PIOTR KSIĄŻEK, BARTŁOMIEJ DROP, MARZENA FURTAK,
EWA WARCHOŁ-SŁAWIŃSKA

Cyfrowy szpital. Jak się w nim odnaleźć?

Digital Hospitals. How to navigate them?

Streszczenie

Celem pracy jest próba wyjaśnienia i omówienia korzyści wprowadzenia nowych systemów informatycznych do szpitala, a zwłaszcza do pracowni diagnostycznych, oddziałów szpitalnych, przychodni przyszpitalnych, aptek szpitalnych, a także pokazania zalet wdrożenia systemów w funkcjonowaniu i pracy zakładu opieki zdrowotnej. Praca omawia podstawowe pojęcia związane z tak potrzebną w dzisiejszych czasach informatyzacją szpitali oraz wyjaśnia i opisuje podstawy funkcjonowania systemów informatycznych – ich poszczególnych modułów w obrębie całej jednostki ochrony zdrowia.

Początek tekstu przedstawia rys historyczny powstawania i wdrażania różnego rodzaju systemów cyfrowych w placówkach zdrowotnych na świecie, jak również w Polsce.

Kolejna część przybliża natomiast problemy, cele do osiągnięcia i zalety wdrożenia systemu IT w pracy zakładu opieki zdrowotnej. W tekście został również scharakteryzowany polski rynek zdrowia oraz dylematy, jakie dotykają tego właśnie sektora w momencie podjęcia przez dyrektorów ZOZ-ów decyzji o informatyzacji placówki.

Praca odpowiada również na szereg pytań, dlaczego informatyzować i w jakim celu? Opisuje pokrótce funkcjonowanie poszczególnych modułów zainstalowanych w szpitalu, począwszy do systemu szpitalnego HIS, radiologicznego RIS, archiwizacyjnego PACS, poprzez system laboratoryjny LIS, kończąc na systemie farmaceutycznym PIS.

W zakończeniu przedstawiono korzyści i efekty wdrożenia mobilnej informatyki medycznej. Tekst umożliwia znalezienie odpowiedzi, dlaczego właśnie wdrożenie systemu informatycznego i zastosowanie nowoczesnych technologii komputerowych w szpitalu ma tak ogromne znaczenie w całym procesie leczenia. Wyjaśnia, że właśnie dzięki temu zabiegowi pracownicy szpitala mają dostęp do wszystkich faktów medycznych pacjenta, możliwe staje się również przesyłanie informacji pomiędzy jednostkami ochrony zdrowia na terenie całego kraju, a nawet świata.

Słowa kluczowe: informatyzacja, system informatyczny, RIS, PACS, WEB, HIS, LIS, PIS, telemedycyna, teleradiologia.

Abstract

The purpose of this work is to explain and discuss the benefits of introducing new IT systems to hospitals, especially for diagnostic laboratories, hospital wards, hospital pharmacies, as well as to demonstrate the advantages of systems in operation and running of a health care facility. This article is a review of the basic concepts related to the much needed computer technology in hospitals nowadays; it explains and describes the basic functioning of information systems – their individual modules within the entire health care units.

The beginning of the text presents a historical outline of the formation and implementation of various digital systems in health institutions in the world, as well as in Poland.

The text also outlines the problems, aims to achieve appropriate solutions, and demonstrates the advantages and implementation of IT in healthcare facility operation. The text also describes the Polish medical market and the dilemmas of health care issues affecting this sector at the time when the hospital directors/managers make decision to introduce new technology to their hospitals.

This article also responds to various questions, for example why and how to computerize the facility. It briefly describes the operations of individual modules installed in the hospital, from the hospital system HIS, radiological RIS, archiving PACS, through the laboratory system LIS, ending with the pharmaceutical PIS.

The conclusion of this work shows the benefits and effects of the implementation of mobile medical informatics. The text allows to find answers why the system implementation and application of modern computer technology in the hospital is so important throughout the treatment process. It explains that due to this operation the hospital staff have access to all medical data of their patients, it becomes also possible to send information between health care units throughout the country and even the world, where the computer with the appropriately installed software has become an indispensable tool for collecting and processing information.

Key words: computerization, information system, RIS, PACS, WEB, HIS, LIS, PIS, telemedicine, teleradiology.

Department of Public Health, II Faculty of Medicine with English Division, Medical University of Lublin

INTRODUCTION

The turn of the twentieth and twenty-first centuries witnessed enormous changes in every area of human life. In view of this fact, modern technology which is growing rapidly has a significant impact on our daily functioning. Thus, a mobile phone, credit card, handheld computer and mobile internet become indispensable nowadays. The application of IT has become so standard that cannot miss the health sector either. The computer in the medical profession has become an essential tool and does not seem unusual. Medical informatics has become a basic element of the curriculum to be taught to all future doctors in medical universities in Poland. It happens very often that patients move between health care entities, and their medical records are transferred from one hospital to another. So then, how to organize effectively the circulation of medical information and ensure the safety of patients and their diseases? The answer is simple: computerization. It became a milestone in modern times that medical information systems allow for the effective implementation of social and health policy of the country. Without them, it is difficult today to create telemedicine systems which are intended to improve the effectiveness of treatment and quality of patient care. In addition to these benefits, there should also be mentioned the improvements of hospital management, reduction and control of medical expenses in connection with a limited number of them in the state budget.

AIM

The aim of this study has been to clarify and discuss the benefits of introducing new IT systems to the hospitals, and in particular, to diagnostic laboratories, hospital wards, hospital pharmacies, as well as the advantages of systems in operation and running of the Polish health care.

THE CONCEPT OF AN INFORMATION TECHNOLOGY SYSTEM

A modern fully digital hospital can be described as the meeting of a scientist and a doctor. A physician formulates his or her requirements, defines the functions, specifies what conditions should be fulfilled by the system which can be effectively used in his or her work. An informatics scientist prepares the software and devices in accordance with applicable law and current market demand. It is very important that the system should be adapted to the work of the hospital and the relevant functions should be created only for the individual medical place. Each health care facility uses different types of forms of internal and external reporting which can be implemented into the system. Then the employees referred to the facility pass a period of adaptation and introduction of new software easier, because some of the implemented elements are already known to them.

However, before the characteristics of the current systems working in a hospital, let us see how they developed over recent years in the world. First, the software was created in the 1970s called back then monolithic systems or isolated modules. In the monolithic systems all utility functions are implemented within a single system. The uniform application software was installed on one server and the then covered the needs of IT [1]. These systems are easy to write as well as allow for efficient management. Typically, they were designed by one software company. An important element that decided to eliminate these systems was a problem with the integration of the modules or external systems. Due to the closed architecture, the system does not allow other software to attach, and therefore, the entity that installed the software was exposed to the need of buying additional modules from one manufacturer.

The second group of systems is so-called previously mentioned isolated modules. They were not standing applications, whose main advantage was the ability of independent installation by the heads of the hospital organization without having IT policy unit [1]. The problem with their construction comes at a time when the data entered in one module is not accessible from another application.

In order to avoid monopoly in the 1980s the concept of open architecture systems for archiving and transmission of images was created, as well as complex systems (compassable systems) in the hospital system. The creation of such systems was a subject to rapid technological progress in the field of computer networks and transmission standards. The benefits they provide in modern information systems are mainly: the integrity of the modules supplied by different manufacturers and the opportunity to exchange each of them when they fail to meet the expectations of the individual. In addition, there is a possibility of full integration of data related to the circulation in the hospital. Those innovative systems are based on client-server technology that is easy to use and intuitive, accessible via a web browser.

PROBLEMS AND AIMS TO ACHIEVE IN IMPLEMENTATION OF IT SYSTEMS AT WORK OF A HEALTH CARE FACILITY

The implementation of advanced IT system that meets both the legal requirements and functional units unfortunately is not easy to make in Polish reality. The Polish health care today is characterized by:

- Problems with obtaining the financial resources needed for investment – most units are not able to give the amount of several hundred or thousand euros from their pocket, without even mentioning billions from their budget for the implementation of the new project. It almost always happens if the hospital wants any modern equipment the money comes from EU or credit
- Not complete technical background – very often it happens that the hospital does not have the right network infrastructure, and computers are several years old, and therefore, do not have the appropriate software and computing power that could be used in working on innovative systems
- Each implementation and use of modern technology becomes some kind of “mission impossible” that is hardly a feasible task
- Other specific requirements which can include:
  - Sterilization
  - Providing assistance 24 hours/7 days a week
  - Many individuals working in the several shifts.

The Polish health care sector also encounters the following problems associated with the management of medical care, including:

- Medical errors
- Too complicated administrative procedures
- Difficult relationship with the payer
- Compliance with regulations
- Threatened security of personal data
- Long queues and congestion in the system for the provision of medical services
- The low rating given to the quantity and quality of medical services among their customers
- Discomfort of the patients
- Lack of modern technological solutions, disability of using e-technologies by public medical services.

So why to computerize? The answer to this question in the era of vast amounts of information about the patient treated derived from diagnostic tests performed, applied therapy, chronic character of certain conditions, prolonged life of the patient, and the bureaucracy used in the treatments control while the hospital stays and pays for it, is IT effectively influencing:

- The increase in the quantity of generated digital data, which requires:
  - Storage for archiving systems and transmission of images (PACS – Picture Archiving and Communication System)
  - Processing of applications, diagnostic devices
  - Transmission via modern technology (telemedicine – teleradiology, telecardiology)
- Reporting, controlling – systems operating in the lab have in their construction number of forms to help the creation of reports, for example, both external and internal National Health Found report, such as the quantity of wasted materials during one day or a number of tests requested or performed by a specific physician
- Organization of work and productivity growth which is executed in less time and with less force
- The safety data collection in the hospital.

The computerization is also the objective that should be aimed at by each director of the institution implementing the system. The goals may be as follows:

- Improving patient care
- Increasing the maximum amount of medical data available individually and in sets – to obtain as much information about the patient and his or her treatment with a single click in the system
- Make medical decisions more effective
- Reducing the number of human errors
- Shortening the time to respond to medical situations
- Improving interoperability across the health care unit.

The advantages of a comprehensive (completed) information system at work throughout the hospital can include:

- Security and data integrity in the archive - stored data encryption, secure connections
- Modern and trouble free system for radiology RIS (Radiological Information System, a system of archiving PACS (Picture Archiving and Communication System) and the WEB distribution system, – managing the archiving, network traffic, documentation, images and text via a single interface, with support for one entity
- Modern and error-free hospital system HIS (Hospital Information System) fully integrated into the radiological one
- Many years of technical support and updates – to adjust the system to legal requirements and the National Health Found, and customer demand, Help desk – able to report and correct errors by phone
- Faster access to data – a quick transfer of research, on-line access from any location
- The possibility of development, management and integration – worklists, prefetching, autorouting, prioritizing research, a system of "open" – integration through standards IHE (keynote, common language specifying the effective methods of cooperation and information exchange between medical devices and systems from different manufacturers Integrating the Healthcare Enterprise), HL7 (standard electronic exchange of text messages through a network of medical data between systems servicing different areas of health care Helath Level Seven) and DICOM (Digital Imaging Standard and Communication in Medicine which is an essential element of the exchange of medical data between the imaging diagnostic equipment from various manufacturers).

THE EXPERIENCE OF POLISH HEALTH CARE SECTOR – RUM – THE REGISTER OF MEDICAL SERVICES

The previous experience with the implementation and running medical informatics in the Polish health care system dates back to 1999 when the health care reform was introduced. In the early 1090s, the World Bank gave Ministry of Health a loan for funding the process of computerization. The fund received by more than 500 health care units was equipped with infrastructure and hardware, and more than 300 offices implemented the two basic modules, i.e. the movement of patients and computed pharmacy. That innovative program was called RUM - Register of Medical Services and was sufficient to assess the costs in the Polish health care system. It also eliminated the abuse which is obviously associated with obtaining additional savings. It was also created due to the need for an information system for the management of health care. This system is a key element of health policy because of the potential impact on improving the health of the Polish community as well as improving the access to medical services. An indispensable element of the system is RUM books and District Medical Services Registries. This form consists of two parts:1 Fixed part, which records relatively solid medical facts, such as blood type, allergies, medications consistently, disability, 2 Parts with interchangeable coupons which record all contacts of patients and medical personnel, or contacts with institutions providing medical services. This part is also used for financial settlements. The data is stored on cards and marked as a unique identifier of the transaction. It consists of information about the insured person and chronologically increasing number of medical contacts undertaken. The implementation of the

system was not an easy task because it was only introduced piecemeal across the country [2].

A modified RUM system became a stimulus to create a system called START which was a pilot in Silesia. Sośnierz Andrew, then head of the NHF, has the first problems associated with the introduction of a fully computerized system. All health units included in this program are equipped with necessary technical equipment – computers, servers, electronic card readers, modems, software and recording medical transactions. Therefore, the traditional health books can be replaced by electronic patient cards, ATM cards reminding. In the modernized system access to all information in real time is possible as well as a quick way to estimate the demand for medical services available in the market. On plastic cards different types of patient information are recorded. Once it is scanned (read), for example, a doctor is informed that he or she wants to prescribe drugs that may interact with other drugs the patient is currently taking. In addition to these elements, the doctor knows what was happening to the patient before his or her appointment, as well as have up to date access to a database of drugs registered in Poland. All Silesians are equipped with this type of cards. The log in to the system occurs only in a hospital where all the information related to the visit or stay in hospital was recorded. Once a week the hospital sends reports of all medical events to the Silesian branch of the NHF. Later, plastic smart cards were also used in Dęblin, in the province of Lublin, and in Warsaw in the hospital in the South Prague district. The experience with the START system which has been used by our country is preparing to introduce a system of RUM II – Polish ePresciption pilot project [2].

HIS, RIS/PACS, LIS AND PIS SYSTEMS AT WORK OF THE HOSPITAL

A Digital Hospital is integrated with each module, the central and peripheral systems. In the first (central) group includes hospital system – HIS (Hospital Information System) which consists of elements such as traffic unit patients hospitalized patients, the module movement ill patients ambulatory medical unit orders, the system of the clinician, together with an access to the electronic patient record (EPR – Electronic Patient Record).

The second group (peripheral) includes systems that support the individual studios. These include radiology system with system backup RIS – Radiological Information System and PACS – Picture Archiving and Communication System, a system of laboratory LIS – Laboratory Information System and pharmaceutical PIS – Pharmacy Information System.

The HIS system with its constituent parts allows for extended support of patient movement, since the patient's registration in the ER until discharge. During the registration the system records demographic and administrative information about the doctor in charge and management body of the payer and the immediate family. The patient is given a unique ID number together with the number of the ledger and documentation [1].

The RIS is a system for dealing with the processing and record management in the Diagnostic Laboratory which includes patient demographic data, descriptions of imaging tests, referrals, reports, internal and external consultations, schedules of research and many others. The system is responsible for the efficient organization of work in laboratories and data analysis for the NHF, and external entities. Its primary task is to support the patient and the imaging of diagnostic procedures. It is a separate module that operates independently in the absence of a hospital system or fully integrated with the unit.

The PACS system is a system with the basic functions to store, manage, and provide users with imaging data in DICOM 3.0. through communication with the radiology information system (RIS) and hospital information systems (HIS) to ensure efficient flow of information and good organization of work in the studio.

Its basic features can include:

- The technique of lossless data compression. It is a technology that enables multiple increase in the capacity of the archive held by compressing the data stored without affecting the access time to images
- Autorouting i.e. transmission of image data based on predefined conditions on the diagnostic stations, local servers
- Prefetching, which allows cascading of the advance search of available archives for earlier imaging data for planning the next visit of the patient [3].

LIS – Laboratory Information System, its functions include the processing of orders, the combination of the medical device to a computer system and the management of the laboratory work. Among the fundamental tasks of data management should be canvassing the results of tests by connecting the analyzer to a computer system, backup, verification and distribution of results, monitoring quality control, documentation of procedures performed [4].

The final system is streamlining the work of the hospital is pharmaceutical system – PIS. The Pharmacy Information System supports the core activities of the hospital pharmacy, which is the electoral registration and verification of drugs, distribution of medicines in the hospital and participation in monitoring the patient's drug therapy [5].

The benefits and effects of medical informatics

In conclusion, the integrated digital hospital is:

- Digital acquisition of information – automated monitoring, codes, CPOE – computerized physician order, biometrics, digital imaging studies
- Digital presentation of information – desktops, tablet PCs, PDAs, laptops, available in any place and time, shown particularly in the clinical aspect
- Digital medical records – the advanced integration of different sources of information, comprehensive records of multimedia – a safe, portable and available on-line and off-line.

The benefits of digital health records, both textual and pictorial are:

- Access to the different sections of statistical data and data generated in the hospital
- Reducing the costs of operation
- Improving quality and productivity at work
- The elimination of errors during processing and data entry of patients.

- Ability to run telemedicine services – such as teleradiology
- A complete electronic circuit diagnostic information
- Standardize the issuing of results, diagnostic procedures, descriptions of research – meeting the requirements of ISO.

The effects that can be achieved while using a fully integrated medical informatics will provide data from the U.S.A. which are, as follows:

- Optimal management of beds increased by about 40%
- The average length of stay decreased by an average of 10%
- Billing errors fell within the range of 5-20%
- Times are acceptable, discharge and transfer of patients has fallen by as much as 85%.

DISCUSSION, SUMMARY AND CONCLUSION

For each physician the ultimate goal to achieve is a very good state of health of the patient he or she takes care of. Therefore, nowadays, physicians must be up to date with innovations in his or her field. They must be able to associate the right facts accurately, quickly diagnose and immediately take steps to efficient therapeutic effect. A Polish patient has a chance of even faster diagnosis because of the modern information systems that provide just such opportunities. Every day around the world, health care facilities generate millions of patient data. They are not only alphanumeric data in the form of laboratory tests, descriptions, images from radiology, printouts of the ECG and ultrasound, but also the image data is derived from diagnostic equipment. Due to the fact that patients are not always treated in a single facility, the health data is scattered in different places. That is why the system implementation and application of modern computer technology in the hospital is so important throughout the treatment process. Because of this operation the hospital staff have access to all medical information; it becomes possible to also send information between health units throughout the country, and even the world. In view of the fact that today's health sector is a very complicated system, the information generated by it mentioned at the beginning of this text is very important. It becomes a crucial, overriding factor in decision-making regarding further treatment, hospitalization and improvement of the quality of services provided. A computer with a monitor and with the proper software on it is now a basic tool to collect and process all information.

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Informacje o Autorach
Prof. dr hab. n. med. Piotr Książek – kierownik; mgr Bartłomiej Drop – asystent; dr n.med. Marzena Furtak – asystent; dr n.med. Ewa Warchoł-Sławińska – adiunkt, Katedra I Zakład Zdrowia Publicznego, II Wydział Lekarski z Oddziałem Anglojęzycznym, Uniwersytet Medyczny w Lublinie.

Adres do korespondencji
Bartłomiej Drop
Katedra i Zakład Zdrowia Publicznego
Uniwersytetu Medycznego w Lublinie
ul. Chodźki 1, 20-093 Lublin
tel. 081 742 37 54