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We are grateful to Judith A. Webb, M.D., London for revising our English

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In September 2013, the Department of Diagnostic Radiology was the first radiological department in the Capital Region of Denmark to have a feedback session with patients who had been examined in the department.

Five patients agreed to share their experience of having CT and ultrasound scans. Professional interviewers from the Danish Center for Patient Experience and Evaluation organised the process, which was highly structured.

During the interview, the patients were asked how they experienced the complete examination procedure from receiving their appointment to getting their diagnosis. We wanted to find out what was important to them and what we could do to improve their time in the Department of Diagnostic Radiology.

How we use the direct patient feedback:

- In an interview, the patients tell us their experience of being examined in the department.
- We learn more about patient experiences and perceptions throughout the examination.
- We use this knowledge in our work to improve the quality of the patient experience.

None of the patients enjoyed having contrast media injected. They expressed a strong preference for using previously inserted catheters, such as Powerports.

There were many good suggestions. For example, it was suggested that the office staff write the number of the examination room the patients are to be examined in when they receive the patients. This would make it easier for patients to get help if they are lost or to help others.

What the patients said

**Everyone in the group of five rated the quality of the examination highly and found the staff to be professional and empathetic. Even at busy times, the staff conveyed energy and drive, and used humour as part of providing a relaxed atmosphere.**

Everyone agreed that the most important thing was to get a quick report after the examination because this leads to quicker decisions about any further examinations and about treatment.

- “You have a trembling heart when coming up for a scan— you just want the result back as quickly as possible”
- “It is important that the person injecting does not inject so I won’t have to be injected 4 times”
- “If everyone thinks it is a good department to be in – there is a positive atmosphere”
- “The waiting room is more like a corridor – not a bit nice and cozy. An increased effort here would be good”

What we will do next

From the next day, the office staff started to write the room number on the appointment papers or on a prepared sheet given to patients when they arrive at the reception area.

Also, we have continued to think about how we can make our waiting areas more welcoming and comfortable.

At staff meetings, we have exchanged tips and ideas on good techniques for injecting, and we have discussed how many times it is fair to “attempt” to inject a patient before calling for assistance. We have placed greater emphasis on staff training in the use of catheters such as Powerports.

Faster turn-around times have been given a higher priority. In 2013, we have worked with “warm reporting”, with the goal of having the examination report available by the following working day. This is part of making the patient pathway more efficient so that clinicians can plan any further examinations quickly and any necessary treatment can start without delay.
We proudly present the 9th annual report of the Department of Diagnostic Radiology, Copenhagen University Hospital Herlev.

2013 was a great year for our department, because we managed to significantly improve the quality of our patient care, we made a flying start in our clinical innovation project and our working environment was improved both by growth and by a better balance between staffing and workload. We believe that 2013 marks the beginning of promising new times.

Herlev Hospital now covers all but a couple of the medical specialties, and has a major strategic focus on creating its future as an emergency hospital. Beautiful buildings covering a total of 77,000 m² will be added to the current hospital to accommodate future patients, modern healthcare and new technology – The New Herlev Hospital - opening in 2017.

We are now well under way with experimenting, and with designing and planning radiology services for the New Herlev Hospital. While this process is inspiring and creative, it relates to the future. It is, however, becoming increasingly clear that making changes to interdisciplinary collaboration and patient pathways cannot wait until 2017, and that our department plays an important role in many of the changes needed. We need to work on these changes now.

Thus, at the end of 2013, we decided to allocate a specific radiographer to the Emergency Department. We want to find out what happens to patient flow when the skills and experience of a radiographer are added to the team of nurses responsible for the initial diagnostics and treatment of acutely ill patients. We have great hopes for the learning, coordination and communication which we expect to evolve.

In June 2013, we established a CT-innovation unit - a new idea for our department, and also for the Capital Region of Denmark and for Denmark. The unit is intended to drive innovation in the clinical setting by providing state-of-the-art CT-technology, together with the staff and resources for user-driven innovation that can be implemented immediately, as new discoveries emerge. We aim to push the discovery of what works for and with our patients as fast as possible. Our dedicated and professionally enquiring medical staff work with engineers from our scanner manufacturing partner, with radiography teachers and students, and with designers and inventors.

We plan to develop a mobile, tablet-based, communications interface with our patients. This will allow us to systematically investigate the patient’s experience before, during and after their scan. We want to better understand and to optimise the patient experience by asking structured questions and by collecting and analysing patient feedback throughout the patient’s interaction with the department. Our aim is wherever possible to empower our patients.
In 2013, we also implemented fast track CT-scanning of patients from the Department of Urology to optimise outpatient flow and throughput. The project has been a success and the model will be offered to other key referring departments in the near future.

To guide our efforts to change in the near future our department has developed two “beacons” – “Quality in all we do - involving patients when possible” and “Research and innovation put into practice”.

Our two new 256-slice CT-scanners have allowed us to increase the quality of our imaging service, not only for paediatric, cardiac and oncologic imaging, but across the whole clinical spectrum. We have already reduced waiting lists for this expanding imaging modality and expect great diagnostic advances from the spectral imaging technology.

In April 2013, we opened a new 3 Tesla MR-suite – our new flagship in technology and in design of the environment for both patients and staff. The scanner provides the state-of-the-art technology needed for performing MRI of patients suspected of having prostate cancer, and is the first department of Diagnostic Radiology in Denmark to do this. In close collaboration with the department of Urology at Herlev Hospital, we now diagnose and localise malignant tumours in the prostate gland that previously were biopsied “blind” under ultrasonic guidance. Being able to actually see the tumour during the biopsy procedure greatly improves the quality of both diagnosis and treatment planning.

Colour schemes, light, sound, movies, and room design in our new MR-suite have been chosen to reduce stress and give patients a feeling of being pampered. Patient experience in the new MR-scanner is “VIP standard”. Results are very promising as we now rarely experience patients with claustrophobia or high anxiety levels who are unable to complete their scan. In fact, we now routinely bring such patients to the 3 Tesla scanner for an immediate second try after a failed scan attempt in another scanner. Some radiographers have actually never experienced a non-completed second scan in the new scanner – and we have caught a valuable glimpse of the importance of the behaviour of individual radiographers to the results and quality of our diagnostic services.

In 2013, we invited a handful of our patients to our first formal feedback meeting – a structured interview and discussion between patients and staff focused on sharing good and bad experiences and suggestions. As leader of the department, it was heart-warming to listen to our patients’ appraisal of the high level of professionalism and empathy of our staff. They feel that they are in good hands and receive diagnostic imaging of very high quality – but they all express a need for faster turn-around times. We call it “warm reporting” and are committed to our new goal of reporting within one working day.

In our pursuit of core values such as correct and operational imaging analysis, high quality images at low radiation dose and safe and prompt communication, we will need to work more efficiently to achieve the optimal balance between workload, quality and a good working environment.

Our research team continues to put the department among the top ranked departments of radiology in the country for numbers of scientific publications and citations. Our ambition in research and innovation is to continue the growth and expansion described in this report by establishing and maintaining fruitful collaboration with internal and external research and funding partners.

The changing and increasing demands for our diagnostic imaging services have been met because of the creativity and commitment of our competent staff. In 2013 our clinical examination workload increased by 10%.

The great results achieved in the past year, of which we can all be proud, were possible only thanks to the professionalism and co-operation of our committed staff.

2013 was a great year for our department – and the future is looking bright.
The number of examinations performed at the Department of Diagnostic Radiology of Herlev Hospital has been counted the same way for 13 years, so the activity from 2001 through 2013 can be compared. Over the 13 years, total activity has increased by 120%. From 2012 to 2013 workload increased by 10%.

CT scanning has increased more than 18% from 2012 to 2013, and by more than 300% since 2007. In May 2013 our department replaced 3 conventional X-ray rooms with 2 state-of-the-art CT-scanners, one of which is the core of the department’s new CT Innovation Unit. This allows us to perform a technology supported leap in clinical quality in paediatric, cardiac, oncologic, urologic and emergency imaging – and to increase workload.

Innovation in clinical practice enables us to work smarter, to test, invent and clinically validate new technology, and to join with our patients in improving quality of care and the creation of value – from the user and patient perspective.

The changing clinical profile of Herlev Hospital, with increasingly complex examinations supporting decision making in the departments of Neurology and Paediatrics, and the aging technology of an existing MR scanner awaiting replacement, lead to a decrease in numbers of MR scans performed in 2011 and 2012.

In April 2013 our new state-of-the-art 3 Tesla MR scanner was installed and we started to use MRI to detect prostate cancer in clinical practice, as the first hospital in Denmark to do this. MR examination workload increased by 2% from 2012 to 2013. This trend is expected to continue over the coming years as MRI of prostate cancer becomes routine. However, we are still facing challenges recruiting qualified radiologists for the task.

The number of Ultrasound Examinations continues the upward trend which started in 2010. This relates to higher throughput of patients due to the emerging emergency profile of Herlev Hospital, the breast cancer screening programme and accelerated patient throughput in general.
On August 1, 2013, the Department of Diagnostic Radiology, in co-operation with the Department of Urology, introduced an acute CT service for some of the urology outpatients. A ‘walk-in’ CT service was launched in which 8-10 permanent appointments were allocated every day for outpatients from Department of Urology. The outpatient clinic books the patients in advance when the outpatient referrals are received, mainly from general practitioners. This system gives the patient same day access to the CT scanner, but is not a true ‘walk-in’ service, such as that used, for example, for chest X-rays.

Fewer outpatient visits

The idea was to reduce the number of repeat appointments for patients in the Urology Outpatient Clinic and so to provide quicker patient assessment and to reduce the daily attendance at the outpatient clinic.

The new system involves patients attending the Department of Urology in the morning where their history is obtained, and blood samples and any necessary cytological specimens are taken. The patients are then taken to the CT scanner which provides the acute urological service, which is usually the machine in the square close to the Urology Outpatient Clinic.

After being scanned, patients usually wait for about a couple of hours while the CT scan is reported and the various tests are analysed. In the afternoon, patients return to the outpatient clinic for their test results. Possible further examinations and any necessary treatment can be planned or the patients can be discharged from the clinic.

Haematuria and stone disease review

So far, two patient pathways are included in the service: patients with haematuria and patients suspected of having stone disease.

In patients referred by their general practitioner, CT urography, cystoscopy and cytology examinations are performed and reports are sent out on the same day. This reduces the number of visits per patient from three to one.

This leads to a significant improvement in the efficiency of the Urology Outpatient Clinic, but the patient must remain in the hospital longer on the day of their appointment. The scheme provides a further saving because the medical records and test results do not have to be retrieved several times. Also, it is usually the same doctor who sees the patient throughout the day, so providing better continuity for both the doctor and the patient.

The patients are very pleased to receive their diagnosis quickly, especially since the patients with haematuria could potentially have a serious malignant disease, but in fact more than 60% of them do not have a serious condition.

In patients suspected of having stone disease, the history taking and the urinary tract CT scan can be done and the results given on the same day. If no stones are found, the patient can be discharged from the clinic on the same day. If stone disease is detected, the course of treatment can be planned, usually by consultation with a urologist specialising in stone treatment. This group of patients too have been satisfied with the new clinic arrangement and approximately 75% of them can be discharged from the clinic on the same day.

Quality and resources

There is now a direct phone line between the urologist in the stone/haematuria outpatient clinic and the radiologist who reports the scan. In most cases the urologist will just read the radiologist’s report, but problematic cases can be discussed immediately between the two medical specialists and it can be decided whether any further examinations are necessary.

Usually the CT scans are not shown at a urologic/radiological conference unless there is a particular problem which the urologist or the radiologist wants to have discussed in a larger forum. This has reduced the number of outpatients discussed at the daily urologic morning conferences, producing a further small financial saving.

Overall, the system is a success. Both patient satisfaction and the efficiency in the Urology Outpatient Clinic have increased significantly.

However, since the system requires a report from the Department of Diagnostic Radiology within a few hours, a greater minimum number of radiologists is needed in the department, as well as a medical secretary to prepare the report immediately, so that the other work in the department does not suffer.

Also, initially there were problems because some patients did not attend for their outpatient appointments. This appears to have been solved because the outpatient clinic can usually use these appointments for other patients, with the result that in November 2013 there were only five unused appointments for CT of the urinary tract and none for CT urography.

In conclusion, this project contributes to ensuring some of the aims of Herlev Hospital, namely increased patient satisfaction, a better quality service and increased workflow in the hospital.
Presentation of our Teams: The Abdominal Team

The Abdominal Team consists of 25 radiographers, 6 Senior Hospital Physicians and 3 Staff Specialists. There are always 2-3 radiography students and 3-4 residents associated with the team. The team is managed by Senior Hospital Physician Henrik Nørgaard and team managing radiographer Lisa Marie Nilsen, who started as new team managing radiographer on March 1, 2013.

Originally, the Abdominal Team’s work was to provide a service to the general surgical and urological departments of the hospital. The work consisted of doing plain x-rays, intravenous urography, pyelography, gastrointestinal examinations with contrast media, arteriography and other interventional procedures. Later, the Abdominal Team got its own CT scanner. CT urography replaced intravenous urography, and CT colonography (virtual colonoscopy) replaced fluoroscopic colon examination. Urologic exams have always been a major part of the workload of the Abdominal Team, and today, for example, we provide fast track access to CT in co-operation with the Department of Urology.

Herlev Hospital has grown over the years and radiology has gained a greater role in patient management. The examinations have become more complicated and require more specialisation. This has led to sharing of some examinations among the Abdominal, Oncological and Musculoskeletal Team. For instance, radiographers from the teams participate in skeletal radiology, abdominal CT is performed by radiographers from both the Abdominal and Oncological Team and abdominal MR scans are performed by the Musculoskeletal Team. The radiologists have become increasingly specialized and some topics, such as colorectal cancer and coronary artery disease, are treated by specialist groups of radiologists from the different teams.

Fluoroscopically-guided interventional radiology, however, is still the exclusive responsibility of the Abdominal Team. The procedures are mostly chemoembolization of liver metastases and liver cancer, and catheterisation of the urinary tract. The Abdominal Team is also responsible for CT colonography, and four radiographers are part of a project of describing CT colonography.

It will be interesting to see how the workload is best allocated among the specialists of the department in the future, when the hospital gets its new extension and the radiological department is split into two separate parts. We look forward to taking part in this process and leading the team through future challenges and developments.
Presentation of our Teams: The Oncological Team

Short description

The Oncological Team consists of 25 Radiographers, 10 Medical Specialists (8 Senior Hospital Physicians, 2 Staff Specialists) and 2-3 Residents. The team is managed by Senior Hospital Physician Lone Rasch and Team Managing Radiographer Jesper Beyer Pedersen. The team primarily conducts examinations for 4 main departments: Department of Oncology, Department of Haematology, Department of Cardiology and the Diagnostic Unit of the Department of Medicine. In addition, the team radiographers run the plain X-ray examination room where patients from all departments and specialties are examined, including the emergency room. The Oncological Team works with the Abdominal Team to cover acute CT scanning during the day.

The team has the main responsibility for the radiological part of PET/CT in co-operation with the Department of Clinical Physiology and Nuclear Medicine. The Oncological Team is one of two teams in the department with on-call duties, which means that there is a minimum of one radiographer from the Oncological Team present in the hospital twenty-four hours a day, all year round.

The last two years

During the last two years, there have been many new and exciting developments. A few of these are:

• The team has placed great emphasis on achieving the goal of having 90% of all examinations reported at the latest by 12 midday on the next day.

• Two radiographers from the Oncological Team are studying to become diagnostic radiographers. They have passed the examinations at the end of the first part of their course and start the second (and last) part of the course on February 1, 2014.

• Reconstruction of the examination room in the emergency room has been undertaken so that chest X-rays can be performed. This has been done to achieve better patient throughput.

• During the last two years, the number of CT scanners in the department has increased from 5 to 7. The number of PET/CT scanners has also increased. This allows the department to respond faster, so providing a better service to the referring departments and allowing them to deal with their patients without delay.
The Breast Team of the Department of Diagnostic Radiology is involved in the diagnosis of breast diseases. The team examines patients who have been referred from their general practitioner or hospital department with suspected breast cancer, and also examines patients as part of their follow-up after breast cancer. The team is also part of the Capital Region of Denmark’s mammography screening program, together with the University Hospital of Copenhagen. In the team there are 5 Senior Hospital Physicians, 2 Staff Specialists, 13 radiographers and 10 mammography assistants. The clinical section where examinations and follow-up of breast cancer takes place is at Herlev Hospital in the Department of Diagnostic Radiology. Mammography screening takes place partly in a building connected to Herlev Hospital, and partly in a building connected to Hillerød Hospital. In the clinical section, there are seven double rooms which have mammography machines and ultrasound scanners, and two further rooms with ultrasound scanners only. There are three mammography rooms in each screening clinic. The clinical sections have digital x-ray equipment and ultrasound scanners especially suited to breast diagnostics. Within the past two years, the mammography equipment which the team acquired in 2009 has been upgraded, and it is now possible to perform tomosynthesis. The team therefore now has the most modern equipment available for breast diagnosis.

Mammography and ultrasound scanning are performed on most patients. Mammography can be supplemented with different special recordings and tomosynthesis (see below). Ultrasound scanning can be supplemented with Doppler examination and elastography. Doppler examination allows the tumour blood supply to be visualised, and so assesses whether the tumour is benign or malignant. Elastography assesses how elastic the tumour tissue is, which helps to decide whether the tumour is benign or malignant, since most malignant tumours have very hard tissue. For the definitive decision on whether a tumour is benign or malignant, an ultrasound-guided biopsy is usually performed to obtain a tissue sample.

The team also routinely do stereotactic vacuum-assisted biopsies. Suspicious or malignant changes in the breast tissue can occur which cannot be felt on physical examination. If these changes can be seen using ultrasound scanning, an ultrasound-guided biopsy can be performed. If the changes are only seen on mammography, stereotactic biopsy is performed instead. During the stereotactic biopsy, images of the suspicious area are taken from two angles. When the suspicious area is marked on both images, the mammography apparatus can work out where and how deep the breast biopsy should be done. The biopsy is taken using a biopsy needle connected to a vacuum system. This means that more and larger biopsies can be performed in rapid succession without taking the needle out after each biopsy. The tissue sample is sucked into a container by the vacuum. After the procedure, the samples are sent to the Department of Pathology for assessment.

The stereotactic equipment is also used when the breast surgeons want to remove an abnormality which cannot be felt but can only be seen on mammography. In such cases, a thin metal wire must be inserted into the abnormality so that the breast surgeon can find it during surgery. In the same way as in a stereotactic biopsy, the mammography apparatus works out where the metal wire must be inserted. This method has led to more precise placement of the metal wire, and also is quicker and less unpleasant than when the marking wire was placed without stereotactic guidance.

During 2013, the new examination of tomosynthesis was introduced. During tomosynthesis, images of the breast are taken in the same way as with normal mammography but instead of only making the image in one plane, 15 different images are made at different angles. The mammography apparatus can manipulate the images electronically, and uses them to make image reconstructions which show the breast in slices. This makes it possible to find smaller tumours which would otherwise be hidden by the surrounding breast tissue. Tomosynthesis is especially suited to the examination of breasts with a lot of glandular tissue. Despite the larger number of images, only an insignificant radiation dose is used.

We constantly seek to improve the quality of the examinations, and in the two screening clinics repeated audits of image quality are performed. The highest possible standard of the interpretation of the mammography images and of the reports are ensured by systematic follow up checks.

During the past year, the team had a great challenge when it received patients on the “National Integrated Cancer Pathway”. The purpose of the “National Integrated Cancer Pathway” is to ensure that patients start their examination for breast cancer within seven working days of the hospital receiving the referral. We have attempted to achieve this by changing our procedures so that the team usually receives patients for examination a short time after the women have seen their own General Practitioner.

The work of the team is undertaken in close co-operation with other departments that work with breast cancer patients – the Department of Breast Surgery, the Department of Pathology and the Department of Oncology. The team ethos is to work to a high professional standard for the benefit of both patients and staff.
The Musculoskeletal Team has had an exciting 2012/2013 with new developments in several areas. During this time the Musculoskeletal Team received a new MRI scanner with a 70 cm opening which gives more room for larger patients and for patients with claustrophobia. The scanner room has been provided with Ambient Experience, which through light, sound and pictures gives a different and better experience for the patients and staff. One of our main duties is to make our examinations as patient-friendly as possible, and this is facilitated by the Ambient Experience room arrangement.

The musculoskeletal team undertakes prostate MRI scans, and this is the only place in Denmark where they are done. The prostate scans started as a research project in cooperation with Department of Urology at Herlev Hospital, but have now become standard examinations. This type of MR scan is one area where Denmark lags behind other countries.

During 2012/2013, the Musculoskeletal Team co-operated closely with the department’s research unit in a number of very interesting projects such as cardiac MRI, breast MRI and MR angiography of the lower limbs. In addition, we have focused on diffusion weighted imaging (DWI) of the liver and the MRI safety of implanted stents.

The Musculoskeletal Team co-operates closely and well with the clinical departments and with other partners both internally and externally.
Presentation of our Teams: The Ultrasound Team

We are pleased to present the dedicated Ultrasound Team of the Department of Diagnostic Radiology at Herlev Hospital.

Ultrasound imaging (also called sonography) uses high-frequency sound waves to obtain images from inside the human body, which generate real-time sonograms of patients. Unlike X-ray radiography and CT scanning, sonography involves no ionising radiation exposure and this is better for patients, especially for children.

The Ultrasound Team consists of 3-4 doctors who are radiologists specialised in ultrasound imaging, 4 sonographers and 1 medical secretary. The sonographers are highly trained and experienced and are able to complete many examinations without consulting a doctor. We work exclusively with sonography, so that our service is of a high professional quality. In addition, we often have 2-3 residents attached to the team, so we participate in the postgraduate education of future radiologists. What distinguishes education in ultrasound is the hands-on approach to sonographic diagnosis, and the fact that ultrasound is highly operator-dependent.

Each year we perform approximately 12,500 examinations of adult and paediatric patients. We undertake a wide variety of ultrasound procedures, from general abdominal and paediatric ultrasonography to the most advanced techniques, including contrast enhanced ultrasound (CEUS), and ultrasonographically guided biopsies and aspirations. We perform a high number of interventional procedures: 20% of all ultrasound examinations involve some sort of invasive intervention.

Our medical secretary has a challenging job planning our day and helping us optimise our workflow, for example by checking blood test results before interventional procedures and ensuring that the patients arrive at the right time. We use speech recognition dictation, so most of our reports are ready immediately after the examination.

We provide a service to almost all clinical departments in the hospital: emergency, abdominal surgery, medical gastroenterology, nephrology, urology, intensive care, paediatric, neurology, internal medicine, cardiology, oncology, haematology, orthopaedic surgery and plastic surgery. We also provide services to local primary health care.
Hypertrophic pyloric stenosis. The image shows the thickened pylorus.

Spectral Doppler of the internal carotid artery showing a high grade stenosis.

Atherosclerotic plaques of the carotid artery.

Normal colour Doppler image of the femoral vein.

Longitudinal ultrasound scan of the hip showing a joint effusion.

Normal kidney of a newborn.
In September 2012, three radiographers from the Department of Diagnostic Radiology at Herlev Hospital started a course at University of Southern Denmark to learn how to become diagnostic radiographers. The main purpose of the course is to increase the skills of radiographers, who normally obtain radiographs (X-rays), so that they can also make a diagnosis on conventional skeletal X-rays. The first part of the course is about diagnosing abnormalities of the peripheral skeleton, i.e. the long tubular bones, which include the upper and lower limbs, and the second part is about diagnosing abnormalities of the axial skeleton, i.e. the spine. The course should be completed in two years. Teaching mainly takes place on Friday and Saturday, and in part one seven different courses must be completed. The subjects in the course include health law and health statistics. These subjects are not necessary to establish a correct diagnosis, but they help to provide an overall context for radiographic practice. The course also aims to establish competence in quality assurance so that the diagnostic radiographers can be involved in monitoring and developing standards for radiography of the axial and peripheral skeleton.

At the same time as the university course, one day a week has been set aside for the radiographers to report X-rays from the emergency room. This new task has been a major challenge, because it takes a methodical approach and considerable knowledge to separate the appearances of normal and abnormal bones. The report must describe the bone abnormalities with the Latin anatomical terms to provide the emergency room doctors with the information they need to give the patients the correct treatment. Because these tasks are new to the radiographers, the supervising doctors sometimes have to show considerable patience. In August 2013, all three radiographers took the final exam for part one of the course. This five-hour written exam consists of 50 carefully chosen radiographs of different skeletal diseases which have to be identified and a score of at least of 95% is required to pass. At the end of 2013, all three radiographers had completed part one and they start part two on February 1, 2014.

The future work plan for the diagnostic radiographers at Herlev Hospital remains an open question, and is still under discussion between management, the departments involved and ourselves. Our aim is to be members of the team that deals with emergency patients and patients who have a fracture in the peripheral skeleton and so to help optimise the patient pathway and the workflow in the emergency room. Eventually, diagnosis of the axial skeleton will also be part of our role. Another part of our new role will be to contribute to optimising the image quality of X-rays. This will involve establishing greater quality awareness in the radiographers producing the images, and also checking the technical aspects, such as whether our equipment is installed to deliver the best images possible. We hope that our new role will allow us to provide a better service to the Department of Diagnostic Radiology, to our referring departments and most importantly to our patients.
During spring 2013, the Department of Diagnostic Radiology expanded its CT capacity by acquiring 2 new CT scanners, so the department now has a total of 7 CT scanners. The two new machines are ‘Somatom Definition Flash’ scanners, which are described as “state of the art” by the supplier Siemens.

Right from the start-up phase, from the design of the CT scanner room to the purchasing procedure, innovation has been integral to the whole plan. The CT scanner rooms are decorated in a minimal style and have round-ed corners, blue sky, and musicure (a series of specially composed ‘soundscapes’ created specifically for a variety of therapeutic purposes) in the loudspeakers. These measures all aim to establish a calm and professional environment for the benefit of the patients and the staff. An important part of the plan has been to establish cooperative working between radiographers and radiologists. This has been achieved by siting their workspaces close together to promote interdisciplinary discussion and co-operation.

To encourage innovation as much as possible, one of the two CT scanners is dedicated to innovation, development and research for 50% of the time. Much of the development involves optimising CT scanning procedures to reduce radiation and contrast media doses without compromising the diagnostic quality of the images. Two radiographers and one radiologist are permanently attached to the new scanners to develop and implement new ideas, but everyone in the department is involved and is encouraged to contribute new ideas and suggestions for changes to practice.

We also work closely with Siemens and their specialists so that they contribute to the innovation. In addition, we co-operate with Metropolitan University College, with other departments in Herlev Hospital, and in the future hope also to co-operate with other hospitals in the region.

We would like to be able to use the scanners to their fullest technical capability, and hope to use some of the new techniques to optimise CT procedures in the other 5 CT scanners in the Department of Diagnostic Radiology.

We place great emphasis on patient experience and involvement, and we would like to support the patient empowerment project of the Capital Region of Denmark. How can we integrate these aspirations into a busy day in the CT scanner? Can we help the patients help themselves and also ourselves to achieve an optimal patient pathway? All of this will be part of our innovation and development work during most of 2014.

So, what can our new CT scanners do which has not been possible at Herlev Hospital previously?

Siemens Somatom Definition Flash, unlike other CT scanners, is equipped with two X-ray tubes instead of the usual one. We can therefore scan with dual energy, meaning that we can scan the same area of the patient with different X-ray energies (KV). Technically, this means that we can remove iodine-based contrast media from the images, remove bones from vascular examinations, reduce noise from implanted metal, and more easily diagnose gout and characterise kidney stones.

The openings in the scanner gantries are a little larger than in the other CT scanners in the Department of Diagnostic Radiology. This together with the two X-Ray tubes means that it is possible to optimise the quality of examinations in obese (bariatric) patients.

Another innovation is the Flash technique, where we can use the two X-ray tubes and the quick couch movement to scan the lung and abdomen in approximately 2 seconds, 5-6 times faster than we have done previously. A major advantage of this is seen for instance with heart scans where we can scan the coronary vessels fully without interference from heart motion, because the scanner speed almost makes the heart “stand still”. Another major advantage of the quick scan time is for scanning children who cannot lie still and also for patients who have difficulties breathing or holding their breath during an examination.

All in all, the two new CT scanners are technically very advanced. A part of the innovation in the radiological department is to focus on staff education in using this new advanced technique. Over a four-week period, a pilot project will be carried out to assess alternative learning methods in the new CT scanners so that staff training can be optimised. The familiar person-to-person training will be tested, and the competence of the staff in CT will be increased at the same time.

We look forward to an exciting, challenging and innovative 2014 in the CT scanners.
Overweight and obesity are growing problems in Denmark and can lead to chronic complications such as diabetes mellitus, hypertension, non-alcoholic fatty liver disease, hypercholesterolemia, polycystic ovarian syndrome, and other diseases of the cardiovascular or digestive systems.

The Department of Diagnostic Radiology at Copenhagen University Hospital Herlev participates in a number of research projects devoted to overweight, obese and diabetic patients. Over recent years we have undertaken the most research examinations of fatty liver, muscle fat and subcutaneous/visceral fat distribution in Denmark. In the research projects we cooperate with other departments at Herlev University Hospital, with Bispebjerg Hospital, Hvidovre Hospital, Holbæk University Hospital, Århus University Hospital and University of Copenhagen. Over recent years we have participated in the following projects:

- "DIRECT: Diabetes Research on patient stratification" (http://www.direct-diabetes.org/, The Novo Nordisk Foundation Centre for Basic Metabolic Research, Faculty of Health Sciences, University of Copenhagen)
- "CUT-IT: Randomized study comparing interval training and weight loss in obese (BMI 28-40) patients with ischemic heart disease (Department of Cardiology Y, Bispebjerg Hospital)
- "ERGEM: effects of gastric bypass surgery on energy consumption, gastrointestinal hormones and body composition." (Department of Human Nutrition, University of Copenhagen & Hvidovre Hospital)
- "COLA: Energy in liquid form. Importance of appetite, appetite regulatory hormones, metabolic factors and the weight." (Department of Human Nutrition, University of Copenhagen & Medical Endocrinology Department, Århus University Hospital)
- "The Danish Childhood Obesity Biobank: Establishing reference limits on adipocytokines, cytokines and CVD markers distributions of gene polymorphisms, and ensuring biological materials for research in lifestyle diseases related to obesity in childhood." (The Children’s Obesity Clinic, Holbæk University Hospital)
- "Immit FASTE: The effect of fasting every other day in patients with type 2 diabetes" (Biomedical Institute, Faculty of Health Sciences, University of Copenhagen)
- "APPROACH: An optimized programming of healthy children - the most favourable dietary protein: carbohydrate ratio during pregnancy in the context of New Nordic Diet" (Central kitchen, Herlev Hospital)
- "LIFT – Liraglutide for women with polycystic ovary syndrome" (Gynaecology and Obstetrics Department, Herlev University Hospital)

Techniques.

The advantages of Magnetic Resonance techniques are that they are non-invasive and use no ionising radiation, so they are safe.

The Department of Diagnostic Radiology at Herlev Hospital contributes to the research projects by measuring:

1) Volumes of subcutaneous and visceral fat (Magnetic Resonance Imaging)
2) Fat content in liver and in muscle (Magnetic Resonance Spectroscopy)

Measurement of fat volumes with Magnetic Resonance Imaging.

There are two types of fat: subcutaneous and visceral. Subcutaneous fat is found just underneath the skin, and may cause dimpling and cellulite. Visceral fat is located within the abdominal cavity and surrounds vital organs. Visceral fat is linked to everything from bad cholesterol and hypertension to diabetes, heart disease and stroke, so it is important to measure fat distribution and, especially, the volume of the visceral fat. Since fat is easily identified on MR images, the volumes of visceral and subcutaneous fat can be calculated.

Measurement of liver fat content with Magnetic Resonance Spectroscopy.

Fatty liver disease is one of the diseases caused by obesity. Fatty liver disease in adults is considered present when the fat content of the liver cells makes up more than 5-10% of the liver’s weight. Liver biopsy is the gold standard for diagnosing and assessing the severity of fatty liver disease, but it is an invasive procedure associated with serious risks. Therefore, non-invasive measurement by magnetic resonance spectroscopy (MRS) is a better alternative for detecting fatty liver disease. MRS shows the composition of tissue metabolites in a given volume.
Psoriatic arthritis (PsA) is an inflammatory joint disease associated with the skin disease psoriasis. There are no precise and sensitive methods for measuring the manifestations of the disease. Computed tomography (CT) is considered the reference modality for evaluating bone structure, and recently, two new magnetic resonance imaging (MRI) methods have been introduced. Dynamic contrast-enhanced MRI allows quantification, which is partially user independent, of inflammation, and whole-body MRI allows the entire musculoskeletal system to be visualised in one session.

The main objective of this thesis project was to assess inflammation and structural damage in PsA using modern MRI and CT methods. We performed a longitudinal observational study (study I), and a cross-sectional study (study II).

In study I, we used CT as the reference method to investigate structural changes in the hands of 41 PsA patients. Bone erosions were located in the metacarpal heads in 90%, but bone proliferations were primarily located distally on the sides of the distal interphalangeal joints. During 48 weeks of adalimumab therapy, we observed no overall change in structural damage. MRI in study I gave a sensitivity and specificity for bone erosions of 100 and 40%, and for proliferations of 83 and 93% respectively. We observed longitudinal decreases in MRI scores for synovitis, tenosynovitis and bone marrow oedema. Inflammation was present on MRI in all 24 patients scanned at week 48, despite a clinical response to treatment. Baseline bone marrow oedema was associated with progression of erosions on CT, although we rarely observed progression. Baseline dynamic contrast-enhanced MRIs were available for nine patients, and the dynamic MRI parameters of inflammation decreased between baseline and follow-up. Twenty-two patients had at least one dynamic contrast-enhanced MRI available and the parameters of inflammation correlated with MRI synovitis (rho 0.43-0.62).

In study II, we used whole-body MRI to evaluate inflammation and structural damage in 18 patients with PsA, 18 with axial spondyloarthritis and 12 healthy subjects. Evaluation of whole-body MRI was most frequently possible and reproducible in areas located centrally in the scanner. Bone marrow oedema assessed in peripheral joints showed higher scores in PsA than in healthy subjects, and correlated with the swollen joint count. Whole-body MRI in PsA showed similar involvement in the hands and feet, but in spondyloarthritis the feet were more frequently involved. Enthesitis assessed by whole-body MRI showed limited correlation with clinical examination.

In conclusion, patterns of structural damage and inflammation in psoriatic arthritis were investigated by CT and MRI, and aspects of reproducibility, inter-modality agreement, relation to clinical findings, sensitivity to change, and prognostic value of conventional MRI, dynamic contrast-enhanced MRI and whole-body MRI were evaluated.
Contrast media are important and frequently used tools for diagnosing disease during computed tomography (CT) and magnetic resonance imaging (MRI) examinations, but they can cause serious and potentially fatal non-renal and renal adverse events. It is very important to clarify whether adverse events after CT and MRI scans directly relate to the contrast media or have other causes.

The purpose of this study was to compare patients having enhanced and unenhanced CT and MRI to determine the true frequency of adverse effects related to contrast medium. The frequencies of non-renal acute adverse events (AAEs), late and very late adverse events (LAEs and VLAEs) in patients undergoing enhanced or unenhanced CT or MRI were measured. The frequency of renal adverse events, as evidenced by fluctuations in estimated glomerular filtration rate (eGFR) in outpatients, was measured and the value of a structured questionnaire to identify outpatients with renal dysfunction before CT or MR examinations was studied.

This investigation was done by Manal Azzouz (MSc. Pharmacy) as a PhD project in the Department of Diagnostic Radiology at Copenhagen University Hospital Herlev from 2010 to 2013.

Before their examination, all patients completed a questionnaire to detect five risk factors indicating renal dysfunction, and had estimated glomerular filtration rate (eGFR) determined immediately before the CT or MRI scan. The patients were interviewed 72 hours after the CT or MRI examination about the occurrence of AAEs using a structured questionnaire. They also had eGFR determined, and were interviewed about the occurrence of LAEs. One month later, the patients received a questionnaire to check for the occurrence of VLAEs.

From the results of this PhD study several conclusions were drawn. AAEs, LAEs and VLAEs were all experienced by patients undergoing unenhanced CT or MRI, as well as by those receiving contrast medium, but the incidence of AAEs, LAEs and VLAEs was higher in the patients who had received contrast medium. These findings indicate that AAEs, LAEs and VLAEs are not always caused by the contrast media. The eGFR in outpatients undergoing CT or MRI varied independently of whether the patient received contrast media or not. The findings reflect natural variations in serum creatinine levels, which should be taken into consideration when contrast-induced nephropathy is studied. The questionnaire used to identify renal dysfunction in patients aged less than 70 and eGFR determination in patients aged over 70 identified 99.6% of patients with an eGFR between 30-45 ml/min/1.73m2.
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