Assessment of PACS (Picture Archiving Communication Systems): An Impact Analysis

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Abstract

In order to make rational decisions for further PACS-implementations in Viennese community hospitals a (neutral) assessment of the SMZO**-project was launched by the Viennese community hospital financing body. The aim of the technology assessment was to gather the experiences of the day-to-day practice, organizational aspects and hindrances to develop the full potential of the PACS installation. The study analyses the conditions for employment of digital radiology, gathers the experiences of national and international projects and presents a view on critical points, from which action options for further implementations can be derived. In the center of interest stood work organisation, handling and user attitudes, perceptions of radiologists and clinicians, realism of expectations regarding economic efficiency, technical aspects, influence on quality of medical care as well as tele-radiological aspects.

1. Introduction

The study performed in 1996 launched by the Vienna Hospital Cooperation (KAV) and the Ministry of Science (BMWWK) had the aim of analysing the conditions under which digital radiology can be used most effectively and their implications: before decisions were to be made about implementations at other community hospitals, daily routine experiences with the handling of PACS, organisational aspects as well as hindrances to develop the full potential of PACS installations had to be determined. In complementation to the participatory experiences at the Viennese hospital SMZO – which had worldwide one of the first full-scale PACS implementations - further information was gathered through visits of national (LBK-Wien, LKH-Steyr) and international (Hammersmith Skejby) PACS installations. Method: an interdisciplinary team of three researchers in the areas of sociology, economics and computer science stayed at the hospital SMZO for three months: participatory observation, expert-interviewing and data-collection were used as methods. An international literature analysis of 300 citations and expert interviews in other hospitals with PACS installations supplemented the collection of information.

2. Results

The study gives an overall view on critical points, from which options for action regarding further implementations are derived. In the following the essential points are listed in a compressed form.

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2.1. PACS Variants and Extensions

Viewing the different development options, in other words alternatives for implementing digital radiology (small scale, full-scale etc.), it is sensible to go the evolutionary way from the already digitized image procedures (CT, MRT, Angiography) via inclusion of the other modalities (digitizing the conventional apparatuses) to the radiology-internal networking. Since the greatest cost savings are in the area of film-costs, a parallel-running of analogous and digital radiology within one hospital must be avoided under all circumstances and full digitalisation of radiology must obtain priority. Confronted with this, the distribution of images has little priority. Nevertheless, whereever radiological images are definitely needed (neurology, neurosurgery, orthopedy, surgery, etc.) and the networking brings clinical advantages, it should be put into operation.

An essential prerequisite for exploiting the potentials of digital radiology is the question of interfaces. They have considerable influence both in technical and in work organisational areas. Technical problems in the interlink of different modalities as well as in the integration of various subsystems (PACS-RIS-HIS) hinder the potentials of PACS. A previous disadvantage of earlier installations - high integration expenditure of different modalities into one net - should be overcome by international standardisation. Special attention should be given to this point when making new investments. The important public purchasers in the area of medical technology are called to put pressure upon the producers to guarantee true DICOM capacity (instead of DICOM-dialects) and to help to achieve a break-through of “multi-vendor-philosophy". International groups such as ACR-NEMA and CEN/TC 251 appear not to be too far apart in the standardisation projects and to pursue parallel developments, which limit markets, require adjustments and maintain a high price level unnecessarily.

In view of ergonomy, acceptance by users and economic efficiency and also in view of the desired goal „electronic patient record“, integration to subsystems (PACS-RIS-HIS) should be given absolute priority. The necessary initial stages (for this) therefore, should receive early consideration in planning the system (digital radiology). Goal should not only be the provision of all necessary functions but the most complete integration of all functions into one working unit (workstation) under the same user surface.

For a functioning integration of HIS-RIS-PACS two fundamental principles must be observed when including a new software package into existing systems:

• the administration of patient data must take place in HIS
• the information flow between HIS and other systems must be steered by HIS (like pre-fetching functions)

Databank structure and data organisation: image data should always be stored and administrated separated from patients data. A centralized data bank can ensure consistence, availability and safety of all data, this makes also a hierarchically structured organisation of data and the control procedure possible. Through divided data banks data can be physically separated but consistently administered. If neither a central nor a divided data bank can be used, the integration between HIS-, RIS-,
and PACS data banks must be established through adjustable control mechanisms and be maintained for all system conditions.

### 2.2. Technical Functions Analysis

It is sensible when great PACS networks are not limited to one topology (bus, star, ring, tree). The employment of backbone technologies, such as FDDI or ATM, is one possibility of increasing the net-capacity. Although load-independent ATM-solutions are obtainable on the backbone up to 625 Mbit/sec, their employment is at present still a problem. Products of different manufacturers cannot be mixed into a common ATM-net, as there is no standardization of bridging between ATM and Ethernet. FDDI or ATM networks should be limited to the radiology department and those clinical areas, which have intensive communication with the radiology department and regularly draw large data amounts, they should be separated from the slow Ethernet networks, which can be used for netting the remaining areas of the hospital. The integration of HIS, RIS and PACS is a primary goal. Allocation from clinical areas should be made electronically.

A failure concept (with scenarios, organisational and technical controls, automatic mechanisms) and explicit as well as implicit measures for quality-guarantee (with functions for monitoring) should be developped and implemented.

The system must make reporting easier for radiologists and facilitate the flexible shaping of work procedure. The storage of individual settings and the access to data of other patients while dealing with one patient are work reliefs and should be made possible. Online help and tutorials, clear precise reports, administrative and image functions and working lists help to promote the acceptance of PACS. An adequate (automatic) pre-fetching function meeting the needs of radiologists has proved itself essential for an optimal working procedure. It is the pre-fetching function which relieves the radiologists from time-consuming search of old images. While the pre-fetching function can be implemented in the SW without great problems, it is the autorouting function which is conflicted with non-technical questions. Automatic pre-fetching autorouting can function successfully only under the condition that HIS and PACS as well as RIS and PACS have been integrated without problems (smoothly). In a system in which RIS resp. PACS are integrated into HIS, prefetching and autorouting are the responsibility of HIS.

The gain of speed and quality, which emerges in radiology departments, can be lost through slow computers in clinical areas with poor user-interfaces. At present new PACS-versions are in development, which run on Pcs. They are better suited for clinical areas use than the specific PACS-computers.

The maintenance of the PACS-system should be systematized and consistently performed in accordance with the organisational structure and the work output. Instead of being dependent on a general manufacturer or company, a system administrator is desirable who works company-independent in the interests of the hospital and who guides the development of the system in accordance with hospital management needs and priorities.
2.3. Work organisation

As with other technologicall developments, already existing tendencies (f.i. technology-oriented radiology, specialization of radiologists with simultaneously changing qualifications of RTAs, demand pressure by clinicians, efficiency and productivity controls) are supported and fostered by digital radiology, unless explicit countermeasures are introduced (f.i. control facilities to limit the demand and against dequalification of RTAs, explicit statement against productivity control). The shift of administrative and archiving work into the working area of radiologists is the must obvious change when introducing PACS into radiology. The functions automatic prefetching and autorouting are in this connection the most substantial work relief, without which the administrative and archiving work would require much (highly qualified) time of radiologists and would hinder the speeding potential of PACS. Essentially the introduction of PACS is concentrated upon radiologists. Without re-shifting of tasks a dequalification of RTAs can be foreseen. From a work-organizational point of view the solution of interface and capacity problems is a priority responsibility when integrating PACS to its „environment“. A poor RIS/HIS-docking creates an additional work load for the recipients, it causes delays in the transmission of reports and reduces the acceptance of PACS on the periphery.

The demand for radiological examinations is great. While the pressure of demanded sectional layer radiology examinations is combatted with the goal of imitation by requiring to call for an appointment in order to restrict indications, the demand for conventional X-rays is undiminished. Hopes of reducing the number of radiological images by cutting down on repeats have so far not been fulfilled: supplementary and follow-up images replace them. In the long run a control and indications, esp. of so-called routine images seems necessary.

The linking of image and report as a „radiological unit“ emphasizes the sovereignty of radiologists over primary reporting. The pressure of de-linking by clinicians is great. Internationally the primary reporting is increasingly taken over by the quality and speed of the result. A new-positioning of the standing of radiologists is - due to digital radiology - foreseeable. Technology appears to have launched a transformation process, whose outcome cannot really be foreseen: radiological images are (theoretically) available immediately after acquisition, the expectations of clinicians will increase regarding the speed of results. At the same time radiologists definitely have the possibility of living up to meeting these expectations and to establish themselves as highly qualified specialists and partners of clinicists. (Cit. Rad: from the Photographer to the Image Manager.)

2.4. Quality of Medical Care

Some expectations on the impact of PACS on the improvement of the quality of medical care prove to be true even when taking a close look at them (reduction of radiation doses, quality of reporting in view of post-processing possibilities, interdisciplinarity partly in training and in research, in documentation). For other factors (reduction of radiological services, decrease of time during which patients
have to wait or lengths-of-stay in hospital) the correlation with PACS is to some extent plausible, the proofs are still outstanding.

The reduction of radiation doses, made possible by digital radiology, speaks for a retrospective digitalisation of all, but at least of all x-ray apparatuses in pediatric-stations. Although the initially high expectations (up to 60%) of radiation dose reduction could not be fully met, it has established itself at a lower level (30%). The demand pressure for radiological images and inaccuracies in setting the radiation exposition for reasons of follow-up processing can counterbalance the potential of an individually lower radiation dose.

In Mammography the analogous/conventional way has been reinstated for reasons of handling the images.

The hospital-internal communication between medical departments and outpatient-stations is of great importance for the information flow and for the quality of medical care, as well as for reaction, resp. waiting and length of stay times. Digital radiology is in the context of speeding the information flow in a hospital only one medium which supports this flow.

2.5. Perception of Users

The perception of advantages and disadvantages of digital radiology and the patterns of use are greatly varying and depend upon the expectations aroused. While PACS-trained radiologists experience digital radiology primarily as a work relief, the expectations of medical specialists on the periphery are disappointed regarding the any-time availability of their patients’images (even without report). The positioning of the radiologist and his report-sovereignty is under question due to the facilities of digital radiology. A new positioning of radiology, which stresses the additional value of it is recommended to arouse „merely“ realistic expectations when introducing PACS. The access-rights to the images are matter of dispute in some hospitals (those with high competition between disciplines), others allow the „just-after-acquisition“ access of the clinicians to their patients’images.

The primary advantages of DR for medical departments on the periphery lie in the accelerated distribution of images and the possible image-view. The potential of PACS for accelerated image distribution and access has not been fully exploited due to the unsettled situation of access rights. The reliable transmission of daily quotas (all patients’ images of the day) is a minimum requirement.

2.6. Economic Assessment of PACS - Potentials and Expectations

Considerable saving potentials lie in avoiding film costs and the related costs for development and disposal. Reductions in personnell costs through a possible (but hardly achieveable) acceleration of the whole working process appears difficult to be carried over into reality. Evident are also cost reductions in space, although they cannot drop to zero as it is said in many calculations (storage of optical disks,
mammography, etc.). A connex between digital radiology and the reduction of length-of-stay in hospital could not be convincingly established.

Important appears to be the adjustment of digital radiology into the complete system of the hospital, which stresses again the special importance to the interface and integration problems. At present the necessary adjustment effort is great and should be minimized. The „greed“, the demand for radiological images grows, which means that it cannot be proved that in PACS equipped hospitals fewer radiological images are made than in hospitals with conventional practices. For this reason, the reduction of repeat images must be compared with the increase in supplementary control and follow-up images.

The intensified interdisciplinary communication is therefore desirable also from the economic view-point, radiologists should gain the right to share in decisions about demanded examinations in order to cut numbers and thus reduce the costs. An excellent aid in such determinations can be an efficient controlling which offers the actors an overview of the development of services and costs and promotes a better cost-awareness.

However, economic arguments alone, cannot be the crucial factor for a decision pro or contra digital radiology. A decision for digital radiology is only “a logic consequence“ and a step in the direction of a electronic patient record, which is still a vision and – at least in Austria – far from reality.

2.7. Data Security, Data Protection, Legal Aspects

Technology is context-dependent, data in the medical sphere are under all circumstances „sensitive“ and the costs for implementation of datasecurity-mechanisms are relatively small in relation to the potential damage. The increasing importance of data protection and data security must be specially emphasized in the context of telemedical application. New technologies continue spreading, new areas are being covered and should be appropriately secured. To alert users to a high data security consciousness seems of prime importance. The access protection should no longer be guaranteed by password alone. Chipcards are handler and present an economically justifiable development. In dataprocessing the employment of cryptographic methods for coding is also indispensable. Through the „electronic signature“ the legal binding of electronic documents (medical reports, case histories) can be guaranteed if relevant frame conditions are established.

2.8. Tele-Radiology in Austria

The most frequent application of tele-medicine happens in long distance reporting, the teleconsultation and the admini-strative/medical data exchange. The question of imminent treatment is of real relevance. From the patients view-point the quality of medical care stands in the foreground. When supportive telecommunication is used essential aspects of communication (non-verbal, direct-physical) are always lost. Since telesettings cannot be arranged without losses it must be determined case by case whether tel medical application is acceptable. For (tele-radiology) this can be
answered affirmately unless interventional methods are used. The simplest possible user surfaces must be aspired for ergonomic reasons and in view of the generally rare application. An important aspect in tele-medicine is the question of data protection and data security, unsatisfactorily solved in the present application.

From the economic point of view it could be shown with the help of the example Zwettl/Innsbruck (small regional hospital and big university hospital, 500 km apart) that tele-radiology via ISDN caused the least costs from all investigated variations. This on one hand generates the danger of starving out small hospitals from personnel. On the other hand tele-radiology can contribute towards the tendency of better medical care which points out the ambivalence of the development: advantages of teleradiology lie primarily in the regional context, where several small hospitals share the expertise of one (nearby) center.

In case of rarely necessary „2nd opinion“ the first question is one of costs for infrastructure and technical installations and the second is one of the daily routine practice of handling. Starting from the assumption that only in 1 to max. 5% of cases a 2nd opinion is actually needed (i.e. that it produces an additional diagnostic or therapeutic benefit, the handiness and the user-friendliness of telemedical systems has great importance. Only when the handling is very simple there will be no problems even in cases of rare use. The integration of local doctors depends apart from concrete interface problems upon the presently poor degree of computerisation of doctors’ practices in Austria.

Above all the questions of health policy and organization have not yet been solved. Questions of reimbursement and liability must be settled. A final assessment must therefore be left up to further studies.

Conclusions and Summary

• An expansion in stages which firstly provides for the inclusion and networking of all radiology-internal modalities, secondly for the linking (with possible image distribution) of clinics in priority rank appears to be most sensible from an economic and organisational point of view.

• The problem of interfaces (between PACS-RIS-HIS) must not be underrated both from economic and organisational view points. If it remains unconsidered it would cause additional energy and expenditure.

• Also in connection with the desired goal „electronic medical record“ the integration of subsystems must receive priority.

• There is great advantage in building up a hospital internal „know-how“ for the daily routine, which also means that the employment of a systemadministrator is advantageous to using company-dependent maintenance personnel.

• The PACS-facilitated availability of radiological images immediately upon acquisition and access rights are conflict areas in which reporting sovereignty and radiology services must be considered.
• Increased interdisciplinary communication is desireable from an economic point of view. However, the expected reduction of repeat images through PACS has not yet been achieved as they are replaced by supplementary and follow-up images. Control measures are recommended, radiologists should gain the right to share in decisions regarding demanded examinations.