

**International Day of Radiology 2014**  
**Interview on brain imaging**  
**Belgium / Prof. Rik Achten**



**INTERNATIONAL  
DAY OF  
RADIOLOGY**  
AN INITIATIVE OF THE ESR, ACR AND RSNA

The ESR spoke to Professor Rik Achten, head of radiology at Ghent University Hospital (GUH), Belgium, about the main indications for neurological imaging and the advantages of the different modalities.

**European Society of Radiology: Imaging is known for its ability to detect and diagnose diseases. What kind of brain diseases can imaging help to detect and diagnose?**

**Rik Achten:** In 2011, I was asked by the European Society of Magnetic Resonance in Medicine and Biology to give a talk on the 10 most important indications for neuro-imaging, and my conclusion was:

1. Stroke
2. Epilepsy
3. Headache
4. CIS (clinically isolated syndrome), MS (multiple sclerosis)
5. Acute neuropathy
6. Neurocognitive decline
7. Birth asphyxia
8. Head trauma
9. Presurgical risk estimation
10. Stereotaxy & neuronavigation

This is of course a somewhat biased selection, based on the available expertise at Ghent University Hospital.

**ESR: How useful is imaging in brain disease management? Does it improve the understanding of disease or improve patient prognosis?**

**RA:** Many examples of research can be found where neuroimaging is essential for the understanding of disease. On the level of the individual patient who is referred for a magnetic resonance (MR) scan because of a newly developed headache, when a tumour in the brain is found, this gives insight in the symptoms of the patient and a diagnosis has been made, which means therapy can start. In order to understand why brain tumours are developing, a collaborative effort between many scientific domains is needed, from genetics to cell biology, and factors like the environment and lifestyle have to be taken into account.

One of the best examples where neuroimaging has historically had a very big impact is the use of magnetic resonance imaging (MRI) in patients with multiple sclerosis (MS). Such patients, typically young and female, often had and have fluctuating neurological problems, which were considered psychiatric in origin in the past, resulting in several young women being locked away in psychiatric care. With MRI, suspected MS is detected early, and now MRI is an integral part of the management of patients suspected of developing MS. Because of the availability of new immune-modulatory drugs, early detection by MRI and early therapy have considerably improved the prognosis of these patients. In stroke, measuring blood perfusion in the brain with computed tomography (CT) and MRI has allowed us to select patients in whom thrombolysis, which is the resolution of the blood clot blocking an artery in the brain, can save brain tissue at risk of further infarction. This has improved the outcome for many patients with stroke. MRI also enables us to easily detect hippocampal sclerosis in patients with intractable (no medication helps) epilepsy, and has become an indispensable tool in any epilepsy referral centre. We have developed functional MRI (fMRI) procedures to test memory in epilepsy patients who are selected for surgery. The classic test for

memory and language (Wada test), which cannot be performed anymore because there is no more amytal (a short-lived barbiturate) available, has now been successfully replaced by a language and memory test using fMRI to assess the risk of proposed brain surgery.

**ESR: What kind of technology and techniques do radiologists use to image the brain? Are there any specific techniques for particular diseases?**

**RA:** Imaging of the brain can use any of the typical radiological imaging techniques, but most exams are performed using CT or MRI. Ultrasound is only used in neonates because the skull is not closed around the brain. Plain x-rays do not show the brain, but are used to measure pressure valve settings in patients with ventricular shunts. CT is nearly always the first exam in emergency cases because it is available in the emergency department and does not impose immediate risks for patients and carers caused by metal objects, as they would in an MRI environment. Patients also remain much more accessible because the gantry (opening) of a CT scanner is much shorter than the tunnel of an MRI machine.

MRI is the best technology we have for neuroimaging. In Belgium, the amount of CT scanners, unfortunately, greatly outnumbers the amount of MRI scanners, which results in long waiting times. This in turn results in the overuse of CT scanning for neurological problems. It is my belief that a joint effort between neurologists, neurosurgeons, GPs and radiologists is needed to reduce the number of unwanted CTs in favour of MRI, but also that the policy makers in this country should better support the transition of CT to MRI by allowing more MRI scanners to be installed.

**ESR: What is the difference between a radiologist and a radiographer? Who else is involved in performing brain imaging exams?**

**RA:** A radiologist is a medical doctor specialised in making a diagnosis from radiological images like CT, MRI, ultrasound and plain x-rays. Some radiologists are specialised in what is called interventional procedures. This means that they enter the body's blood vessels with catheters to cure blood vessel occlusions, bleeds and other blood vessel abnormalities like aneurysms and arteriovenous malformations. Interventional radiologists also perform diagnostic and therapeutic punctures of organs and lesions in the body under imaging control.

A radiographer is a professional radiology technologist trained to make the images required by the radiologist. Her or his work is indispensable in the process of radiology, and the time when a radiologist had all the required knowledge to make the images her or himself is long gone. Some nurses are also engaged in the radiology department, they carry out more care-related tasks, especially in interventional radiology.

**ESR: How many patients undergo brain imaging exams in your country each year?**

**RA:** I don't know the total amount of radiological exams in Belgium. At GUH, we performed 240,000 radiological exams in 2013 in 170,000 patients. There were about 17,000 brain scans, of which around 7,500 were CT scans and 9,500 were MRI scans.

**ESR: Access to modern imaging equipment is important for brain imaging. Are hospitals in your country equipped to provide the necessary exams?**

**RA:** Yes, they are.

**ESR: In many countries there are waiting lists for MRI exams. How long can patients typically expect to wait for an exam in your country?**

**AR:** The waiting time for a non-emergency brain MRI for an adult patient is more than three weeks, for paediatric patients who require anaesthesia it is over four months. For CT, the waiting list is only a couple of days. There is no waiting time for medical emergencies for either MRI or CT.

**ESR: As the global population gets older, the risk of developing neurocognitive and neurodegenerative disorders increases. How can imaging help tackle this issue?**

**RA:** Imaging in neurodegenerative disorders is often essential to make a diagnosis and to rule out curable diseases that may cause the same symptoms. Many neurodegenerative disorders have a typical signature on MRI images.

It is true that early stage neurodegenerative diseases cannot be discerned from the effects of normal aging. A large body of research is currently underway and plans to improve detection accuracy of early Parkinson's and Alzheimer's diseases, and other dementias.

For Alzheimer's disease (AD), there are five biomarkers. A biomarker is a kind of a number derived from a test that correlates with disease progression and is not necessarily linked to clinical symptoms. There is only one AD biomarker from MRI, e.g. brain atrophy. There are three PET biomarkers and one in the cerebrospinal fluid. Current research is trying to replace one of the PET biomarkers (FDG-PET) with quantitative perfusion measurements of the brain's grey matter using a fancy technique called arterial spin labelling (ASL). The advantage of ASL is that it is cheap and widely available while FDG-PET imaging is expensive, can only be performed in dedicated centres and comes with radiation exposure. Possible new biomarker candidates for early diagnosis and efficient therapy response monitoring in neurodegeneration come from MRI-related techniques that measure the connectivity in the brain, e.g. how strong brain regions are communicating with one another. This can be done by resting-state functional MRI for functional connectivity and diffusion tensor imaging (DTI) for structural connectivity. When comparing groups of patients with neurodegeneration with groups of normal subjects using these new techniques, clear abnormalities can be quantified in the patient groups. Unfortunately, until now, most of the new imaging biomarker candidates have not yet performed well enough to be used in individual patient diagnosis and monitoring. But being part of this research has convinced me that we are making great progress towards making it happen in the near future.

**ESR: Some imaging techniques, like x-ray and CT, use ionising radiation. What risk does this radiation pose to the patient and what kind of safety measures are in place to protect the patient?**

**RA:** Radiation exposure is detrimental to health, and there is enough evidence that cumulative doses of x-rays lead to a cumulative risk of developing cancer. Younger patients are the most vulnerable. On the other hand, the risks of a diagnostic exam have to be weighed against the positive effects of early and accurate diagnosis, which often results in life-saving therapy. As radiology professionals, it is our duty to make excellent images with as low a dose as reasonable achievable; the ALARA principle. CT will always be part of the neuroradiological arsenal. At the GUH, we use guidelines for radiology, dose reduction software on the scanner, a quality monitoring system (ISO9001), and dose registration software to minimise radiation exposure to the individual patient.

The guidelines for medical imaging (radiology and nuclear medicine) exams tend to favour lower use of CT and more MRI for most sub-acute and chronic conditions, but CT is still the number one choice for emergencies. To always comply with the guidelines, we need more MRI systems because of the long waiting lists. To reduce the dose of each exam, we have very modern equipment with the latest state-of-the-art dose reduction software installed. Furthermore, we use patient dose-registration software to screen procedure choice for optimal radiation dose values for every CT exam. Such software also allows us to issue a radiation dose passport to every patient on the condition that all data from all individual dose registration databases in every radiological centre are synchronised. This is something for our policy makers.

**ESR: What kind of role can imaging play in preventing and predicting brain diseases?**

**RA:** I don't think neuroimaging is useful in individual disease prevention; there are many inexpensive and sensible measures when it comes to keeping us healthy. On the other hand, the knowledge that leads us to such preventive measures and insights in health and disease comes from the joint efforts in research, in which neuroimaging has an important role.

Predicting disease is altogether something different. If preclinical stages of disease can be detected with imaging, then that is definitely useful.

MRI is already used as a predictor. In neuro-oncology (neurofibromatosis, malignant brain tumours, etc.), repetitive preventive scanning in patients with such diagnosis will detect tumour growth before the development of symptoms. Early therapy can then be started to prevent further deterioration. The addition of the stage 'pre-clinical Alzheimer's disease' is an example in research. Hypothetically, when a subject has a biomarker value that shows that she/he will develop AD, then she/he will be categorised as having 'preclinical AD'. This can be interesting to monitor progression or to monitor therapeutic interventions in the future when they become available.

**ESR: In general, patients don't see the radiologist. A patient will discuss the image with the neurologist, neurosurgeon or oncologist. When they ask a question, they're often told: "I'm not a radiologist". Why don't radiologists discuss the image with the patient first?**

**RA:** The role of the radiologist as a doctor is to attend to the patient's needs and that means, amongst other things, that they have to provide the right information to understand her or his situation. This can, in many cases, only be inferred from a complex set of data in the medical files, and knowing the patient's family and background. Probably the best person to communicate a diagnosis is the referring doctor who then can also talk about therapy and prognosis. We as radiologists seldom have all the necessary information. Notable exceptions are interventional radiology, ultrasound and mammography, where close contact with the patient is necessary and a more typical relation between doctor and patient exists. I encourage my staff and residents to communicate with patients on request, and to be very careful when making strong statements.

**ESR: How expensive are radiological examinations to the health service and is there a risk that some of these examinations could be blocked by health technology assessment agencies deeming them to be not cost-effective (especially in relation to screening)? If so, how can patients help to ensure that these examinations are made available?**

**RA:** The cost for radiological exams varies. What the insurance companies pay for these exams varies roughly between €25 for an x-ray to €250 for a functional MRI exam. Some interventional procedures are even more expensive. These per exam fees cover about 50% of the income of radiology at the GUH, the other 50% is a combination of a lump sum for GUH and several fixed sums per exam. The decision as to which exams have to be performed for which indication is defined by the guidelines for medical imaging, available on the website of our government. Patients can help by asking their referring doctors to take these guidelines into account when prescribing a radiological exam. It is the responsibility of the referring doctor to make a correct prescription for any radiological exam with concise but relevant clinical information and a clear clinical question to be answered by the radiologist. It is the responsibility of the radiologist to check if the prescribed medical imaging exam is the correct one. Also here, we encourage our patients to ask questions if in doubt.

***Eric (Rik) Achten*** is head of the radiology department at Ghent University Hospital, where he has been working as a neuroradiologist since 1990. He previously worked in the MRI department of the Free University in Brussels and the Netcare Unitas Hospital in Pretoria, South Africa. He has a major interest in magnetic resonance imaging (MRI), which started during his radiology training with Prof. Ole Henriksen at Hvidovre Hospital in Copenhagen. Dr. Achten's participation in many research projects has resulted in over 120 publications. He has served on the board of University Hospital Ghent for four years, and is currently an elected member of the medical council of Ghent University Hospital and director of the Ghent Institute for Functional and Metabolic Imaging. He is also a promoter of I-Brain, a local initiative to bring brain science to the general public. He was recently appointed president-elect of the European Society for Magnetic Resonance in Medicine and Biology (ESMRMB).

