

INNOVATIVE APPROACH TO COMMUNICATION SERVICES DEVELOPMENT IN ELECTRONIC HEALTHCARE SYSTEM. INTERNATIONAL EXPERIENCE ANALYSIS

ІННОВАЦІЙНІ ПОДХОДИ У СТВОРЕННІ КОМУНІКАТИВНИХ СЕРВІСІВ ЕЛЕКТРОННОЇ СИСТЕМИ ОХОРОНИ ЗДОРОВ'Я. АНАЛІЗ МІЖНАРОДНОГО ДОСВІДУ

The article summarizes the results of foreign and domestic research regarding the development of innovative information and communication technology in development of communicative services as a part of the electronic healthcare system both in countries with high quality healthcare systems and in countries where the healthcare systems are under development. The analysis of medical service efficacy and review of different approaches to development of innovative targets availability to medical services and better access to data for patients, healthcare professional and government authorities contribute to formation of the powerful medical data management system and enhance the capability of public-driven branch management. An analysis of the impact of open data on public administration of healthcare. The clear classification of e-Health tools has been provided based on the main component: communication tools, technical tools, etc. The special features related to introduction of data management and communication systems focusing on the needs of the healthcare system and the end users – both the doctor and the patient were reviewed. The level of public trust and acceptance for various elements of e-Health system in different countries has been established. Issues related to the implementation of innovative communication services of the Electronic Health Care System targeting elimination of medical illiteracy and the economic impact of such measures have been identified. The risks of e-Health system implementation are reviewed. The analysis of risks and benefits related to the introduction of electronic medical records has been conducted. In addition, the pro's and contra's regarding the use of personal data in electronic medical records, and the risks related to their availability are summarized. The ways of e-Health implementation into public healthcare management applicable for public administration and introduction of the Electronic Health Care System in Ukraine are considered.

Key words: Communication technologies in healthcare, electronic healthcare system, e-Health, Tele-Health, mHealth, Electronic health record, Digital Healthcare Systems.

У статті узагальнено аналіз закордонних та вітчизняних науково-практичних досліджень стосовно створення інноваційних комунікативних сервісів електронної системи охорони здоров'я у країнах, що мають розвинену систему охорони здоров'я, та країнах, де система охорони здоров'я тільки розвивається. Проведено аналіз ефективності сервісів, розглянуто різні підходи до створення інноваційних інструментів для полегшення доступу до медичної послуги й інформації для пацієнта, до популярної системи управління медичною інформацією та розширення можливості публічного адміністрування цієї сфери. Надано чітку класифікацію інструментів Електронної системи охорони здоров'я (ЕСОЗ) залежно від основного компонента: комунікаційний, технічний тощо. Висвітлено особливості впровадження інформаційно-комунікативних систем для задоволення потреб системи охорони здоров'я та кінцевого користувача – лікаря та пацієнта. Визначено рівень довіри та сприйняття громадськістю різних елементів Електронної системи охорони здоров'я в різних країнах. Визначені питання щодо впровадження інноваційних комунікаційних сервісів Електронної системи охорони здоров'я, спрямованої на ліквідацію медичної неграмотності, та економічний вплив таких заходів. Аналізуються ризики впровадження Електронної системи охорони здоров'я. Проведено аналіз щодо зіставлення ризиків та вигоди впровадження електронних медичних записів. Крім того, узагальнено аргументи та контраргументи, наведені в науковій дискусії щодо використання персональних даних в електронних медичних записах, ризики щодо їхньої доступності. Розглянуто шляхи впровадження Електронної системи охорони здоров'я в публічному управлінні охороною здоров'я, які могли бути використані в публічному управлінні й адмініструванні Електронної системи охорони здоров'я в Україні.

Ключові слова: комунікаційні технології в охороні здоров'я, електронні системи охорони здоров'я, e-Health, телемедицина, mHealth, електронні медичні записи, цифрові системи охорони здоров'я.

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Introduction. At present, governments have a powerful and high-tech toolkit targeting treatment and life expectancy prolongation for the whole population. However, the performance gap in different health care systems is expanding; this difference is reflected by both direct economic performance (procurement of medical services, procurement and logistics of medical supplies, risk and fraud management) and the burden of disease and disability. According to the

World Health Organization, a perfect healthcare system is based on six properly balanced pillars: service delivery, health work force, medical technologies, health financing, leadership and governance and health information. It is not possible to fully separate them or recognize the main pillar neglecting the others. To ensure both the operational and financial robustness of the system, continuous receive feedback is required in order to implement immediate changes into the health-

care system; therefore, health-related information is an important factor. The function of this pillar is to ensure the production, analysis, distribution and use of reliable and timely information regarding the public health and healthcare systems operations; Obviously, communication is required to get this information, namely the data exchange between provider and recipient. Another important communication issue is the data channels delivering information for public services and respective feedback. In case when instant data exchange should be implemented in large areas, the concept of e-government is becoming increasingly important and, in particular, the e-Health system is crucial.

Today electronic communication systems in healthcare are booming. According to the expert group Global Market Insights the volume of the global digital healthcare market in 2019 topped \$ 106 billion. Considering the steady growth of smartphone users number worldwide, further market growth is expected [64; 65].

Electronic health technologies include a large number of diverse information and communication tools as well as communication services, which create a common platform of the Electronic Health System (e-Health) at the national level. In the best models, e-Health provides an opportunity of a dialogue between public services and citizens regarding the critical health issues.

At present, the second stage of health care reform is being conducted in Ukraine, and e-Health has become an integral part of this reform. It is crucial to establish data exchange network between all players involved in the healthcare system of Ukraine in order to ensure effective management and administration, flexible and instant response to challenges, risk protection and improved satisfaction of the end user – namely, every man or woman living in Ukraine. In order to understand the trends of e-Health system development in Ukraine it is necessary to review foreign experience of electronic systems implementation, to identify the most promising communication services, and to develop appropriate descriptions (communication subjects, means of communication, public administration and administration of particular communications).

Literature review. Today, when e-Health in Ukraine has become the cornerstone of healthcare system reformation, national science focuses on the particular issue.

E-government and the efficacy of the communication process as a concept were studied by many authors [1; 17; 20; 21]; however, these studies are not focused on the e-Health issues, which are for sure an important element of e-government.

J. Radysh determines the importance of creating a common medical space and the possibility of using information and communication technologies as the main components of data exchange within this space [14].

V. Gavrilovich, T. Gruzdova, Yu. Lazebnyk, Yu. Trius and other scientists review the general national strategies of e-Health system development and study the basic elements, without highlighting a separate communication component [2; 3; 7; 10; 19].

A. Krutz has reviewed foreign experience of e-services provision for healthcare using the Internet technologies [9]. O. Dovhan, N. Korobchynska [5; 8] consider the current situation based on data collected in one or more regions of Ukraine. Many researchers such as T. Skrypyk et al., V. Zhuk et al., and Z. Deren consider some details of e-Health system and do not pay any attention to the communication components [4; 6; 16].

V. Morguntsov has reviewed mobile technologies of the e-Health system (mHealth) only, and established the general trends of various mobile devices application for data access and communication [12].

L. Tereshchenko et al. studied only a separate component of e-Health – an electronic prescription system, and reviewed the communicative component in an indirect way [18].

Many studies of e-Health system are focused on the legal issues – both the protection of personal data and development of regulations covering the function of e-Health system in general [11; 15].

G. Mulyar believes that the introduction of e-Health system works as an artificial obstacle for professional activities as it would neither include the human factor nor provide an intuitive and easy communication element [13]. O. Litvinova points out that in Ukraine there are no nurses ready to operate the e-Health system [49].

Aims of the articles. Review of the up-to-date foreign scientific and practical researches of communication services of the electronic healthcare system (e-Health) as the main communication tool of the healthcare system. Establish the most important and promising communication services based on foreign sources analysis and provide their description (communication subjects, means of communication, public administration and administration of particular communications).

Methodology and research methods. In order to meet the objectives of this study, the most relevant publications were selected. The search request has been made in the Scopus database (Scopus, 2020); WoS database, WHO and UN regulatory documents; the following key-

words were used “communication technologies in healthcare”, “electronic healthcare system”, “e-Health”, “Tele-Health”, “mHealth”, “Electronic health record”, “Digital Healthcare Systems”. The most relevant documents were selected, as well as the documents that had the largest number of citations.

Results. According to The Good Governance Standard for public services, proper management should have the following features: provide justified, transparent decisions with weighted risks, and develop opportunities for effective functioning; also public services should be as close to users as possible [62].

According to C. Ciborra & D. Navarra the e-management system enables all the necessary communication components to develop good governance [30]. According to C. Leitner, the e-government is defined as the implementation of information and communication technologies in public administration practices in combination with organization changes and introduction of new methods targeting improvement of public services, installation of democratic processes and strengthening of public policy support. Thus, it covers the dimensions of public administration, democracy, governance and policy-making [48]. According to I. Holeman et al., e-Health system is an integrated but separate component of e-government, as it has its own special properties, enabling the multimodality pattern of health care [42].

According to M. Domenichiello, in 2005 the European Council has adopted the e-Europe Action Plan, which sets the strategic objectives of public administration and the basis for all subsequent initiatives in the e-government system and particularly in the e-Health sectors. It ensures the availability of basic government services, outlines Internet programs and their content; it also ensures the ease of use and accessibility of such platforms and content applicability. It also enables access for challenged people (e.g. people with various disabilities and the elderly patients). In order to meet this objective the European Committee has proposed the following measures ensuring the result: wide availability of broadband access at competitive prices, interoperability between national systems at EU level supporting the provision of pan-European e-government and e-health services for citizens [34].

A. Ekeland & L. Linstad also note [36] that e-Health provides an opportunity for effective communication between the state and global policy actors, medical and self-governing actors, as well as global business structures and health care institutions. Based on the data of S. Badawy et al. e-Health components should be subdivided

according to the final beneficiary, namely health-care professionals, healthcare facilities, pharmaceutical entities (pharmacies, drugstores, etc.), diagnostic and imaging centers, outpatient clinics, clinical units, patients, public service representatives (Departments of Health, regional institutions, other public services related to medicine) and other stakeholders [26].

Regarding the payer-driven approach, e-Health services should be divided into public policy entities (CHP, DOZ and other public services) and private entities (patients, relatives, citizens) [68].

According to D. Gustafson and J. Wyatt [41] communication services and e-Health systems are divided in the following way:

- Tele-Medicine;
- Mobile applications and fitness gadgets (mHealth);
- Electronic health records or Digital Healthcare Systems;
- Customer’s (patients) management;
- Health literacy for non-healthcare professionals;
- Healthcare analytics;
- Radiology information systems;
- Image archiving and communication systems;
- Vendor archives;
- Supply chain management;
- Fraud management;
- Revenue cycle management.

Technically, e-Health components are divided into hardware, software and maintenance components [66].

E-Health communication systems targeting primarily patients and the citizens are tele-medicine and Mobile applications and fitness gadgets (m-Health).

Tele-Medicine: many articles are focused on the role of tele-medicine during the COVID-19 pandemics [47; 58; 70].

Data from The Department of Health and Human Services (USA) indicate that over 60% of all medical institutions and up to 50% of hospitals use tele-Health to some extent [52].

The study by R. Tuckson et al. indicates that in the United States, private insurers pay for Tele-Medicine services if they provide benefits for patients, while Medicare pays only when Tele-Medicine elements are used in rural areas [63].

According to research by Y. David Tele-Medicine can be divided into two main sectors: Telecare (Activity monitoring, Remote medication management) and Tele-Health (Long-Term Care monitoring, Video consultation) [33].

The main advantages of tele-medicine are operational diagnostics, analysis of rare disease

cases, selection of drugs, development and search of molecules using digital libraries. Under the conditions of pandemics in conjunction with innovative potential, tele-medicine enables remote examination of the patient and further monitoring of his condition. Five large groups of issues that can be possibly managed by the means of tele-medicine are identified: sorting of patients and considering hospitalization into specialized COVID-19 hospitals or ordinary hospitals; providing care and advice to self-isolated patients with COVID-19 and treatment of patients at home; coordination between hospitals and providing specialist's consulting; training of medical staff on anti-epidemic measures and care in patients with COVID-19; providing routine consulting in patients with non-emergency diseases or with chronic disease, as well as providing palliative care.

B. Melius & W. Conwell studied the use of Tele-Medicine and conducted an economic evaluation, empirically measuring and comparing the conventional healthcare system and the costs of Tele-Medicine [52]. They report that the cost-efficacy ratio of Tele-Medicine may depend on multiple factors, including the services being evaluated; costs associated with professional services, in hospital care or patient-associated expenses; type of economic analysis; quantification mode; technology change rate; as well as the overall utilization rate of the service. The evaluating side is also important, because economic values for the patient, doctor, CHC and society may differ.

C. Snoswell et al. conducted a thorough analysis of the economic benefits of Tele-Medicine in Australia and demonstrated greatest economic benefits of Tele-Medicine in rural areas, especially when compared with the model in which the patient travels to the doctor (patient travel model) [59]. However, the authors note complete shift of the focus to Tele-Medicine is impossible because patients will still have to attend procedures, as well as diagnostics and outpatient visits. In such cases, tele-medicine consultation mode is not appropriate. Spinks et al. and Kaambwa et al. report that patients choose face-to-face consultations when it is possible; however, Tele-Medicine becomes more attractive when the consultation requires long travel, or waiting after working hours [61; 44].

Mobile applications and fitness gadgets (m-Health). Mobile health (m-Health) is defined by the World Health Organization's (WHO) Global Observatory for e-Health as medical and public health practice supported by mobile devices, such as cell phones, monitoring devices, personal digital assistants (PDAs), and other wireless devices [69].

Mobile devices, fitness gadgets are becoming more popular due to the boom of smartphones, tablets and mobile platforms in general. According to Statista, by the end of 2019, the global m-Health market exceeded \$ 52,6 billion. M-Health includes many health services and applications such as Wearables (blood pressure monitors, plasma glucose level monitors, heart rate monitors and pulse oximeters, sleep apnea monitors, others). Supplements (medical and fitness supplements) also provide extensive access to health information. E. Boudreaux et al. Report that these gadgets are beneficial for both patients and physicians [27]. According to Majed Kamel Al-Azzam et al. in developing countries, m-health plays an important role in promoting positive changes in the approach to health care delivery and access to health care [24]. Other studies report that cell phones and mobile devices for medical advice and health monitoring improve access to healthcare for people living in rural areas. According to T. Huda et al. [43] such approach had low positive effects on both access to health care and economic. V. Cook et al reports the main issue: most m-Health applications are developed without the involvement of healthcare professionals [31]. M. Marcolino et al. notes that despite the growing popularity of m-Health devices, the evidence base for their economic and medical benefits remains limited [50].

Electronic medical records are a system of e-Health data recording based on treatment results and measures taken to manage the condition reported upon admission. Electronic medical records are included directly in order to enable statistical data exchange with the e-Health Central Database; the same is applicable to electronic medical records, electronic referrals and electronic prescriptions. The volume of information to be stored is associated with the system's properties [22; 37]. Some researchers suggest the term "Digital Healthcare Systems" to define the gross data amount [35].

One of the main issues of public administration is personal data protection, because electronic health records include a large amount of confidential information and thus can become a target hacker attacks; on the other hand through electronic medical records the medical staff can potentially gain access to information that is not supposed to be disclosed to anyone but the patient's family member or attending physician [32; 56; 67]. These issues emerged since the implementation of electronic medical records [54].

To unify and standardize the electronic medical records, the international standard ISO 18308:2011 (Health informatics et al

Requirements for an electronic health record architecture) has been adopted; it has become a source guideline for national level standards [40; 46; 53]. J. Saleem & J. Herout have reviewed the transition from locally-developed systems to certified commercial medical information systems for electronic medical records management; the authors consider it an important step of healthcare system management [55]. R. Evans believes that healthcare reform and changing medical environment require the conversion of all medical data into electronic format. It ensures the access to these records for vendors, healthcare providers, government agencies, and health departments. Thus, successful healthcare professionals will have to change the format of medical care provision in the future. EMRs allow comprehensive recording, including patient mapping, billing, disease coding, planning, and data transfer to third parties [37].

Health literacy resources for non-professionals

The World Health Organization notes a direct relationship between critical health indicators (such as high mortality rates) and incompetence of population regarding the health-related issues. That is why medical literacy is a popular development trend for the next 5 years. However, according to M. Fagnano et al., given the increasing attractiveness of mobile gadgets for self-diagnosis and treatment, two important components of health-related literacy should be considered: general health-related issues and a separate type of education targeting operating the particular devices that provide e-Health services [38].

Health literacy is the degree to which people are able to receive, process and understand the basic health information needed to make appropriate health-related decisions [60]. In the digital world, however, the wording should be somewhat different: e-Health literacy is a set of knowledge and skills needed for the effective use of technology-based health innovations and monitoring tools [28].

Numerous websites with educational material regarding various public health issues are available for improvement of health-related literacy: vaccination, healthy lifestyle, obesity, etc. However, according to J. Choi and S. Bakken, the data presented in these web-sites is quite difficult for understanding in people with a low health-related literacy; therefore, it is very important to simplify the content by focusing on the visual presentation of information (infographics, motivation pictures and videos) [29]. A. Austvoll-Dahlgren et al suggest using web-based apps with audio and video elements that are less time consuming and are easier to understand [25]. H. Kim & Xie, point to several major trends in health literacy related to

digital media and e-Health [45]. First, people with poor health-related literacy usually have a low level of perception of written information, so organizations that implement Health literacy through the Internet should take this into account and simplify the text for better perception, and even switch to Web-based apps and e-Health apps that make the understanding easier. In addition, the use of electronic digital technologies makes it possible to present Health-related information using the interactive format (tests, games, etc.).

Digital image exchange communication systems: Vendor Neutral Archive vs Picture archiving and communication system (PACS)

Today, there are two main approaches to exchange of digital images: X-ray, ultrasound images, CT images, etc. These are the approaches of the Vendor Neutral Archive and the Picture archiving and communication system. There is a discussion regarding the difference of these two approaches, because they have many common features [39]. Both approaches provide the transmission of medical digital images and reports through the computer network, eliminating the need for manual manipulation with X-ray films and other images; usually DICOM (Digital Imaging and Communications in Medicine) format is used [57].

Nevertheless, the main feature determining the separation of these two approaches is the way of data storage, access and transfer. According to T. Agarwal & Sanjeev, if hospitals need to transfer a PACS provider, all previous data should be converted into the format of the recently purchased PACS. It takes both time and money. A new concept for the Vendor Neutral Archive (VNA) has emerged to address this issue. VNA simply separates PACS and workstations at the archive level. This is achieved by developing an application mechanism that receives, integrates and transmits data using different syntax of the digital image format and communication in medicine (DICOM) [23].

Conclusions. Summarizing the available literature, we can detail each area: Telemedicine 1. Telecare (Activity monitoring, Remote medication management) and Tele-Health (LTC monitoring, Video consultation); mHealth 1. Wearables (BP Monitor, Glucose meter, Pulse oximeter, Sleep apnea monitors, Neurological monitors, Others) Apps (Medical apps and Fitness apps); Health analytics; Digital health systems; (Electronic health records; E-prescribing systems,)

Today, the provision of e-Health services plays a key role in the empowered involvement of information and communication technologies into public administration and administration of healthcare. On the other hand, e-Health technologies need to be regulated.

Tele-Health technologies play an important role today, especially during the COVID-19 pandemic, as they enable reduction of direct interactions between doctors and patients, less travel for patients; thus, they reduce the risk of infection transmission significantly. However, today there is a serious concern regarding legal issues of counseling through information and communication tools, the possibility of patient-driven misuse of these resources, and inability to get the full clinical picture compared to visual examination. In addition, patients are still consider remote consultations as non-serious, resulting in reduced cost-efficacy.

Today electronic health records induce the transition from printed forms, recommendations and records that are associated with reporting bias and incorrect figures, to innovative digital tools that provide transparency and accountability, facilitate healthcare analytics processes, and thus have a direct impact on economic processes in healthcare. They provide an opportunity to see the real picture and track changes and trends of the health status in all segments of population followed by the changes of the principles of financing and the direction of financial flows depending on the actual population needs. The availability of the electronic health records also creates opportunities for the automation of business processes in medicine and the use of artificial intelligence to develop innovative solutions in health economics.

Another less obvious advantage of electronic health record is reduction of administrative forces, as the entire patient-related archiving system is based on digital copies storage; therefore, document turnover operations can be reproduced faster and without any errors. In addition, this information should not be necessarily provided by the doctor; therefore, the doctor becomes free to perform his purely professional duties.

However, there is a significant concern about the security of data stored in the format of electronic health record because of the cloud storage or use of servers that are connected to each other and have access points from the outside world and thus can become an easy prey for hacker attacks.

Other branches of electronic health records use are various image archiving and distribution systems, which allow receiving of medical images (ultrasound, X-rays Etc.) without any loss of quality from any device.

The active growth of the use of mobile devices leads to an empowerment and better compliance of the mHealth sphere and is associated with better of health-related literacy in population due to the high availability and ease of use of various

mobile devices. Today, a large number of applications related at a healthy lifestyle and improving health-related literacy are available. However, the main issue here is the low involvement of health professionals in development of these applications, so they may contain false information.

Thus, it should be noted that innovative approaches in the development of communication services of electronic healthcare system significantly affects not only the economic performance of particular medical institutions, but also changes the entire health economics, through reduction of the burden on medical staff, healthcare network and patients. In addition, the unification of the development of electronic healthcare system contributes to globalization in both medicine and public administration in general.

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