take responsibility for all aspects of our working life.

Thirdly, living in and focusing on the present instead of the past or the future is a way of getting rid of old habits. Torben Wiese’s final statement was: “Without a goal you cannot score”, encouraging us to be proactive in our everyday work.

The next session of the study day considered how we handle stress and stressful situations. We worked with vocational psychologist from the Department of Development at Herlev Hospital, Monique Hartmann. She encouraged us to think about how we become stressed and so to identify what stresses us in our everyday life. In groups, we discussed the main causes for stress in the department, and came up with solutions to avoid them.

The second part of Monique’s session involved workshops where we discussed how the Department of Diagnostic Radiology would be in the future. Some of the suggestions for taking the department further were focus on new technology, research and innovation and improvement of quality with special focus on our patients.

The study day was rounded off with a presentation by humorist Rune Green. Rune gave us ideas on making the working day more humorous, how we get people’s attention by using humour and how the use of humour makes the working day smoother and pleasanter. Humour is a good way to lighten a situation and to create a more relaxed work environment among colleagues and between patients and staff.
Magnetic Resonance Imaging in Patients with Inflammatory Bowel Disease

Inflammatory bowel disease (IBD) is a chronic intestinal inflammation and the two major types of IBD are Ulcerative colitis (UC) and Crohn’s disease (CD). The peak age of onset of UC and CD is between 15-30 years.

The diagnosis is based on clinical, endoscopic, radiological, and histological features, and re-evaluation of the condition is often required, as the disease tends to progress over time. The ideal imaging of patients with IBD would be a method that is reproducible, well tolerated by patients and free of ionizing radiation. Magnetic Resonance Imaging (MRI) fulfils all three criteria. It has proved to be a very good tool for examining disorders of the small bowel and its use in the diagnosis of IBD has rapidly expanded. MRI is very effective for evaluating luminal, mural and extraluminal abnormalities, and has the further advantage of avoiding exposure to radiation, because multiple imaging examinations are often necessary to monitor these patients.

There are two main ways to visualize the small bowel using MRI: MR enterography and MR enteroclysis. MR enterography is performed following administration of an oral contrast medium, while MR enteroclysis is done following administration of contrast medium through a nasoduodenal catheter. The nasoduodenal catheter intubation is done under fluoroscopy which necessitates exposing the patients to some radiation.

Optimal distension of bowel loops is very important for making the correct diagnosis. Collapsed bowel can mask pathology, such as thickening of the wall. Optimal distension is more frequently obtained by MR enteroclysis than with MR enterography. However, the nasoduodenal catheter used in MR enteroclysis often causes considerable discomfort.

Many studies have compared these two examinations, but only a few have included a plain MRI scan where patients are not given any contrast medium. Kayalvily Nielsen, MD, is from 2011-2014 doing a PhD project carrying out a cross-sectional study comparing the three MRI techniques, plain MRI, MR enterography and MR enteroclysis, in patients with IBD. The patients fast for four hours before the examinations. The plain MRI scan and MR enterography are performed on the same day, while the MR enteroclysis is done 6-8 days later. Ideally, every patient would undergo all three examinations, but the somewhat traumatic experience of MR enteroclysis has, as expected, resulted in a significant number of patients opting out of this examination.

Overall, MRI provides an excellent tool to guide and monitor appropriate treatment and is reproducible, well tolerated by patients, and either free of ionizing radiation, or only involving small amounts of radiation for nasogastric tube placement.

The coronal post gadolinium T1 weighted image shows wall thickening in the colon, findings consistent with active inflammation.

The coronal post gadolinium T1 weighted image with fat suppression shows a fibrotic lesion of the terminal ileum.
Prostate cancer (PCa) is now the most frequently diagnosed malignancy in males in Denmark with more than 4000 new cases each year. PCa is the second leading cause of cancer related mortality in the western world. During their lifetime, one in six men will be diagnosed to have prostate cancer and approximately one in thirty will die of the disease. We know from autopsies that more than half of the male population above the age of 60 have histological changes of cancer. Therefore, the majority of men with histologically proven cancer never develop a clinical disease which would affect their morbidity and mortality.

A raised level of prostate specific antigen (PSA) in the blood and/or an abnormal rectal examination are indications of PCa. The diagnosis is made by Trans-Rectal-UltraSound guided biopsies (TRUS-biopsies) followed by histological examination. Each biopsy session involves taking 10 to 12 biopsy cores from standard locations throughout the prostate. Since over 40% of the cancers are isoechoic on ultrasound, they cannot be seen and there is a high risk that the tumour is either missed or that the most aggressive part of the tumour is not biopsied.

If prostate cancer is detected, it is important to know if it is localized within the prostate or if it extends outside the capsule. This is determined by staging and is essential for choosing the best treatment and for assessing the patient’s prognosis. In Denmark, staging is determined by digital rectal examination and sometimes by TRUS, even though it is known that these examinations are inaccurate and have limitations. Since the majority of men diagnosed with prostate cancer will die with their disease and not of their disease, and some of the treatment options involve significant side effects, it is important to improve the diagnostic localization and staging of the tumour so that clinical management and choice of therapy are optimal.

The development of modern Multiparametric high-field Magnetic Imaging (mMRI) offers new possibilities and approaches for detecting, localizing and staging prostate cancer because of its high resolution and soft-tissue contrast. mMRI can provide information about the morphological, metabolic and cellular changes and can characterize tissue and tumour vascularity and correlate them with tumour aggressiveness. This helps to locate and stage a possible tumour and

Dynamic contrast MRI with contrast curve for the tumour (blue) and normal prostate tissue (yellow).
to guide targeted biopsies towards areas where there is suspicion of disease. Internationally published data support the rapidly growing use of mMRI as the most sensitive and specific imaging tool for prostate cancer patients.

While mMRI is internationally a well recognized and accepted method for detection, localization and staging of prostate cancer, the use of mMRI in the diagnosis of PCa has never been applied in Denmark. Therefore, Lars Boesen, MD, Department of Urology, Herlev Hospital, is carrying out a PhD project from 2011-2014 in close collaboration with the Department of Diagnostic Radiology in order to evaluate the use of modern mMRI in the diagnosis of prostate cancer in a Danish setting. The project involves three separate studies evaluating the additional diagnostic value of mMRI over the conventional standard diagnostic evaluation and treatment.

Multi parametric MRI with tumour on the left side to the capsule.
Macroscopic haematuria (blood in the urine) is a symptom that most patients take seriously. They contact their doctor immediately in most instances. The most likely reason for the haematuria is infection (30-50%), but for some patients (5-10%) the cause is cancer in the urinary system. Patients with macroscopic haematuria are referred to a urologist, who requests CT urography to visualize the urinary tract. The patient also has various laboratory tests and cystoscopy, in which the inside of the bladder is examined with an endoscope.

CT urography uses radiation and iodine-based contrast media. Radiation dose should be kept as low as possible, particularly in children and adolescents, and some patients cannot tolerate iodine-based contrast media. Severely reduced renal function is also a problem for CT urography because the contrast medium may further reduce renal function and because so little of the contrast medium may be excreted that there is not sufficient opacification of the structures.

MR urography is a possible alternative to the gold standard of CT urography. It has the advantages of no radiation, low amount of contrast medium, and the possibility of multiple imaging sequences, but it has yet to be proved that MR urography can replace CT urography.

Therefore, Karen Lind Ramskov, MD, is doing a PhD project from 2011-2014 carrying out a cross-sectional study comparing CT urography with MR urography. All recruited patients have been referred to CT urography because of macroscopic haematuria. The MR examination takes place within one week of CT urography. By January 2012, there were over 100 patients in the study and we hope to have a total of 400 patients. We should then be able to tell whether MR urography is better, worse or as good as a split bolus CT urography with two scans. It is important in macroscopic haematuria to have an examination that allows healthy people to be tested simply with minimal risks from the procedure, and at the same time identifies patients with disease that can be treated. More than 60% of patients with macroscopic haematuria have no pathology at CT urography.

MR urography produces high quality images of the urinary bladder, tract and kidneys. We examine three phases of the contrast medium passage: 1) the arterial phase, in which the vascular structures leading to the kidneys are visualized, 2) the parenchymal phase, where we examine the tissue of the kidneys and the bladder and therefore can discover tumour tissue, and 3) the excretion phase in which we look at ureters and check for evidence of obstruction. We have incorporated diffusion-weighted sequences into the MR urography in order to study natural water transfer. Malignant tissue has a lower water transfer than normal tissue. Tumour tissue will often contain swollen cells, and we can therefore use diffusion-weighted images to pinpoint an area that might be malignant. It is our aim to obtain more knowledge about water diffusion in the urinary tract. This method seems to be a promising tool particularly in relation to cancer.

The current project will also be a quality-assurance project for our simple CT urography (split bolus urography, contrast medium maximum dose 75 ml, at a concentration of 400 mgI/ml, with two scans). Other departments use much more contrast medium and do more scans. By doing multiple MR sequences we should be able to find all lesions of the urinary tract. If MR urography does not show more than simple CT urography, it would indicate that a simple CT examination is sufficient in patients with macroscopic haematuria. If MR urography is just as good, it can replace CT urography, for example in young patients, patients ‘allergic’ to iodine-based contrast media and patients with poor renal function.
In 2011, the number of publications returned to its normal level. That was expected, as the main reason for the increased level in 2010 was the publication of educational and informative articles on the internet as part of a national project sponsored by the hospital owners (the Danish regions). Despite the return to our normal level, we are still the most productive department in the Capital Region per professor. The majority of the publications have an employee from the Department of Diagnostic Radiology as first author.

Funding for research continues to be tight because the financial recession makes it more difficult to get financial support for radiological research. Also, access to equipment becomes more and more difficult. Radiological research faces a challenging future.

At the moment, the following PhD students use our equipment for their research:

Dorte Sadowa Frederiksen
Cilius Rune Fonvig
Rene Poggenborg
Mette Axelsen
Carsten Lauridsen
Manal Azzouz
Kayalvily Nielsen
Karen Lind Ramskov
Faisal Mahmood
Mette Linnert
Lene Pedersen
Rasmus Huan Olsen

The number of citations continues to be high.
Publications 2011


Chabanova E, Bille DS, Thomsen HS. MR spectroscopy of liver in overweight children and adolescents: Investigation of 1H T2 relaxation times at 3T. Eur J Radiol 2011; Epub.


Ejrild P, Thomsen HS. The pharmacokinetics of gadobutrol in patients with severe renal insufficiency treated conservatively or undergoing hemodialysis or continuous ambulatory peritoneal dialysis. (Letter to the editor) Acad Radiol 2011; 18: 1060.


