

# Health Information Systems: Background and Trends of Development Worldwide and in Russia

Elena Vaganova<sup>1,2</sup>, Tatiana Ishchuk<sup>1</sup>, Anatoly Zemtsov<sup>1</sup> and Dmitry Zhdanov<sup>1,2</sup>

<sup>1</sup>National Research Tomsk State University, 36, Lenin Ave., Tomsk, Russia

<sup>2</sup>Diagnostika + LLC, of.47, 8, Razvitiya Ave., Tomsk, Russia

**Keywords:** Medical Informatics, Health Information Systems (HIS), Special Aspects of Development, Opportunities and Challenges, Trends.

**Abstract:** The paper is to study the background, opportunities, challenges, and trends of development of health information systems in Russia and worldwide. There are two main types of HIS: electronic medical records and clinical decision support. The key areas of their application include patient management, clinical management, diagnostics and treatment, research and education. The development of economic efficiency of HIS is considered to be one of the future research field in medical informatics.

## 1 INTRODUCTION

Health information systems (HIS) belong to IT-industry, which contributes to the global economy providing jobs for IT-specialists and increasing tax revenues from the activities related. The development of medical engineering and technologies in general and HIS in particular is related to changes in the needs of health care industry including steady increase of knowledge in medical field, complexity of the examination, diagnostic, and treatment methods.

## 2 BACKGROUND OF THE DEVELOPMENT OF HEALTH INFORMATION SYSTEMS

Medical informatics as a discipline is still young, in particular when compared with other medical disciplines. However, approaches to the data processing in medicine and health care have over 50 years of history.

A historical analysis shows major milestones of the development of global medical informatics and HIS:

1959, Robert Ledley and Lee B. Lusted published a widely read paper on diagnostic decision-making appeared in *Science*, in which the authors expressed hope that by using computers,

much of physicians' work would become automated and that many human errors could therefore be avoided.

1965 – one of the first clinically-oriented health care Information Systems Technicon Medical Information System was developed as a collaborative project between Lockheed and El Camino Hospital in California.

1967 – Health Evaluation through Logical Processing (HELP) was the first hospital information system to integrate clinical data accumulation and clinical decision support.

1967 – International Medical Informatics Association (IMIA) was established. It has close ties with the World Health Organization (WHO) as a Non Government Organization, and with the International Federation of Health Information Management (IFHIMA).

1968 – Computer STored Ambulatory Record (COSTAR), an electronic medical record, was developed by the Laboratory of Computer Science at Massachusetts General Hospital between for Harvard Community Health Plan by Octo Barnett and Jerome Grossman.

1960s – first hospital information systems were first introduced. The staff used them primarily for managing billing and hospital inventory. Major work on: signal analysis, laboratory applications, modeling and simulation of some biological processes, databases; first attempts on decision support (diagnosis).

1973 - in the Netherlands at the Free University in Amsterdam the department of Medical Informatics started under the chairmanship of Jan van Bommel.

1974 - the department of Medical Cybernetics and Informatics was established in the Soviet Union, headed by S.A. Gasparyan.

1976 - The Problem-Oriented Medical Information System, or PROMIS, was designed for maintaining health care records at the University of Vermont by Jan Schultz and Dr. Lawrence Weed, M.D.

1980 - Edward H. Shortliffe founded one of the earliest formal degree programs in biomedical informatics at Stanford University, emphasizing a rigorous and experimentalist approach.

1986 - European Society for Artificial Intelligence in Medicine (AIME) was established.

1970s - 1980s - a shift from a paper-based to computer-based records system; founding most national and international organizations, conferences; attempts to systematize major areas of medical informatics; first specialized schools and courses; principles of clinical and hospital information systems, security and medical data protection; advanced decision support systems – expert systems.

1990s–2000s - medical Informatics consolidates its position as an independent discipline and is mandatory in most medical schools; hospital information systems are implemented in some hospitals, mainly for management; first e-health and telemedicine research; notable progress in data bases, medical imaging; more visible importance and complexity of electronic health record (HER), including confidentiality, data protection, standards etc.

2000 – 2010 - clearer understanding of e-health potential as a specialized industry and business; hidden gaps and difficulties in real implementation: integration and interoperability, modest rate of user acceptance, quality assessment. Clear contour of sub disciplines: bioinformatics, neuroinformatics etc.

### 3 KEY CONCEPTS OF HEALTH INFORMATION SYSTEMS

In recent decades medicine and health care have changed significantly. Major companies (IBM, Cisco, Microsoft, AGFA, GE et al.) are involved in the development of hardware and software solutions

for health care. Special attention is paid to standards of digital medicine, HIS and their components. For Russian conditions (a lot of remote parts of the country) implementation of e-health programs including telemedicine systems, networks and data banks is of great current interest.

Intended use and functional options of HIS depend on the territorial level of health care, as well as the special features of a particular health care organization. The main objectives of HIS usage are enhancement of efficiency of treatment (reducing of medical errors), and optimization of diagnosis and treatment expenses including health and clinical management and patient records. The most urgent and challenging task is considered to develop computer-based medical decision-support.

Healthcare information systems, health information systems and hospital information systems are often used today to refer to the same concept. A series of terms such as *computerized patient records*, *electronic medical records*, and *electronic health records*, have been mentioned in scientific papers in the evolution of this phenomenon from its early foundations in the 1960s. They are commonly used almost interchangeably.

Thus there are two main types of HIS: *electronic medical records (EMR)* и *clinical decision support (CDS)*.

Electronic medical records maintain patient information and physician notes in a computerized data base. Electronic records allow the provider to track the patient's health over time, read the input of other consulting physicians, or recall his own clinical assessment from a previous day or hospital visit. Clinical decision support provides timely reminders and suggestions to medical practitioners. Decision support may recommend screening tests based on a patient's age and medical conditions, and drug allergy information. Electronic medical records and clinical decision support systems together form the backbone of the hospital information system.

The main application fields and functions of HIS consist of:

*Patient management* (patient registry, scheduling of appointments, admittance and bed control; emergency care; in-patient/out-patient system);

*Clinical management* (hospital releases; medical reports, electronic prescriptions; surgery appointments);

*Diagnostics and treatment* (lab exams);

*Supplies management* (stockroom; ordering of supplies; pharmacy; current assets);

*Financial management* (accounts payable and receivable; banking control);

*Support services* (hospital infection controls; assets maintenance; vaccine control);

*Research and education* (library; convention center scheduling, recruiting and personnel).

## 4 SPECIAL ASPECTS OF THE DEVELOPMENT OF HEALTH INFORMATION SYSTEMS

HIS is a set of software, hardware, and data for automation of health care processes in medical institutions health and recreation resorts. Besides the above mentioned main application fields and functions a corporate HIS carries out the following tasks:

- maintaining of common information space, intended for immediate access to data;
- improvement of the quality of medical records;
- control of health care quality and reduction of medical errors;
- increasing transparency of a medical institutions;
- constant analysis of economic aspects of health care;
- reduction of time of examination and treatment.

The developers of health information systems have to deal with a constantly changing subject area. The most important sources of these changes are:

- development of social and economic spheres;
- development of medical science;
- the influence of information technologies on patients' behavior (they become more informed) and health management in general.

Unlike most industries, in medicine there are three sides of financial and economic relations: the party that receives services (patient), the party that provides services (medical organization), and the party who pays for services (patient, insurance company, government).

Another special feature of health information which must be always considered is *privacy*.

## 5 OPPORTUNITIES AND CHALLENGES OF HEALTH INFORMATION SYSTEMS

### 5.1 Opportunities

*Economic and administrative efficiency of a hospital:*

- cost savings due to reducing of paper work and errors in billing;
  - cost savings on medication due to instant access to comparison of drugs consumed);
  - cost savings on laboratory studies (due to access to comparison of total annual costs of laboratories);
  - standardization of hospital administration;
  - improvement of management decisions due to an integrated information system;
  - access to a more complete, accurate and structured documentation of clinical data;
  - automatic sorting of data;
  - direct access to instant updates, including remote access to a patient's medical history;
  - reduction in medical errors due to more accurate data entry;
  - continuous remote monitoring of patients;
  - access to analysis and interpretation of data that can be used for the study of diseases and preventive measures in clinical practice.
- Improvement of patient care quality:*
- access to patient data from other hospitals;
  - simplification of administrative procedures;
  - processing of medical records and quick results.

*Remote data processing and transmission - cloud technologies.*

### 5.2 Challenges

The development of HIS is a complex socio-technical process, characterized by a *high level of uncertainty*.

*Different needs* of practical health care representatives (regional authorities, chief physicians, doctors, nurses etc.).

*State medical institutions* which purchase devices and equipment have to adhere to very serious *limitations*.

*Long-term implementation* of HIS in the context of constantly changing healthcare conditions and obligations of staff.

*My baby syndrome*: most of the innovation products in the field of healthcare are promoted by developers who are too confident in their project. They may not be able to abandon their project, ignoring its economic efficiency.

*Implementation* of information technologies is *time-consuming*. It is impossible to immediately estimate the efficiency of a freshly introduced HIS. Users need to get used to new tools and new opportunities provided by software or hardware modifications. The value and applicability a particular HIS are constantly changing due to different economic and management reasons.

Each HIS is to some extent unique. Some information technologies may be similar in various aspects, but the functionality may be different.

The success / failure of a HIS depends on compatibility between the developed device and existing realities of current medical institutions.

Two key stakeholders of HIS development, developers and users, may have different versions of a reality. Developers see HIS exclusively from its technical feasibility.

Hospitals are concerned about the costs, payback period, and even the interests of external stakeholders, e.g. the government.

Creation of large regional and national health information systems for the exchange of data regarding patients and specialized medical centers is one of the key directions in health IT. The problem of such projects is they often *do not involve actual participants of the process*. Obtaining and sharing medical data stored in isolated systems require a carefully specified product developed by professionals. At the same time, different regions and countries apply *very different requirements to such complex systems*. The product must have easily and quickly adaptable to these demands and provide additional developmental options.

## 6 FACTORS OF THE DEVELOPMENT OF HEALTH INFORMATION SYSTEMS

The main *aspects* of the development of medical informatics in general are progress in information and communication technologies (including data processing methods), improvement of public healthcare, and constant changes in the needs, requirements and expectations of the society.

In Russia and worldwide there are *factors* which are more likely to influence the development and

implementation of health information systems at local and regional levels.

The *state policy* in the field of IT-based management is one of them. In this regard attention must be paid to the problem of *different levels of knowledge in the field of information technologies*. Computer literacy of medical professionals, software and hardware, unification and standardization of primary data, methods of processing and transmission, the possibility of treatment in remote data centers (cloud architecture), data availability for physicians and patients are required.

The worldwide popularization of *cloud computing* and gradual integration of health information systems in *web-applications and mobile devices*, requiring support of international standards, must be noted as another impact factor.

Financial capacity of healthcare institutions directly affects the future of HIS. No matter what potentially interesting and attractive ideas and opportunities are offered in the industry, available financing of each health facility in particular and a region in general must be properly assessed. The costs of the proposed solutions and possible financial support must be considered. Thus, another *important factor* of the development of HIS is the *cost - efficiency ratio* of information technologies.

## 7 CONCLUSIONS: TRENDS OF THE DEVELOPMENT OF HIS

The globalization of IT business is one of the main tendencies. At present, any person (or company) is a potential data consumer. Therefore, even considering tough competition of major manufacturers, the possibilities of IT market are still boundless. The main market players include producers from the US, Japan, France, Britain and Germany, South Korea, Taiwan, Singapore and others.

Implementation of software products in medical institutions for clinical examination and treatment includes mobile networks, virtualization technologies, and telemedicine systems which provide medical professionals with a fast and secure access to necessary data.

The main trends of the decade 2010 – 2020 include: big data approach; cloud computing; social networks on health; certification of educational programs in medical informatics; full interoperability - communication, devices, semantic interoperability; integration of molecular & genetic

data; patient empowerment, involvement of Personal medical record; further steps towards *personalized medicine*, increase of patient safety, reduction of medical accidents and errors; improvement of preventive medicine and reduction of curative medicine; use of portable/wearable devices for monitoring, prediction & prevention; deployment of home monitoring systems and tele-assistance; deeper penetration of IT tools in medical research (modeling & simulation, digital patient etc); advanced decision support systems.

At present in Russia Medical Cybernetics is a full-blown health care specialty. Education is provided by the Siberian State Medical University, Penza State University and the Voyno-Yasenetsky Krasnoyarsk State Medical University, in addition to the education provided by the Pirogov Russian National Research Medical University. In 2000 the Russian Ministry of Health approved a program for this discipline, prepared by the Second Pirogov Moscow Medical Institute.

In Russia, one of the key trends is creation of a united national electronic information system including telemedicine, providing a hot link between medical organizations of various levels aimed at remote consultations of physicians. Distance learning courses and continuous educational programs for health care workers are to be developed.

In recent years, in Russia a growing number of health information systems for automation of health care institutions have been developed and implemented. Russia is a comparatively young participant in the market discovering the achievements of health informatics, reproduction and restoration of human resources on the basis of new technologies.

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