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PATIENT ELECTRONIC MEDICAL RECORD – THE IMPORTANCE OF PROPER IMPLEMENTATION ASSESSMENT

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Digital technologies offer the potential to transform health care. Electronic Medical Record (EMR) is used to make paperless computerized patient data in order to increase efficiency of hospital systems and reduce chances of human errors. Its level of implementation is usually assessed using an EMR Adoption Model (EMRAM)
Keywords: *Electronic Medical Record, digital healthcare, hospital information systems, medical informatics, eHealth*

Цифрові технології пропонують потенціал для перетворення охорони здоров'я. Електронна медична карта (EMR) використовується для створення безпаперових комп'ютеризованих даних пацієнта з метою підвищення ефективності лікарняних систем і зменшити шанси людських помилок. Її рівень реалізації, як правило, оцінюється за допомогою моделі адаптації EMR (EMRAM)
Ключові слова: *електронна медична карта, цифрова охорона здоров'я, інформаційні системи лікарень, медична інформатика, електронна охорона здоров'я*

1. Introduction

Since the 1990 we have witnessed a substantial development in the field of telemedicine and eHealth. Technologies that support (i) storing, managing, and transmission of data; (ii) clinical decision making; and (iii) health services from a distance have become an important part of many health care systems, especially in Western societies.

Electronic medical record (EMR) or electronic health record (EHR) are among the most important components of eHealth. Although both terms are often used interchangeably, on legal grounds they have a different meaning. EMRs are defined as patient treatment records, including a patient's background information and history of patient care, that maintained within a hospital or an outpatient clinic. On the other hand, EHRs are all patient health records, include clinical data and

information from multiple sources that are maintained outside of a single hospital or clinic.

EMR has been designed as a tool for paperless collection, use and storage of patient information in order to improve communication among healthcare providers within and between organizations, decision makers and patients. It is intended to improve the quality and efficiency of patient care, reduce the risk of medical errors and minimize healthcare delivery costs. However, the adoption of EMR can be challenging for all involved parties and does not guarantee *per se* all those expected benefits [1].

The aim of this paper is to review the process of implementation of EMR with special emphasis on tools for assessing the level of implementation.

2. Implementation of Electronic medical record

Large-scale expenditure on eHealth is usually justified on the grounds that electronic health records (EHRs), picture archiving and communication systems (PACS), electronic prescribing (ePrescribing) and associated computerized provider order entry systems (CPOE) and computerized decision support systems (CDSSs) will help to minimize the problem of uneven quality and improve safety of health services. Unfortunately, the amount high-quality evidence is still not sufficient and it often fails to prove that eHealth solutions are superior over conventional services in terms of effectiveness [2–6]. Noteworthy, a systematic review of 53 systematic reviews published between 1997 and 2010 revealed a marked discrepancy between postulated effectiveness and empirically demonstrated benefits [2].

However, is seems justified to assume that adoption of EMR may bring small but significant clinical benefit. In Japan it reduced the time required to access previous patient information and share patient information, but it did not affect the time required to produce medical records and the overall time for each medical care [7]. Moreover, the introduction of a basic EMR in USA resulted in small but significant reduction of length of stay and 30-day mortality with no effect on inpatient mortality [8].

EMR may include mobile solutions for both patients and healthcare professionals [9]. It may also facilitate conduction multicenter registries that monitor the quality of care or provide aggregated data for comparative effectiveness research [10]. Besides, data from EMR can be used to increase the efficiency of patient recruitment for clinical trials. However, such functionality is not yet available in commercial systems [10, 11].

Among issues relevant for the adoption of EMR/EHR for everyday clinical practice, system usability is considered to be of major importance. It is followed by functionality, speed, support for hardware and software, required learning time, typing proficiency, understanding of the EMR system as a whole, motivation and user-developed strategies [12]. Especially customization and the possibility of adding new functionalities later on [13].

It is also extremely difficult to reliably compare different products in terms of usability, as it very much depends on the socio-technical setting of the healthcare system or even particular institution. In the same time, the software is developed to meet the needs of a broad spectrum of different user types who have different requirements, work across geographic, temporal, organizational and cultural boundaries [12].

There is also a problem of communication between systems provided by different manufacturers, as data sharing is often difficult and require additional proprietary solutions [14, 15].

3. Worldwide Electronic Medical Records Market

The worldwide market of EMRs is estimated to be worth more than $20 billion and continues to grow. The emerging markets are considered to have the highest potential for implementation of innovative technologies. Therefore they are expected to become a primary growth driver globally. Emerging markets may even leapfrog more developed nations in terms of adoption and usage of EMR, as they may avoid wasting resources on suboptimal technologies that had already been implemented elsewhere. However, the future of these markets will largely depend on regulatory standards and government long-term policy [16].

4. European Electronic medical record Adoption Model (EMRAM)

From the perspective of policy makers, it is important possess tolls for objective assessment whether and to what extent particular units managed to implement certain policy. EMRAM is a well-recognized maturation model for evaluation of current EMR capabilities. Although it was originally designed by HIMSS Analytics for the USA setting, after slight modifications it proved applicable in other countries. EMRAM may serve not only as a benchmark, but also support local decision makers from individual hospitals in optimizing further implementation strategy.

The model identifies eight non-overlapping stages, ranging from zero (a predominantly paper environment) to seven (an advanced, predominantly paperless environment). Stages of maturation can be achieved only consecutively. It means that to reach a certain level of EMR implementation, requirements of all lower levels must be also met [17].

Table 1

Electronic Medical Record Adoption Model [18]

Stage	Cumulative Capabilities
Stage 7	Complete paperless environment with data warehousing, business continuity plan, health information exchange, data and system governance and medical devices integrated with the EMR. Data continuity with the Emergency Department and outpatient clinics.
Stage 6	Physician documentation, full Clinical Decision Support System (CDSS, structured templates related to clinical protocols trigger variance and compliance alerts) and Closed loop medication administration.
Stage 5	Full complement of Picture Archiving and Communication System (PACS) displaces via intranet all film-based images.
Stage 4	Computerized Practitioner Order Entry (CPOE) in at least one clinical service area and/or for medication (i.e. e-Prescribing); may have CDS based on clinical protocols.
Stage 3	Nursing/clinical documentation (e.g. vital signs, flow sheets, care plan charting); may have CDS for error checking during order entry (i.e. drug/drug, drug/food) and/or PACS available outside Radiology department.
Stage 2	Clinical Data Repository (CDR) / Electronic Patient Record; may have Controlled Medical Vocabulary, CDS for rudimentary conflict checking. Document Imaging and health information exchange (HIE) capability.
Stage 1	Ancillaries – Laboratory, Radiology, Pharmacy – all installed OR processing Laboratory Information System (LIS), Radiology Information System (RIS), Public Health Information System (PHIS) data output online from external service providers.
Stage 0	All key ancillary department systems (LIS, RIS, PHIS) not installed OR not processing Laboratory, Pharmacy and Radiology data output online from external service providers.

Stage 6 hospitals are considered to have established clear goals for improving safety, minimizing errors, and prioritizing IT. Stage 7 shows that the hospital no longer uses paper charts to deliver and manage patient care but it has a mixture of discrete data, documents images and medical images within its EMR environment. Clinical data warehouses are being used to analyze patterns of clinical data to improve quality of care and patient safety, as well as to feed outcomes reports and business intelligence. The hospital demonstrates data continuity for all hospital services, and clinical information can be shared via standardized electronics transactions with all entities authorized to treat the patient or receive particular health-related information. Therefore, reaching stage 7 means that the hospital has achieved the ultimate capabilities of electronic data management, which should improve performance, quality of care and patient safety. However, the EMRAM model does not measure how effectively these hospitals are using the EMR applications to improve care delivery [19].

In order to obtain the Stage 7 certificate, hospitals must first participate in the HIMSS Europe Annual Study that collects detailed HIT data and tracks the implementation and adoption of EMR applications through each stage of the EMRAM. Validation of Stage 6 achievements is completed with a phone interview but the final evaluation of Stage 7 status is done in the course of the on-site visit [20].

5. The level of Electronic medical record adoption in the United States and Europe

The first EMRAM profile of US hospitals was released in 2006. At that time over 20 % of evaluated hospitals were below Stage 1 and almost none of them reached Stage 5 or above (Table 2). The impact of the US federal government's involvement in the EMR industry in year 2009 resulted in steady reduction of hospitals in low (0–2) EMR capability stages [17]. Nonetheless, the proportion of Stage 7 hospitals remains marginal (Table 2).

Table 2

Changes of EMRAM distribution in US hospitals from 2006 to 2012 [17]

EMRAM	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Stage 0	20,4 %	19,3 %	15,6 %	11,5 %	10,1 %	9,0 %	8,4 %
Stage 1	17,4 %	14,0 %	11,5 %	7,2 %	7,1 %	5,7 %	4,3 %
Stage 2	40,0 %	37,2 %	31,4 %	16,9 %	14,6 %	12,4 %	10,7 %
Stage 3	18,7 %	25,1 %	35,7 %	50,9 %	49,0 %	44,9 %	38,3 %
Stage 4	3,1 %	2,2 %	2,5 %	7,4 %	10,5 %	13,2 %	14,2 %
Stage 5	0,5 %	1,4 %	2,5 %	3,8 %	4,5 %	8,4 %	14,0 %
Stage 6	0,1 %	0,8 %	0,5 %	1,6 %	3,2 %	5,2 %	8,2 %
Stage 7	0,0 %	0,0 %	0,3 %	0,7 %	1,0 %	1,2 %	1,9 %

European EMRAM data from the third quarter of 2013 show marked differences between particular countries and the distribution of implementation levels observed in USA (Fig. 1).

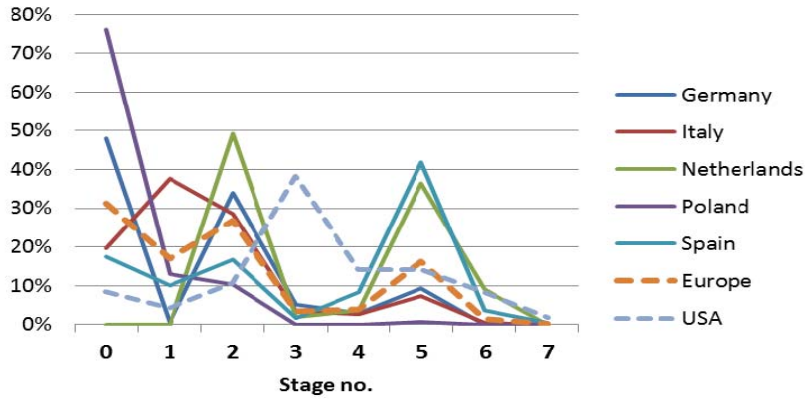

Fig. 1. Comparison of EMRAM in selected European countries and USA (own modification of source data from HIMSS Analytics, December 2014 and [17])

The highest level of EMR implementation in the Netherlands, which is also not a surprise. Poland, as a country that transformed from socialist-style planned economy into a market economy in the early 1990s and joined the European Union in 2004, is far behind Western Europe, as expected. However, almost 50 % of German hospitals have still not reached Stage 1 (Table 3). In the same time, the mean EMRAM stage value for Turkey almost matches the mean value for Switzerland (Fig. 2). It indirectly proves that gross domestic product may play an important role in implementation of EMR but it is not enough to assure that the implementation will be carried out fast.

Table 3

EMRAM across Europe in year 2013 (own modification of source data from HIMSS Analytics, December 2014)

EMRAM	Germany	Italy	Netherlands	Poland	Spain	Europe
Stage 0	47,9 %	19,7 %	0,0 %	76,2 %	17,4 %	31,2 %
Stage 1	0,5 %	37,7 %	0,0 %	12,9 %	10,0 %	17,0 %
Stage 2	33,9 %	28,5 %	49,1 %	10,2 %	16,6 %	26,8 %
Stage 3	5,2 %	3,4 %	1,8 %	0,0 %	1,7 %	3,3 %
Stage 4	3,0 %	2,7 %	3,6 %	0,0 %	8,3 %	3,8 %
Stage 5	9,2 %	7,4 %	36,4 %	0,7 %	41,9 %	16,2 %
Stage 6	0,0 %	0,5 %	9,1 %	0,0 %	3,7 %	1,5 %
Stage 7	0,2 %	0,0 %	0,0 %	0,0 %	0,4 %	0,1 %
No. of hospitals	401	583	55	147	241	1613
Mean Stage	1,66	1,73	3,89	0,43	3,44	2,08

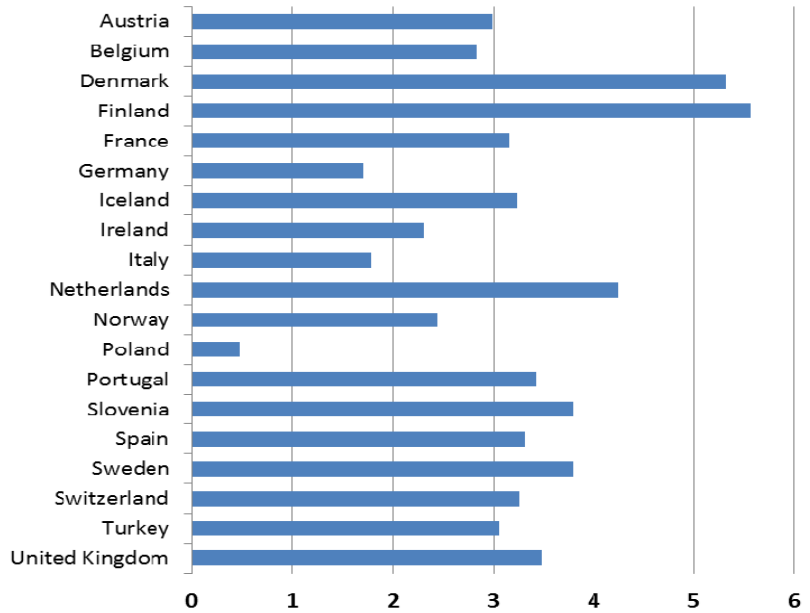

Fig. 2. Mean EMRAM stage values across Europe
(own modification of source data from HIMSS Analytics, December 2014)

6. Conclusions

Use of EMR in clinical practice will probably become a standard of care in all developed countries. Although this technology offers both theoretical and real-life benefits, its implementation is a costly and challenging process. Therefore, objective assessment of current implementation level seems necessary for ensuring optimal allocation of resources. This paper describes the use of EMRAM, which is a reliable 8-stage scoring system developed to measure the level of EMR adoption in particular hospitals.

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ОБОСНОВАНИЕ ВЫБОРА МЕТОДА ЛЕЧЕНИЯ ЯТРОГЕННОГО ГАЙМОРИТА В ЗАВИСИМОСТИ ОТ ПРИРОДЫ ИНОРОДНОГО ТЕЛА И МИКРОБНОЙ АССОЦИАЦИИ

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Выявлены особенности микробной флоры, степени обсемененности, а также изменений слизистой оболочки гайморовых пазух в зависимости от природы инородного тела в просвете синуса. На основании полученных результатов исследования клинического материала гайморовых пазух 45 больных хроническим верхнечелюстным синуситом определен объем лечебных мероприятий в зависимости от природы инородного тела в просвете пазухи
***Ключевые слова**: хронический гайморит, инородное тело, морфология, обсемененность, микрофлора, хирургическое лечение, ятрогения*

It is determined the features of the microbial flora, the degree of contamination, as well as changes in the mucous membrane of the maxillary sinuses, depending on the nature of the foreign body in the lumen of the sinus. Based on the results of microbiological and histological examination of clinical material of maxillary sinuses of 45 patients with chronic maxillary sinusitis is defined scope of therapeutic measures depending on the nature of a foreign body in the lumen of the sinus
***Keywords:** chronic sinusitis, foreign body, morphology, contamination, microflora, surgical treatment, iatrogenesis*