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## Injuries of the central nervous system – mobile phone consultations

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### Summary

Transmission of visual documentation between a neurosurgery center and a regional hospital, with a mobile phone, significantly improves consultation on a craniocerebral injury. This is one of the methods of fast consultation on image documentation (CT). We reported on one year of experience (September 2007 to September 2008) of our department with this method of image transmission in 16 patients with craniocerebral injury. The images were exported, via the Internet, from local hospitals through the PACS system [Picture Archiving and Communication System], in DICOM III format, to the server of the Regional Hospital of T. Baťa, (KNTB). Browsing of the acquired image documentation at particular stations was possible with the xVision browser. The data were exported to a secure hospital Web server, IIS60, to enable consultation on the images, which were changed to JPEG format. The consulting physician was connected to this server with his/her mobile phone by means of the Internet browser. After establishing the connection, it downloads and gradually displays the images on the screen of the mobile phone. The whole process takes approximately 10 minutes. After comparing the images on the screen of the mobile phone and on the workstation using the xVision browser, we verified that there was no difference in the quality of imaging of the pathological lesions recorded with CT.

**Key words:** consultation • PACS • mobile phone

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### Background

Specialistic services of the KNTB Hospital in Zlín rendered for five local hospitals include treatment of patients with severe injuries of the central nervous system. The consultation network, based on a VPN (Virtual Private Network), enables an adequate evaluation of the imaging documentation on the injury of the central nervous system, without any unnecessary transport of images or patients with ambulances. The network is able to transfer images at a speed of 2 to 10 Mbit/s in the DICOM III format, from the local hospitals to the regional hospital, 24 hours a day. At this place, they are archived with the PACS system, for a future need. The attending neurosurgeon in the hospital is able to inspect the images using the xVision browser and to adequately decide on further procedure (transport to a specialized center or treatment in the local hospital). The neurosurgeon has an access to the images of the same

quality, even if he/she is at home (a half-service), connected with his/her PC to the network through a fixed ADSL (Asymmetric Digital Subscriber Line), as he/she shares the screen of the workstation at the neurosurgery department with their home PC. Both means of consultation prompt the physician to be at a place which provides a fixed connection. Half-service outside the health-care establishment has therefore the status of a full service, with an increasing number of consultations. Therefore, in September 2007, we started to test mobile phones. The aim was to maintain the quality of the consultation service and to enable the physician to be mobile during his/her half-service, without a need to stay at the workstation. For this method of transfer, we intuitively used our PACS system, hospital Internet pages with restricted access, combined with Internet connection provided by a mobile network operator and a mobile phone with a high-quality display (Nokia N95 – display: TFT; QVGA resolution; 16 million colors).



**Figure 1.** Contusion of the brain tissue, with haematoma in the left temporal region.

In the trial period, from September 2007 to September 2008, we tested 16 cases of consultation on a craniocerebral injury, from the whole sub-region.

**Material and Methods**

Our own consultation using a mobile phone consists of two parts:

1. After receiving a message from the local hospital, the neurosurgeon on half-service informs the staff at the department by phone and enters the identification data of the patient who is being consulted on. The health-care personnel seeks the relevant images in the xVision browser (format DICOM III). By clicking in the browser the button 'export into HTML', the set of images is sent, in JPEG format, to the secured Internet server, IIS60.
2. The consulting physician connects by means of the Internet browser in his/her mobile phone to the hospital Internet server at a speed of 512 Kbit/s, using the pre-set user name and password. As soon as the connection establishes, downloading of images at a resolution of 200×200 px (in a JPEG file format of approximately 20 KB in size) is initiated on the mobile phone. The whole procedure takes 2–3 minutes. After downloading the images, the physician evaluates the documentation and selects images. When clicked on, a selected image will obtain its full resolution (in the case of CT, this is typically 512×512 px – ca 60 KB). After evaluating the images, the physician informs the local hospital by phone about the next steps.

Data safety and minimization of data leakage is guaranteed by the method of transfer (VPN), processing (PACS) and connecting the mobile phone to the server with a unique user name and password.

**Results**

From September 2007 to September 2008, we consulted on 16 patients with craniocerebral injury, from the whole sub-region, by means of a mobile phone (Figures 1, 2). The



**Figure 2.** Epidural hematoma in the right temporal region.

**Table 1.** Number of patients and types of craniocerebral injuries assessed on CT.

CT examination of the craniocerebral injury	Monitor of the workstation	Display of the mobile phone
Epidural hematoma	2	2
Acute subdural hematoma	6	6
Contusion of the brain tissue	4	4
Chronic subdural hematoma	2	2
Combined injury	2	2

whole process of downloading and evaluation took from 5 to 10 minutes in all the consulted patients. The neurosurgeon, in cooperation with the radiologist, compared the CT quality on the monitor of the workstation and of the mobile phone. Consistency between the quality of the images on the workstation of the CT device and on the display of the mobile phone was found in all 16 patients with craniocerebral impairment (Table 1). Similarly, we found no differences in the evaluation of the images on the mobile phone and on the workstation. On the basis of our experience, we can conclude that the same evaluation criteria must be used in the assessment of an image on the mobile phone display and on the workstation of the CT device. We did not have to correct any diagnosis of the consulted patients. The only disadvantage of this method of consultation was the small size of the mobile phone display, which requires zooming, shifting and rotation of some of the images on evaluation.

**Discussion**

The increase in the quality of consultation on imaging documentation was discussed by technicians all over the world. In the world literature, there have appeared the first reports on consultation networks created in the end of the last century [1–19]. Because of the legislative changes

regarding the extent of overtime work in the health-care system and a small number of attested neurosurgeons, part of the overtime hours is spent on so called half-service outside the hospital premises. To facilitate the consultations on image documentation in these cases, a consultation network was developed in the north Moravia region between 2002 and 2003, based, initially, on ISDN, and then on ADSL. It enabled the neurosurgeons on half-service to see the images on their home PC. Browsing was possible due to sharing the screens of the workstation in the hospital with a home PC of the physician via the IP addresses. It significantly saved the time and resources of the physicians-specialists by reducing their time at the work place during emergency situations, without affecting the quality of the consultation. This method is now extended to other medical branches, such as radiology, etc.

Despite all the advantages, the co-specialist had to spend his/her time at the place where the PC was connected by a fixed line to the workstation of the hospital. At the turn of the 20<sup>th</sup> and 21<sup>st</sup> century, there appeared articles in the literature, which recommended consulting on image documentation via mobile phone [11,19].

We first tried to transfer and display the images using remote screens by means of a PDA (Pocket Digital Assistant) in 2006. A poor quality of the image on PDA device, problems with data transfer without a fixed line, and remote access discouraged us from further testing.

In 2007, with an increasing number of acute neurosurgery consultations (around 400 per year) at the neurosurgical department in Zlín, after considering the technical and financial possibilities, and basing on the literature information [19], we tried to add a mobile phone to the consultation network.

In the study period, from September 2007 to September 2008, we verified in practice the advantages and disadvantages of this method of consultation. As compared to other methods, the quality and time of consultation remained

practically the same. The image was equally readable on the display of a mobile phone and on the workstation with the xVision browser.

We compared our method of consultation by means of a mobile phone with the experiences of Japanese authors [19] who took images with mobile phones and sent them as an MMS (Multimedia Messaging Service) message. With consultation of image documentation there is a risk of an incorrect selection of images either by a less experienced colleague or by a mediatory health-care employee. Our method eliminates this risk. The images are sent by the health-care staff but the staff is not responsible for the selection of images. There is a whole set of images sent to Web pages. The selection and evaluation is performed by the consulting physician after the images are downloaded to his/her mobile phone. This excludes any possibility of sending an improper image. The only disadvantage of our method of consultation, as compared to the evaluation directly on the screen of the workstation, may be a relatively small size of the image on the display of the mobile phone. It is less comfortable for the user, when compared to the size of the picture in the workstation.

## Conclusion

This method of consultation on image documentation (using mobile phones) appeared to meet the needs of acute neurosurgical consultations in our region. The transfer of images was successful. Every decision on patients' further therapy was adequate and comparable to the decision made on the basis of the data received from a monitor using the xVision browser. The transfer of images uses the standard telecommunication means from our daily practice. It turned out to facilitate the half-service work.

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