Serving Stroke units by Teleradiology - An ideal method to share Specialised Neuroradiological knowledge.

Bodo Kress[1, 4], Isham Jaafar[2], Christian Jakobi[3, 5], Andre Grabowski[1, 4], Paulouse Varghese[6] and Uta Meyding-Lamade[3, 5]

[1]Department of Neuroradiology, KrankenhausNordwest, [2]Department of Cardiosurgery and CEO JPMC, [3]Department of Neurology, KrankenhausNordwest, [4]Consulting Neuroradiologist JPMC, [5]Neuroscience Stroke and Rehab Center, JPMC, [6]Department of Neuroradiology JPMC

Stroke is one of the major diseases in populations. Stroke appears accidentally. Although stroke does not hurt and produces no pain, people may feel uncomfortable and then plegia and aphasia will appear. They wait, hoping that symptoms would disappear. These are the first 15 minutes that we lose to fight stroke. After that period people do realise, that they need a doctor. Indeed they need a specialised hospital nearby and fast.

Stroke Units are an ideal place to take care of stroke patients. In hospitals running such wards, specialised nurses and doctors take care of patients. Caring for stroke patients means to treat hypertension, diabetes, renal failure as well. Lysis therapy is used for treatment of stroke. Lysis therapy only makes sense, when treatment is applied as early as possible. Patients getting lysis therapy 60 minutes after a stroke show a better outcome than patients who get lysis therapy 140 to 210 minutes after onset[1]. Time is brain which means that time should not be wasted so that brain tissue is spared.

Corresponding address:
Professor Bodo Kress
Department of Neuroradiology
Jerudong Park Medical Center
Jerudong Park

Stroke can be caused by ischemic strokes and by hemorrhage. The clinical symptoms are quite the same and therefore an ischemic stroke cannot be differentiated from hemorrhage by clinical symptoms alone. The differentiation can be made by cross sectional imaging – computer tomography (CT) and magnetic resonance imaging (MRI)- only. Therefore these examinations have to be performed before lysis therapy can be considered. After a short clinical examination, the imaging examination should be performed, so that the time window for lysis therapy, which is now 270 minutes (4.5 hours) can be held. Therefore this is an emergency examination and should be done with excellent expertise. We think that the report should be done at once by neuroradiologist day and night. While neuroradiologists are rare, can this be done? This is what we would like to explain further.

CT or MR - which is better?

The question is answered very simple. Of course ischemic stroke is seen on MR easily - and much better than on CT scan. The big stroke studies in late 90s showed us, that people with extensive strokes do not have an effect on lysis therapy but suffer from hemorrhage complications. Therefore stroke with huge infarction are contraindications

for lysis therapy[1,2]. Of course it is much easier for general radiologists to detect an obvious infarct on MR than on a CT scan. But when the sensitivity of MR is better than of CT, is the outcome of the patients will be better too? There may be doubts as accepted evidence-based studies are missing.

The stroke studies in the nineties were CT-driven studies. The studies concluded that when CT scan was perfomed and lysis treatment was applied, the outcome for patient was significantly better than in patient who did not get lysis treatment[1,2]. Therefore we know we did something good for patients, when we are screening them by CT. Even in these successful trials the difference between verum and placebo cohort was so small that the trials failed nearly[1]. Some stroke studies in the early 21st century were not successful (for example DIAS II)[3]. One reason for that could be, that the placebo cohort got the perfect care in a stroke unit as well, being responsible for a better outcome, but these studies have been screened by MR and if we use MR, we lost time.

In specialised neuroradiolgical departments stroke MR protocol does not last more than 10 minutes including FLAIR-, Diffusion-, Perfusion-sequence and MR Angiography. In contrast to CT, where the patient can be taken directly from the ambulance car on the CT table, we have to disrobe the patient for MR and search for signs of a bygone surgical operation(pacemaker, aneurysm clip). In some scanners, they require relocating patient on a separate table and then in a third step on the MR table. In CT, we might have the first image after 2 minutes and in MR usually it takes at least 25 minutes. These are 23 minutes we invest, because lysis therapy is applied later.

Therefore we think, that CT-examination is the method of choice in the 270 minutes window. An experienced neuroradiologist not only will be able to differentiate haemorrhage from ischemic stroke,but will detect early infarction signs with a high sensitivity. These signs can be seen from 45 to 60 minutes after onset of stroke[1]. CT brain-scan is complemented by CT-angiography which detects vessel occlusion, and CT-perfusion which detects perfusion deficit. So with a CT scan neuroradiological report is a reliable base provided fast to discuss lysis therapy in stroke patients.

How to organise neuroradiological service.

Nearly every hospital has its own radiological department. Even small hospitals are running a CT-scanner[4]. In general radiology, CT is an important tool for staging patients in cancer diseases, but at night CT scans are done rarely and plain radiographs are done or ultrasound is usually performed by the physician or surgeon. However, in stroke, CT-brain scans are very common even deep in the night. Indeed it is very common that an acute stroke patient arrives at hospital every night, sometimes twice or more. Therefore radiologists in small hospitals are not able to cover this time consuming and exhausting CT-night service[4]. Even bigger hospitals are employing one or two neuroradiologists only. To cover such nightservice, a department of minimum 5-6 neuroradiologists is needed. CT scan is mandatory

in stroke and in an acceptable quality. Only neuroradiologists can guarantee for this quality and they are rare and expensive. The solution could be a pool of neuroradiologists in big centers with Interventional neuroradiology facilities. These hospitals are able to offer via high quality neuroradiological service to stroke units.

How do these specialists see images from other hospitals?

In former times hardcopy films were transported by cabs and the reading was performed conventionally. Upcoming internet made it change, because ride time was unacceptable in stroke (sometimes more than 60 minutes), and carrying films by car restricts the service on the surroundings of the hospital. Transferring images by internet, which is nowadays much faster than in the late 90´s, solves these problems [5]. Data are transferred via high velocity and therefore distance is not an argument any more against teleradiology. Hospitals are able to rend specialised services where ever they want. The challenge to be solved is time interval and workflow, which should be optimised.

Tele neuroradiological workflow

When a neurologist sees a patient and considers whether this is a stroke, he will be requesting neuroradiological examination. It is very important that the clinical symptoms are exactly described in this request, because the neuroradiologist cannot examine the patient clinically but has to be aware of the clinical symptoms to interpret imaging findings. Ideally this proposal should be send by FAX or by email to the neuroradiologist, who should be on standby for emergency examinations. The neuroradiologist should first decide which examination has to be made and whether an angiography or a perfusion technique is necessary. If a CT-scan is necessary, the neuroradiologist has to prove the indication for this X-ray examination. In Germany this can only be done by a full staff neuroradiologist[6,10]. At night the neuroradiologist on charge is on standby. Therefore the neuroradiologist reads the images at once und reports them immediately. After the CT-Scan is terminated and images are sent via the internet the report should not take more than 15 minutes. It should arrive on the stroke unit 30 minutes latest after the CT - examination was made[11,13]. To obtain this intention it is necessary to work hand in hand with experienced radiographer, who is able to work independently and efficiently. On the other hand the bandwidth of internet connection should have a minimum limit (5 Mbyte) and latency to transfer images in an acceptable time[6].

Our concept for JPMC includes now 11 neuroradiologists including Prof. Dr. Kress, performing a 24/7 teleneuroradiologist service. Doing like this, reporting is faster than on site (unpublished data).

In conclusion we are sure, that neuroradiologists are detecting ischemic lesions on CT with high sensitivity. Teleneuroradiology is at least as fast as onsite service and therefore an ideal tool to share neuroradiological knowledge in satellite stroke units.

References:

1. Hacke W, Kaste M, Fieschi C, Toni D, Lesaffre E, von Kummer R, Boysen G, Bluhmki E, Höxter G, Mahagne MH, et al. (1995) Intravenous thrombolysis with recombinant tissue plasminogen activator for acute hemispheric stroke. The European Cooperative Acute Stroke Study (ECASS)JAMA ;274(13):1017-25

2. Donnarumma R, Kongable G, Barch C, Braimah J, Bratina P, Daley S, Rapp K, Sailor S, Spilker J. (1997) Overview: hyperacutert-PA stroke treatment. The NINDS rt-PA Stroke Study Group.J NeurosciNurs. 1997 Dec;29(6):351-5. Review.

3. Hacke W, Furlan AJ, Al-Rawi Y, Davalos A, Fiebach JB, Gruber F, Kaste M, Lipka LJ, Pedraza S, Ringleb PA, Rowley HA, Schneider D, Schwamm LH, Leal JS, Söhngen M, Teal PA, Wilhelm-Ogunbiyi K, Wintermark M, Warach S. (2009) Intravenous desmoteplase in patients with acute ischaemic stroke selected by MRI perfusion-diffusion weighted imaging or perfusion CT (DIAS-2): a prospective, randomised, double-blind, placebo-controlled study.Lancet Neurol.;8(2):141-150.

4. Weisser G, Walz M. (2007) Basics of German teleradiologyRadiologe. 47(3):267-76; 277-278.

5. Weisser G, Walz M, Ruggiero S, Kämmerer M, Schröter A, Runa A, Mildenberger P, Engelmann U. (2006) Standardization of teleradiology using Dicom e-mail: recommendations of the German Radiology Society.EurRadiol. ;16(3):753-578.

6. Walz M, Brill C, Bolte R, Cramer U, Wein B, Reimann C, Haimerl M, Weisser G, Lehmann KJ, Loose R, Georgi M. (2000) Teleradiology requirements and aims in Germany and Europe: status at the beginning of 2000.EurRadiol. ;10(9):1472-1482.

7. Engelmann U, Schröter A, Baur U, Werner O, Schwab M, Müller H, Meinzer HP (1998) The evolution of a German teleradiology system.. Stud Health Technol Inform.;52 :255-260.

8. Walz M, Mildenberger P, Klose KJ (1999) Standardized image transmission. An important step in the direction of teleradiologyand telemedicine.Radiologe. ;39(4):M77-79.

9. Engelmann U, Schröter A, Baur U, Werner O, Schwab M, Müller H, Bahner M, Meinzer HP, Borälv E, Göransson B. (1998) The German teleradiology system MEDICUS: system description and experiences in a German field test.Eur J Radiol.;26(3):219

10. Engelmann U, Schröter A, Baur U, Werner O, Göransson B, Borälv E, Schwab M, Müller H, Bahner M, Meinzer HP (1997)Experiences with the german teleradiology system MEDICUS.Comput Methods Programs Biomed.;54(1-2):131-139.

11. Baur HJ, Engelmann U, Saurbier F, Schröter A, Baur U, Meinzer HP (1997) How to deal with security issues in teleradiology.Comput Methods Programs Biomed. ;53(1):1-8.

12. Ulsenheimer K, Heinemann N.(1997)Legal aspects of teleradiology, Radiologe; 37(4):313-321.

13. Englmaier M, Haendle H, Glas K, Rupp (1994) Teleradiology with personal computers. N.,Bildgebung;61(3):202-205.