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CASE REPORT

Digitalization in Radiology – 6 years in the St. Elisabeth Oncology Institute

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Abstract: *Objectives:* To determine advantages and specific problems of film-free digital hospital focused on radiology department.
Background: In the St. Elisabeth Oncology Institute in Bratislava we have more than 6-year experience with digital modalities and the PACS system. During this period many difficulties occurred and are expected to rise with an increasing number of digital modalities.
Methods: Statistical evaluation of a 6-year period in numerous graphs and schemes.
Results: The amount of data can be seen in graphs, which show the amount of examinations and data volume from different modalities for specific time period to October 2007 and present volumes and increase of data amount in megabytes (MB) in the last 6 years.
Conclusion: Despite of systematic capacity increase it is a long-term archiving and economical problem. It is crucial to solve the daily amount of data, backup copies, type of archiving media, and priority of data accessibility *(Tab. 1, Fig. 5, Ref. 9).* Full Text (Free, PDF) *www.bmj.sk.*
Key words: digitalization, radiology, archiving, media.

At present, development of new imaging methods in radiology and increasing number of fully digitized modalities are one of the fastest improving fields. Digitalization brings many advantages and implementation of digitized systems in all hospitals is only a matter of time. The effectiveness of radiology is rapidly growing and the results can be accessed through computer not only by radiologist, but also by referring physician, almost immediately. The input costs are relatively high, but lead to the reduction of operating expenses due to exclusion of film material, chemicals, service and the cost of developing machine. The risk of film loss, absence of old documentation and difficult archiving are issues out of date.

The possibility to edit images is very valuable not only to the physician, but brings benefits also to the patients. The radiation dose is reduced by reduction of bad quality images. Additional changes in terms of zoom, contrast adjustment, brightness, rotation, different filters use and at last, but not least post-processing (i.e. 3D reconstructions) are options that were not available in past. Development of these technologies has brought a necessity for systems, capable of archiving and sorting such amount of data (1).

These systems, known as PACS (Picture Archiving and Communication Systems), are necessary for optimal management of many examinations from different modalities. PACS systems came into existence in 70's and 80's (2, 3). There are many different types nowadays, either independent or in fusion with HIS (Hospital information system) (4).

Due to many different modalities and archive systems, in 1983 the universal compatible standard ACR-NEMA (American College of Radiology a National Electrical Manufacturers Association) was developed, which was finalized ten years later in the DICOM standard (Digital Imaging and Communications in Medicine) and is updated from time to time (5, 6). Due to universal standard format and web-based characteristics, a question of sharing the images worldwide has arisen. That is the keystone of a new term "teleradiology" as a component of "telemedicine". The main attribute of teleradiology is the possibility of consulting the images with prominent specialists worldwide, evaluating them outside the workplace and sharing the experience through teaching files available on internet, too (7, 8, 9).

In the St. Elisabeth Oncology Institute in Bratislava we have more than 6-year experience with digital modalities and the PACS system. During this period many difficulties occurred and are expected to rise with an increasing number of digital modalities.

The hospital system reorganization started in 1996, when routine operations with the hospital information system PCS*CARE began. In the years 2001 and 2002 the PACS server was installed and in 2003 its capacity was expanded. Until now, many digital modalities such as computed tomography (CT), magnetic resonance (MR), positron emission tomography (PET), ultrasonography (USG), digital radiography (DR), radiofluoroscopy (RF) and mammography (MG) have been installed (Tab. 1). At present, there are actually 490 workstations, 15 servers and 650 users in the IT administration.

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Tab. 1. Average amount of data for specific modalities for one examination.

Modality	CT	MR	DR	RF	MG
Average (MB)	50–700 MB	60–100 MB	10–20 MB	20–40 MB	38–56 MB

Fig. 1. Radiofluoroscopy: amount of data in MB for period of time from June 2005 to October 2007.

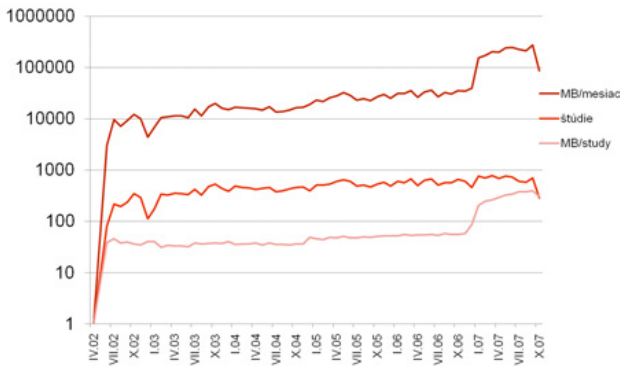

Fig. 2. Computed tomography: amount of data in MB for period of time from April 2002 to October 2007.

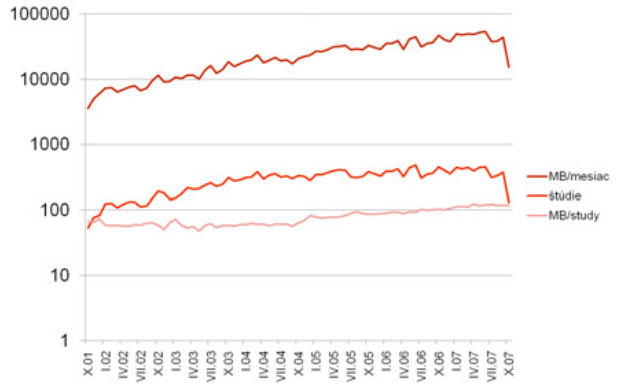

Fig. 3. Magnetic resonance: amount of data in MB for period of time from October 2001 to October 2007.

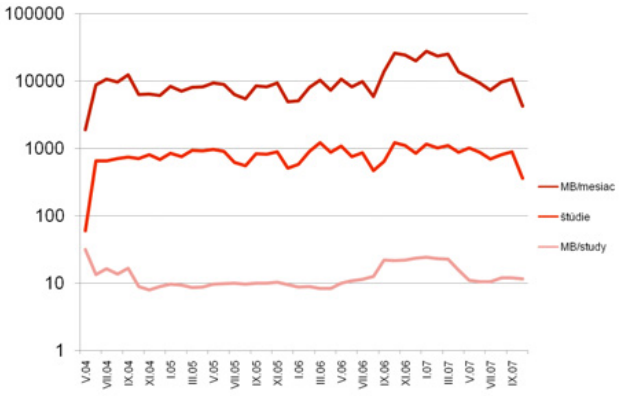

Fig. 4. Direct radiography: amount of data in MB for period of time from May 2004 to September 2007.

There are installed both NIS and PACS TomoCon® Viewer on each workstation. In practice it means, that the operator has the documentation and the images available at his disposal. A special diagnostic workstation serves for the evaluation of images, requiring a certificated diagnostic display.

Current film-free trend does not end within walls of one hospital. In foreign countries there are whole nets of medical institutions, communicating with each other. The transfer of text or image data is a matter of few minutes. The shipment via CD or via e-mail is only a temporary solution due to time and security reasons. In the beginning of 2008, the T3C system was installed in our hospital. This system allows sharing images documentation with other facilities, which are part of the system.

In Slovakia, no defined standard exists for sharing text and image between medical facilities. The HL7 system comes into consideration, which could be a valid standard for the whole European Union. As another add-on electronic patient records, the EHIC (Electronic Health Insurance Card) exists for payment between EU countries, that will contribute to patients comfort.

One of the most serious problems, related to the film-free hospital is data archiving. Nevertheless, archiving in digital form is relatively easy, without need to build special archives for older documentation. On the other side it is a serious hardware problem in long term. One practical solution seems to be the PACS as an archive system for all modalities. An average price for one patient and one modality is derived from the device price (price), administration (admin), number of patients (patient No) and number of devices (devicesNo) for one modality. Administration means operation costs, depreciations, staff costs, energy, consumption material and cost of PACS for a defined period of time (Scheme 1–3).

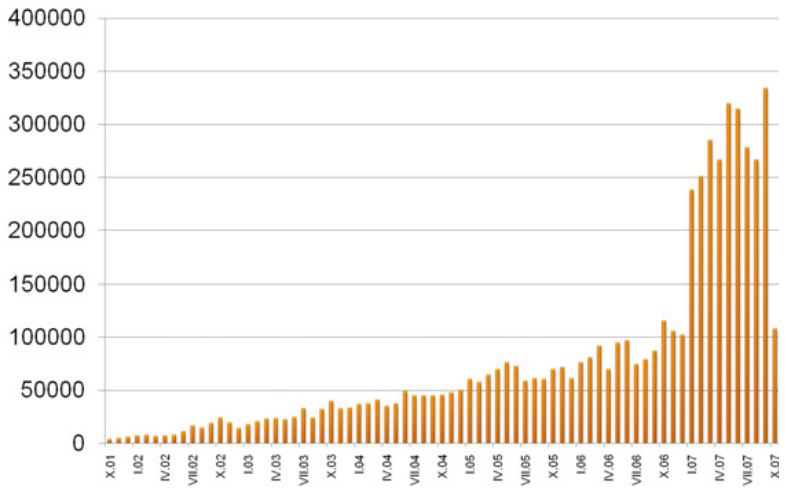

Fig. 5. All modalities: overall amount of data in MB for period of time from October 2001 to October 2007.

The Figures 1–4 show the amount of examinations and data volume from different modalities for specific time period to the October 2007. The disproportion in the number of examinations and server capacity load is clearly visible. Whereas fluoroscopy represents the volume load of approximately one DVD per quarter, CT even 5 DVD per day.

Figure 5 presents volumes and increase of data in megabytes (MB) in last 6 years. After implementation of MSCT modality in the beginning of 2007, there is at least double increase of archived data. Despite of systematic capacity increase it is a long-lasting archiving and economical problem. It is crucial to solve the daily amount of data, backup copies, type of archive media, and priority of data accessibility. Our institute currently works with disc capacity of 7 Terabytes (TB) for actual data archiving. There is also a "twin" server for replication of actual data in case of a system breakdown. Today, the daily production is archived on DVD media that serve just in case of total urgency (1300 media in a safe deposit). From the long-term view, this solution is not sustainable. Therefore, the hospital plans to buy a complex archive system.

Scheme No. 1

$$\frac{\sum_{i=1}^{n} \frac{price + admin}{patientNo}}{devicesNo}$$

Scheme No. 2

$$price\_MB = \frac{price\_pacs + admin}{capacity\_MB}$$

Scheme No. 3

$$examination\_cost = average\_data\_volume * price\_MB$$

A film-free hospital is a system, which increases the effectiveness of physicians, increases patients comfort and spares work and finances in a long term point of view. However, in our country this system brings problems, that were described above and their solution should be a part of transition from classic pictures to digital images.

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