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L4K 0C0
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Digital Transformation of Healthcare

Serik Smagulov,

Viktoriya Smagulova MD

Abstract

In a situation where digital corporations are switching to healthcare, the state obliges medical institutions to constantly improve the quality of services provided, and patients seek high-quality care, which has serious implications for the healthcare sector. The purpose of the study was to understand the growing role of digitalization of health care, based on the experience of western countries, to consider the benefits and identify possible problems faced by medical institutions and their patients. As a result of the study, it was revealed that digital transformation makes it possible to improve the efficiency of healthcare by reducing costs and improving the quality of medical care.

Key words: Digital transformation, digitalization, personal data, health information, patient information, communication, diagnostic tools, transformation, healthcare.

Society is getting older, and health care costs continue to grow. It is assumed that the digitalization of medical services can be presented with lower costs and higher quality.

In Austria there is ELGA, an electronic medical record system that any doctor or hospital can easily access as needed. Doctors in Sweden, Denmark and Estonia send the prescriptions to the patient electronically or directly to the pharmacy that delivers the drugs. The British NHS is working with Google to deploy artificial intelligence in the medical field [1].

Digital transformation and disruptive innovation describe the comprehensive reorientation of an industry including its business models due to the coming of age of digital technologies: the digitization of products, services, and processes [2].

It is assumed that digitization will provide faster access to data.

Another advantage of the digital transformation of healthcare is paperless data which includes a unified electronic record and the exchange of health information. In this case, records and storage of all patient information should be available from any medical institution. The electronic appointment, the digital version of the prescription drug, is transmitted to the pharmacy in real time. Recipe data can be used to automatically check, for example, side effects.

Digital transformation of healthcare provides in-patient communication with staff. This refers to software that allows communication between hospital staff and coordinating its work.

Teleconsultation becomes important nowadays: tools that provide remote interaction between the doctor and patient, especially for small requests or subsequent consultations. It is especially important to conduct remote monitoring of patients with chronic diseases. Most often it is the monitoring of vital parameters of patients at high risk of developing chronic diseases.

Modern digital diagnostic tools are technologies that allow remote diagnostics [3].

Recent modern developments in the digital transformation of healthcare include:

- Use of bar codes: error-free barcode-based identification and confirmation of all prescribed drugs in the ward where the patient is located.

- Radio Frequency Identification (RFID) tracking: spatial tracking of all assets (for example, diagnostic tools, beds, expensive medicines) using RFID technology.

- Vital Parameters Tracking (eICU): remote monitoring of vital signs in the intensive care unit.

- Hospital logistics using robotics: robots that perform repetitive tasks (for example, transporting drugs / patients).

- Automation of processes with the help of robots: the use of robotics to perform simple tasks (for example, monitoring vital signs, processing samples).

- Electronic directions: Referral and discharge information (including test / clinical data) is sent to the next doctor for patient consultation.

- Dashboards to improve performance: to increase the internal availability of data on the doctors work.

- Software to manage the patients flow.

- Genetic testing: individual treatment decisions are made on the basis of patient-specific genomic, proteomic and other data.

- Technologies for the treatment of chronic diseases.

- Programs for patients with diabetes: reminders to patients about compliance with the treatment regimen; connected insulin testing devices [4].

- Online programs of pulmonary rehabilitation for patients with respiratory diseases; connected inhalers.

- Education of patients with cardiovascular diseases: the use of connected sensors / heart rate monitors with alert function.

- Medical chat bots: completely based on artificial intelligence or controlled by special applications.

- Tools for disease prevention: applications, virtual trainers and fitness trackers.

In Europe there has long been an electronic registration system through online portals that allow patients to schedule their own meetings with general practitioners (GP) and specialists. They are also connected to the reminder function.

As for the European health care system, there is a significant financial cost savings when introducing the digital transformation of healthcare. The greatest savings can be expected from the transition to unified electronic medical records, which represents a potential savings of 6.4 billion euros (19 percent). The savings consist in the subsequent increase in productivity and efficiency. For example, by reducing the time required for administration and reducing the number of unnecessary duplicate actions.

The virtual features of the digital platform are particularly useful in remote areas, where the number of locally registered medical specialists is limited. The digital solution represents nurses and doctors, full access to patient information, wherever they work, and allows them to record their results on a tablet [5].

Digital transformation is not just a transformation of the work of doctors and nurses; it also gives patients the opportunity to manage their treatment independently and share data with their doctors.

Professional health care market participants can have serious problems. First of all, control is needed for the introduction of electronic medical records and electronic

prescriptions. It is important that medical records provide open interfaces between online and offline treatment and that patients can maintain absolute control over the personal data that is created and transmitted [6].

It should be noted that there are no tools in the health care industry to ensure real responsibility. For example, when clients make an appointment with a doctor, they do not have the opportunity to know in advance about the successes or failures of this health care provider. Medical companies need a standard set of procedures for handling patient feedback.

Digital transformation in healthcare helps ensure financial transparency. Technology can help the industry provide customers with more information on health spending.

Digitization paves the way for new approaches to medicine and provides opportunities for solving some health problems. While some privacy concerns remain, patients are already taking advantage of digital medical solutions, such as online services and online tools. Using digital solutions can also help make the system more efficient and establish a more integrated approach.

Despite new technologies being constantly introduced, this change has yet to materialize [7-8].

The process of digital transformation in health care should not be limited to the technologies necessary for innovation. It is also necessary to attract specialists.

Indeed, digital transformation has already revolutionized all industries, but it is in the healthcare sector that technologies help us live longer and lead safer, healthier, and more productive lives.

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New Technological Trends in Healthcare

Serik Smagulov,

Viktoriya Smagulova MD

Abstract

This article addresses the question of what today means improving the quality of medical care and reducing the costs associated with introducing innovations in healthcare. Researchers must understand the development of technological trends of the health care system, that will lead to improve the quality of services and, consequently, the quality of life. We consider various fields of activity, starting with Big Data, in the field of medicine and pharmacology, and ending with robotics and chip making. The result is reduced costs and improved quality of care and patient care.

Keywords: Digital transformation, digitization, big data, robotics, chips, pharmaceutical companies, the future of medicine.

In our time, we are witnessing a digital transformation that is rapidly taking place in the field of healthcare. The focus is on exemplary experience in patient care, and pharmaceutical companies and clinical care centers have made radical changes through technological innovation and communication.

Technology has become almost the primary way to increase life expectancy. Technology can save lives. And this has been proven more than once. Fortunately, the scope of techniques for saving lives is greatly expanded.

What does digital transformation mean for the healthcare industry?

Digital transformation is a trend that can only be realized when organizations can rethink business processes. Simply put, digital transformation in healthcare is the use of various forms of digital technology that help the patient lead a better life. The need of the patient becomes the center of the business.

Medical organizations can be intimidated by the enormous amounts of data that they will have to deal with because the data passing through their systems is often unstructured and difficult to manage.

Digital transformation involves various areas of activity in the health care system, ranging from patient registration to smart diagnosis [1].

Consider some of them.

- Big Data used in medicine.

For the first time, the term “Big Data” (Big Data) was used in 2008 by the British journal «Nature» which devoted a special issue to the phenomenon of explosive growth in the volume and diversity of data processed. Big Data analysis has become a significant boon for both patient management and the business aspect of health organizations.

The main strategies for applying Big Data in medicine are the creation of medical data registers in which information can be exchanged, the use of accumulated knowledge to predict possible “waves” of diseases, and the introduction of electronic cards for the patient that will be available to every doctor who treats him [2]. Analysis of various data allows for a detailed and comparative study of the patient, to find out his lifestyle and the lifestyle of similar patients, to develop the right treatment strategy.

Big Data can collect all the data and information about what constitutes a disease - from DNA, proteins, and metabolites to organs, organisms, cells, tissues and ecosystems [3]. In this way, they can help build better health profiles and prognostic models around patients to diagnose better and treat diseases.

There are more advantages of using Big Data in medicine. For example, the Toronto Children's Hospital has implemented Project Artemis. The hospital information system collects and analyzes data on infants in real time. The system can track every 1260 indicators of the state of each child, allows you to predict the unstable state, and in time to start the prevention of diseases in children.

Big data and artificial intelligence are now widely used in pharmaceutical manufacturing and marketing of drugs. The most significant effect of Big Data is expected in the modeling of new drugs. An example of work in this direction is the activities of the IT company Semantic Hub, which is developing services to assess the prospects for the development of new products.

About the collection of clinical data about patients, pharmaceutical companies are seeking access to medical data of patients and racing deals with technology companies with experience in the analysis of Big Data.

Big Data helps to improve the quality of clinical trials. Using these technologies, companies can make clinical trials more efficient. From several databases, analytical systems can select patients who best meet the preliminary requirements of the drug test.

It is imperative to identify the side effects of drugs timely. Big Data is widely used in this area. It is very important that they are used in the prediction of side effects for specific compounds and components even before the start of clinical trials.

Using an analytical method that includes checking dozens of different drug characteristics, companies can save time, money and save patients' lives.

- Medical robotics.

Recently, robotics is continuously being introduced into the healthcare industry. Medical robots are the result of interdisciplinary efforts to automate healthcare. There are robots designed to facilitate the work of nurses, for example, robots for injection and collection of tests, trolley robots to bypass patients who can enter data in the history based on the doctor's speech. Although robots have been part of the health care system for several decades, from small laboratory models to complex ones that can either perform operations on their own or help a human surgeon, the possibilities of using them in medicine have only recently expanded. Robots are currently used to help people with sensory, cognitive and motor impairments [4].

Advances in technology and computers have helped faster in sequencing genomes and a cost-effective manner. This helped scientists to understand in detail the genetic profile of a person and thereby prescribe treatment methods that can lead to more effective treatment.

Doctors, clinicians, and specialists use genomic sequencing for more accurate diagnosis and more precise treatment of their patients. The increase in technology and computing power allows scientists to create a fully personalized form of testing and treatment.

- The use of chips.

The biochip is the result of the merger of two areas of knowledge - biotechnology and semiconductor technology. Source - Biochip in a compact format allows you to identify various intracellular processes, analyzing hundreds or thousands of reactions at the same time.

One of the first commercial chips created the company Affymetrix - GeneChip. This chip was produced using microlithography technology. Biochips are organized placements of DNA molecules on a special carrier.

The use of proven methods of the electronics industry has led to impressive results.

Recently, there are examples of using electronic sensors to measure various types of treatment at the cellular level. As a result, the best possible treatment will be selected, and then assigned to the patient. This trend has been made possible by advances in DNA sequencing and through in-depth stem cell research [5].

There are precedents for the creation of chips of various organs, such as the kidney, heart, intestines, bone marrow, and so on. The organs on the chip device can supply cells with nutrients and oxygen, just as the cells of the human body are supported by blood. These cells grow and react just like real cells of a human organ.

Summing up, it can be noted that digital transformation is always a complicated process, especially if we consider such a complex industry as healthcare. Often you can meet some problems that may interfere with the process of digital transformations in health care. For the transformations to be successful, the industry as a whole must be ready for the change. For some health institutions, return on investment is in the first place, which in most cases puts digital transformation projects into a dead end. In our opinion, in the first place should still be patient care. And, as we see, this is what modern medicine seeks.

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Innovative Technologies of Healthcare

Serik Smagulov,

Viktoriya Smagulova MD

Abstract

This article discusses the possibilities of modernizing the healthcare system using the latest technological developments to improve the quality of the healthcare system, the quality of patient care and the creation of new opportunities for patients using Digital Transformation Technology. The purpose of the study was to understand the growing role of health digitization, based on the experience of European countries, to identify the problems faced by IT health professionals and how these problems affect the system of health care and the possibility of improving the health system. We looked at ASI technology, Chatbot, the NETSCOUT platform, and other major innovations in digital health care technology. The result of the considered modernization due to the introduction of new programs is to reduce costs and improve the quality of care and patient care.

Keywords: Digital Transformation, digitalization, personal data, Internet of Things, big data, personal health records, personal health information, diagnostic tools, healthcare, transformation, chatbot, HIPAA, NETSCOUT

In the field of health, there has been an evolution of digital technology, the impact of which is truly enormous. It should be noted that digital transformation is stimulated by the use of technologies such as mobility, Internet of Things (IoT), Web 3.0 platforms, various unified communications (UC), etc. In some developed countries, digital technologies can provide uninterrupted data flow, ranging from medical records and systems to interactions between doctors and patients at any time and from any place.

As for the future of such a digital transformation, each state seeking to modernize the health care system with the help of digital transformation technology sets the ultimate goal of reducing costs and improving the quality of patient care. Medical organizations which use mobility, Big Data, UC and IoT strive to expand the entire chain of medical services from diagnostics to subsequent care, improving the relationship between patients, doctors and insurance companies. With the use of digital technology, all processes are becoming more automated, efficient and mobile.

There is currently a transition from the use of physical assets to digital assets. But there are still practical problems for achieving the correct and accurate functioning of the entire health care system in introducing modern digital technologies.

The introduction of digital technology has an impact on how health care workers diagnose, monitor and monitor the health of patients. Digital services include electronic medical records and enterprise resource planning systems. These digital services are directly related to the provision of medical services (from portable diagnostic tools and crowdsourcing to the development of serious genomic applications, for example, to decoding DNA on a portable device).

The speed of digital transformation and its countless number of digital services contribute to the development of healthcare, but there are also pitfalls here - ranging from the integration of infrastructure and applications to the timely and high-quality provision of services. It is essential how the requirements and expectations of patients are satisfied.

IT professionals in the field of healthcare often face toeing some problems. These problems include such issues as maintaining a developing service delivery infrastructure, identifying service performance problems, ensuring the availability of clinical applications 24/7/365.

Empowering patients leads to significant changes in health care. But confidence in providing the best patient care is possible only with timely access to information. That is why continuous data monitoring based on traffic and real-time analytics is so crucial for determining the best treatment options and achieving successful results for patients.

One of the most critical components for healthcare providers is the ongoing monitoring of EHR transactions.

Health care providers must be able to track Health Level-7 protocol (HL7) transactions, as well as measure application transaction performance based on HL7, detect related error messages, and decode HL7 data fields [1].

The NETSCOUT nGeniusONE Service Assurance platform with its patented Adaptive Service Intelligence (ASI) technology is used in healthcare of many countries. The main functionality of NETSCOUT nGeniusONE allows you to determine the performance problems of services accurately, because it combines continuous monitoring and multi-level analytical capabilities in real time, providing an integrated solution for managing performance in the most complex and demanding IT service environments [2].

ASI technology continuously converts large amounts of traffic-based data into structured metadata optimized for real-time analytics platforms, which, in turn, are capable of supporting the evolving network infrastructure of service provision, while ensuring round-the-clock accessibility for patients.

The NETSCOUT platform allows network and application teams to quickly identify and sort service performance problems and reduce risks for both the organization and the patients it ultimately serves [3].

Another new trend in the digital health industry is chatbots, which act as digital assistants for doctors.

As in any other industry, cost savings are also a significant concern for the healthcare industry. Chatbot technology helps to solve common medical inquiries at an affordable price using messaging systems and AI-enabled voice systems. Modern chatbots are designed to study the interaction with the patient and assuming the role of the general practitioner. Some chat robots, such as Woebot, now also have the opportunity to act as digital therapists. Smart bots serve as digital assistants for doctors in tracking contacts and arranging meetings with patients. On the other hand, chatbots also make life easier for patients by providing timely recipes, conducting laboratory tests and making the billing process easy.

Even though chatbots technology is still at an early stage of development, research firm Grand View Research has calculated that the global chat bots market will reach $ 1.23 billion by 2025. The United States and the cumulative annual growth rate (CAGR) will be 24.3% [4].

In the current digital healthcare industry, medical chatbots can be divided into two categories: the first is patient-only applications that help patients keep track of health data; and, secondly, clinician-patient applications that serve as a link between the two groups for diagnosis and treatment.

It is worth noting the growing role of artificial intelligence (AI) in health care. This is another emerging digital healthcare technology. With the help of data analysis, physicians

can now explore various approaches to treatment. Scanning the body with artificial intelligence reveals many chronic severe diseases at an early stage.

Pharmaceutical companies are introducing machine learning algorithms to study chemical and biological interactions to develop new drugs, replacing an earlier clinical trial process that used to cost billions of dollars and take more than ten years [5].

Another critical point in the digitalization of healthcare is the introduction of cloud services. The main reason for the rapid adoption of cloud computing in the health sector is that only cloud solutions provide health care workers and patients with the necessary access in accordance with the Health Insurance Mobility and Accountability Act (HIPAA), which sets standards for data protection [6], a recent CIF study found that 98% of companies have never experienced security breaches when using a cloud service. World experts predict that more than 50% of the healthcare industry enterprises that are on the path to digital transformation will rely on at least one public cloud platform.

More and more healthcare providers, payers, and IT professionals are using cloud-based pay-per-use cloud services to process, store, and transfer sensitive medical information.

For example, Amazon - AWS allows organizations covered by the United States Healthcare Authority Data Transfer and Protection Act 1996 (HIPAA) 1996 and their business partners to use the AWS secure environment to process, maintain and store sensitive medical information.

Digital transformation is rapidly transforming the healthcare industry. From the material examined by us, it can be concluded that patients have moved from passive recipients of medical care to active consumers. As a result of this transition and the policies of the governments of countries, health care providers should improve patient care and improve the quality of care. This requires the adoption of a large number of custom applications.

Summarizing, it can be noted that numerous digital solutions, such as, for example, the NETSCOUT considered in this article, provide uninterrupted service performance. This allows providing high-quality services to patients while optimizing costs.

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Internet of Things in Healthcare

Serik Smagulov,

Viktoriya Smagulova MD

Abstract

This article discusses the impact of the Internet of Things (IoT) on the development and modernization of healthcare. The demand for connected devices covers many industries, including healthcare. The Internet of Things revolutionizes patient data collection and records, performs individual health assessments. The author examines various possibilities, recent advances in the field of the Internet of things, including various mobile health monitoring applications, inhalers, smart contact lenses. Special attention is focused on intelligent continuous glucose monitoring (CGM). The progress of the Internet of Things has reached even the launch of smart hospitals. Managers have access to predictive analytics, thanks to which they can solve a problem before it happens. The problem of the help of the Internet of Things when solving problems of chronic diseases is considered. As for the future, the growing interaction of artificial intelligence and the Internet of things in the health sector is likely, according to the author, to create more intelligent IoT devices that can perform actions autonomously. Besides, in the future, such next-generation devices will be able to provide intelligent services, allowing real-time data processing.

Key words: Internet of things, healthcare, applications, diabetes, technology, artificial intelligence.

Internet of Things (IoT) is a concept of a computer network of physical objects ("things") equipped with embedded technologies for interacting with each other or with the external environment, considering the organization of such networks as a phenomenon that can restructure economic and social processes, excluding the need for human participation from some actions [1].

Patients, doctors, and medical facilities benefit from the use of IoT in healthcare. And, despite security concerns, the future of IoT in the health sector is bright.

The Internet of things is not new, but recently it has attracted more and more attention. The concept involves the use of electronic devices that collect or track data and connect to a private or public cloud, which allows them to trigger certain events automatically.

The demand for connected devices covers many industries, including healthcare.

Just a few years ago practitioners closely followed the development of IoT to see if this would be part of their future. Today it is not only a reality but also a relief for both medical professionals and patients.

In the past decade, Internet-connected devices have been presented to patients in various forms. The use of IoT devices has played an essential role in providing more valuable real-time data to doctors and reducing the need for direct patient-doctor interaction [2].

The IoT revolutionizes patient data collection and records, performs individual health assessments [3].

Many applications have appeared to give people more control over their health [4]. For example, sleep apps track sleep cycles to make sure the person gets enough rest. Fitbits track exercises help people stay fit. Calorie planning apps help in cooking; many apps offer an individualized meal plan, so people know what to eat and which food to avoid.

IoT facilitated remote health monitoring system has many benefits over conventional health monitoring system [5]. IoT devices can be used to enable remote health monitoring of patients with chronic diseases such as cardiovascular diseases (CVD) [6], while long-term Electrocardiogram (ECG) monitoring in residential environments has been proposed [7].

Another IoT achievement is Intelligent Continuous Glucose Monitoring (CGM).

Diabetes is fertile ground for the development of intelligent devices since this disease affects about one in ten adults and requires constant monitoring and prescription of treatment.

The Continuous Glucose Monitor (CGM) is a device that helps people with diabetes continuously monitor their blood glucose levels for several days by taking readings regularly. The first CGM system was approved by the US Food and Drug Administration (FDA) in 1999. In recent years, several intelligent CGMs have appeared on the market.

Intelligent CGMs, such as Eversense and Freestyle Libre, send blood glucose data to an app on an iPhone, Android, or Apple Watch allowing the user to check their information and identify trends easily. The FreeStyle LibreLink application also allows for remote monitoring by caregivers.

Another smart device that improves the lives of patients with diabetes is an intelligent pen with insulin. They have the ability to automatically record the time, amount and type of insulin given in a dose, and recommend the correct type of insulin injection at the right time.

The devices interact with a smartphone app that can store long-term data, help diabetics calculate insulin dosage, and even (in the case of Gocap) allow patients to record their

food intakes and blood sugar levels to see how their diet and insulin consumption affect their levels blood sugar.

IoT also includes connected inhalers. The largest manufacturer of intelligent inhalers is Propeller Health. Instead of producing whole inhalers, Propeller created a sensor that connects to an inhaler or Bluetooth spirometer. It connects to the app and helps people with asthma understand the causes of their symptoms, tracks the use of medications.

One of the advantages of using a connected inhaler is that medications are taken more consistently and more often. The Propeller sensor generates inhaler usage reports that you can share with your doctor and shows if they use it as often as prescribed.

Medical smart contact lenses are another ambitious IoT application in healthcare. Some companies are working on programs for smart lenses which are aimed at the treatment of hyperopia caused by the loss of elasticity of the lens of the eye, and recovery after surgery to remove cataracts. The results, of course, still create skepticism but according to some scientists, this development has the right to exist.

The Swiss company Sensimed has also developed the non-invasive intelligent Triggerfish contact lens which automatically records eye size changes that can lead to glaucoma.

Progress IoT reached even the launch of smart hospitals. Smart Hospital uses related assets to improve services, procedures, and capabilities. Connected assets enhance the functionality of all hospital equipment. The work of maintenance managers will be simplified, as they can remotely control the temperature in the hospital, humidity and air regulation.

Managers will also have access to predictive analytics through which managers can solve a problem before it happens.

IoT reduces emergency waiting time. For example, the Sinai Medical Center in New York effectively cut waiting times for 50% of emergency room patients who need inpatient care.

In some cases, patients do not even need to visit the emergency room or hospital. One of the most visible and widespread applications of healthcare and IoT is remote health monitoring, sometimes known as telehealth.

IoT helps with problems of chronic diseases. Utilities such as Fitbit use IoT to monitor personal health. Such information can be passed on to your doctor to help solve recurring problems. A company called Health Net Connect recently created a diabetes care program for the population to improve clinical treatment and reduce the cost of treating patients — and they have already produced some impressive results.

For the future, related technologies can revolutionize the industry and create products such as smart inhalers, smart pills and more, all of which will help people become healthier. Many stakeholders, and especially patients, will benefit from the expansion of IoT in healthcare, so many are keen to invest in this sector.

The Internet of Things (IoT) has opened up a whole world of opportunities in medicine: when connected to the Internet, conventional medical devices can collect invaluable additional data, provide further insights into symptoms and trends, provide remote treatment and generally give patients more control over their lives and treatments [8; 9].

Wearable devices have become products that patients now carry, transferring data to doctors and, thus, allowing doctors to track vital signs in real time, including heart rate, glucose level, and even fall detection.

Thanks to medical remote monitoring devices for patients who collect vital data elements in real time, patients can be in the comfort of their homes, while remaining under the close supervision of a medical professional.

In the future, when IoT becomes more common in medical facilities, we will see that next-generation IoT devices provide intelligent services, allowing real-time data processing [10].

This is very important for scenarios in which traditionally devices may require a connection to a server or network. But thanks to the ability to perform processing at the device level, they now do not run the risk of malfunctioning if the device loses connection or is required to work offline. For example, an insulin pump that operates independently of the Internet will continue to analyze glucose levels on the verge — the patient — and release the right amount of insulin and upload data to the cloud when it connects to the Internet.

How far will IoT go? The growing interaction of artificial intelligence and IoT in the healthcare sector is likely to lead to the creation of more intelligent IoT devices that can perform actions autonomously.

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Challenges of Digital Transformation in Healthcare

Serik Smagulov,

Viktoriya Smagulova MD

Abstract

This article addresses the challenges of introducing digitalization technologies in healthcare. Connected devices mean infinite patient data collection. One of the main issues is the issue of security of personal data. This is a huge problem for all technology industries but more so for health care, given the personal nature of the data. Most healthcare organizations are so cautious about the consequences that they do not decide on a digital immersion. The article details the problems of cybersecurity and cyber attacks. Personal data security issues are particularly tangible in the field of the Internet of Things (IoT). There is another reason that puts most digital conversion plans to a standstill; this is a cost factor. Data aggregation and interoperability is another critical issue for healthcare institutions. Integration and interfaces, in this case, are unnecessarily complicated and risky. The author notes the importance of digital transformation, which should not only revolutionize patient care but also allow healthcare organizations to reduce the amount of time spent on documenting and data entry. And the data itself should be reliably protected.

Keywords: digitalization, cyber attacks, cybersecurity, Internet of things, database.

Connected devices mean infinite patient data collection. Electronic records help medical personnel reduce the time they need to search for information about each patient. Data collected from the patient's wearable device can also be safely stored in his electronic medical record, which makes it easy to diagnose when all the information is in one place. In this case, the main question still arises - the issue of personal data security.

Data security is also essential because of the increasing threat of cyber attacks. This is a massive problem for all technology industries, but more so for health care, given the personal nature of the data [1; 2; 3]. Most healthcare organizations are so cautious about the consequences that they do not decide on a digital immersion.

Embedding big data in healthcare significantly increases data privacy and patient safety. The main reason is that their information is stored in data centers with different levels of security. Moreover, data comes from different places, which carries additional risks.

A cloud solution that uses big data helps strengthen security to meet HIPAA requirements, which is unique to the healthcare industry. Also, it is a cost-effective solution.

The rapid digitization of health care delivery, from electronic health records and telehealth to mobile health (mHealth) and network-enabled medical devices, introduces risks related to cybersecurity vulnerabilities [4].

Experts agree that for enterprises there are many ways to ensure the safety of patient data and research data in the digital environment. Cybersecurity should be a significant concern.

Organizations need to invest in staff with the right skill set, train employees in security measures, update known software vulnerabilities and ensure the safe construction of systems and processes. In an ever-changing digital world, you need to improve security measures in order to control cyber threats constantly.

Cyber attacks may also affect the safety of patients, for example, by compromising the integrity of data or impairing medical device functionality.

The WannaCry and NotPetya ransomware attacks and vulnerabilities in Medtronic Implantable Cardiac Device Programmers are recent examples that have resulted in impaired health care delivery capabilities [5].

Personal data security issues are particularly tangible in IoT.

The Internet of Things (IoT) has opened up a whole world of opportunities in medicine: when connected to the Internet, conventional medical devices can collect valuable additional data, provide further insights into symptoms and trends, provide remote treatment and generally give patients more control over their lives and treatments.

Wearable devices have become products that patients now carry, transferring data to doctors and, thus, allowing doctors to track vital signs in real time, including heart rate, glucose level, and even fall detection.

The introduction of the Internet of Things technology has created many problems regarding the privacy and security of personal data. Although many modern devices use secure methods to transfer information to the cloud, they may still be vulnerable to hackers.

In addition to theft and unauthorized use of personal data, IoT devices can be used to harm. To counter these risks, the US Food and Drug Administration (FDA) has published

many guides to ensure the integrated safety of connected medical devices, and regulators are likely to continue to regulate the connected devices used by patients.

There is a complex structure of controllers and data processors with many different policies, privacy notices, and consents. The sensitivity of the data and the fact that most of their data is still stored on paper facilitates auditing, control, and access.

Often you can face to ransomware attacks. Finding employees with the right skill set, educating employees about security measures, updating known software vulnerabilities, and ensuring that systems and processes have a secure design is crucial to implementing more stringent security measures to eliminate the risks of cyber threats [6; 7].

There is another reason that puts most digital conversion plans to a standstill; this is a cost factor. Medical organizations tend to focus on return on investment (ROI), not thoroughly evaluating the value proposition.

Some businesses find that adopting a digital strategy offers a larger scale, revenue, and profit. Instead of considering the costs incurred, it is better to take into account the money saved as soon as the inefficient processes are corrected by digital conversion. For example, telemedicine can reduce the need for a personal consultation, which allows physicians to serve more patients and, consequently, save money.

The same is true for the treatment of chronic diseases. Telemedicine can really save money [8; 9; 10].

Data aggregation and interoperability is another challenge for healthcare institutions. The amount of data that health organizations generate daily is enormous, but very few can use it wisely.

When data is stored in an organization’s repositories, it is difficult to access, analyze and work using available data. The problem can not be solved just adding a new technology which many enterprises have mistaken for digital transformation.

To make a holistic, patient-centered perspective a reality, health organizations should focus on integrating data from all systems and facilitate cross-functional

collaboration. There should be a comprehensive solution to the problem, not imposing responsibility only in the IT department.

During participation in digitalization, many health institutions are confronted with a lack of an overall picture. Many hospitals claim to be "digital" thanks to the implementation of an integrated hospital information system (HIS) and electronic medical records (EMR). But this is not enough to be digital.

From registration and consultation to inpatient care and follow-up after discharge, the client's entire journey must be considered when planning a hospital's digital conversion. Unfortunately, very few institutions have a clear overall picture before they embark on the path of digitalization.

Companies must develop a clear vision of how they will meet the digital needs of their customers, set goals against this vision, and then begin with implementation. The process should be carried out, starting with investing in upgrading outdated systems and ending with offering real-time solutions and solving security problems.

In any case, when making the necessary changes, it is required to initially change the behavior of the person himself and the action of the management.

Changing a piece of equipment or even software is relatively easy compared to convincing people to change the way they work and spend time learning how to use new systems. This process should be carefully monitored to ensure that change for all is as easy to adapt as possible, and people interested in making changes.

People will use the new system only if they see the gap that it fills or the efficiency that it creates. Early-stage end-user participation is crucial to ensure that the technology meets their needs and that the user interface is convenient for them.

Sometimes in the process of implementing a digitalization program, there is a problem with interoperability for digital health systems. Integration and interfaces, in this case, are unnecessarily complicated and risky.

Staying up to date with the latest technology and changing rules is crucial to improving processes and meeting the needs of patients in a changing digital world. Here both trends remain that need to be addressed in order to preserve health care in the 21st century.

The health care industry must take into account the pace of digital technology diffusion in various sectors. Health care companies must be significantly transformed to remain relevant.

The digital transformation should not only revolutionize patient care but also allow healthcare organizations to reduce the amount of time spent on documenting and data entry. And the data itself must be reliably protected.

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The Need of Big Data Analytics in Healthcare

Serik Smagulov,

Viktoriya Smagulova MD

Abstract

This article addresses the need for big data analytics in the healthcare system. The use of big data demonstrates interesting perspectives for improving health outcomes and cost control. The author noted that the use of big data analytics in health care has many positive results. With the introduction of digital technology, it has become possible not only to collect such data but also to convert it into important information that can later be used to provide better service. The advantages of using big data for online reporting and business intelligence, for tracking various user statistics and vital functions are considered. It noted the importance of collecting and processing data for continuous monitoring of vital body functions so that it is possible to identify potential health problems and assist before the situation worsens. The author also identifies the problem of confidentiality of the collected and analyzed data. At the same time, the positive aspects of this process are noted: the introduction of big data in healthcare significantly increases the confidentiality of data and patient safety. This is due to the fact that the information is stored in data centers with different levels of security. In general, according to the author, big data is a new way to overcome existing problems in world medicine.

Keywords: Big data, Business Analytics, Internet of Things, healthcare.

Big data has long been accessible in various industries, but their application in health care is still in its infancy. The use of big data demonstrates interesting perspectives for improving health outcomes and cost control.

Big data in the healthcare industry is changing approaches to treating patients and doctors [1; 2].

The more data involved, the more effective health care can be.

The use of big data analytics in healthcare has many positive results. Health care uses specific data about the health of the population (or a particular person). In this regard, the analysis of big data allows you to identify signs of serious diseases as they arise.

The treatment of any disease at an early stage is much easier and cheaper. Using medical data analysis for prevention is better than cure, and the ability to create a comprehensive picture of the patient will allow insurance companies to provide an individual package of services.

Not automated collection of vast amounts of data for medical use is expensive and time-consuming. With the introduction of digital technology, it has become possible not only

to collect such data but also to convert it into relevant information that can later be used to provide better service. This is the purpose of analyzing health data.

The need for big data is due to rising costs in healthcare in many countries [3]. But there are many obstacles to the widespread dissemination of medical data [4].

One of the most significant barriers to the use of big data in medicine is the way medical information is distributed across many sources. Integration of these data sources requires the development of a new infrastructure in which all data providers will cooperate with each other.

The introduction of new software for online reporting and business intelligence is equally important [5].

The goal of business intelligence in health care is to help doctors make decisions based on the data obtained in a short time and improve patient care.

Big data can drastically modernize the health sector.

Big data and analytics, along with the Internet of Things (IoT), is revolutionizing a way to track various user statistics and vital functions [6].

In addition to the primary wearable devices that can monitor the patient's sleep, heart rate, exercise, etc., there are new medical innovations that help control the patient's blood pressure, blood glucose and much more.

Continuous monitoring of vital body functions, as well as data collection from sensors, will help identify potential health problems and provide assistance until the situation worsens.

Big data helps reduce the cost of medical institutions [7; 8]. They become an excellent way to save costs for hospitals with large numbers of medical personnel to help with its distribution.

In fact, big data helps maximize investment. The use of medical trackers allows patients to stay at home under 24-hour remote medical supervision, which in turn reduces the funds of insurance companies for their inpatient stay. Predictive analytics based on Big Data also helps reduce costs by reducing the frequency of re-admissions.

Another advantage of Big Data is to help high-risk patients [9; 10]. The ideal option is to digitize all hospital data that can be accessed. This will help identify patients who go to the hospital repeatedly and identify their chronic problems. Such an understanding will help to take better care of such patients and provide insight into corrective measures to reduce their inpatient stay.

Big Data helps to prevent human errors. Often there are cases when experts prescribe the wrong medicine or send a prescription by mistake. It is possible to reduce the risk of such errors by using big data to analyze user data and prescribed medications. Such software can be an excellent tool for doctors who serve many patients per day.

Big data can be a significant advantage for the development of science and technology. In the health sector, some programs can be used to view multiple data for a few seconds in order to find solutions for various diseases.

Big Data can improve the quality of services. Predictive analytics helps to get more accurate results. Moreover, algorithms can provide personalized treatment based on existing information.

Personalization includes comparing drugs with a person's genetic characteristics and developing them based on various factors such as the environment and lifestyle.

In addition, patient data will not be analyzed in isolation. They will be considered along with other cases that allow you to create templates for better analysis. Thus, doctors get valuable predictive modeling with data on how to cure patients with the same conditions.

There are already several completed projects in the field of Big Data. For example, Apple and IBM have developed a big data platform for exploring new biometric data and activity in real time. Users can track health-related data, and the system will offer appropriate treatment for them. In addition, these medical tips will be based on human habits, age, past conditions, etc.

The primary goal of such a platform and healthcare devices is to give people the opportunity to get professional advice remotely. Information from smart devices allows doctors to keep in touch with their patients, track their condition and set an automatic reminder about taking medication.

Another need to use big data in healthcare is related to informed strategic planning.

The use of big data in health care allows for strategic planning due to a better understanding of people's motivation. You can analyze the results of checks among people in different demographic groups and determine, for example, which factors prevent people from starting early treatment.

As an example, consider the activities of the University of Florida, where Google Maps and free public health data were used to prepare maps reflecting various problems, such as population growth and chronic diseases.

Subsequently, scientists compared these data with the availability of medical services in different areas. The findings allowed them to review their work strategy and add more care units to the most problematic areas.

Embedding big data in healthcare significantly increases data privacy and patient safety. The main reason is that their information is stored in data centers with different levels of security. Moreover, data comes from different places, which carries additional risks.

A cloud solution that uses big data helps strengthen security to meet HIPAA requirements, which is unique to the healthcare industry. Also, it is a cost-effective solution.

Many companies use a hybrid approach to their data storage strategy with flexible functions. However, it should be borne in mind that all systems can interact and exchange data with other segments of the company.

Lack of control may allow fraudsters to hack the system. In this regard, there may be enormous losses for the company.

In general, big data is a new way to overcome existing problems in world medicine, such as low budget and overworked medical workers. When doctors have all the necessary information in one place, you can achieve excellent personalization and offer treatment that is suitable for a specific person.

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Innovative Health Technologies Based on Big Data

Serik Smagulov,

Viktoriya Smagulova MD

Abstract

This article discusses the possibilities of using big data (Big Data) in innovative technologies in healthcare. We are talking about processing and storing large data which allow making diagnosis more accurately, checking medical data without burdening doctors, and integrating the results of studies performed on different devices into a common system. Big data analysis is also needed to optimize the staffing of healthcare institutions. The author also discusses various healthcare applications for smartphones and other mobile devices that also work on the basis of big data (CareAware Connect, MyChart, Healthtap). Of course, one of the biggest trends in business intelligence remains predictive analytics in healthcare. With examples of using big data in this industry, this article examined the main trends in improving the quality of treatment for patients, especially those suffering from chronic diseases, tracking the general health of the population and reducing the overall costs of medical institutions.

Keywords: Big Data, business analytics, mobile applications, electronic health record (HER), telemedicine.

The world of big data represents fertile ground for various IT products. IT solutions can lead to the extension of the life of a particular person and improve the quality of his life. Processing and storing big data allows you to make diagnosis more accurately, to check the medical data without the burden on doctors, and also to integrate the results of studies performed on different devices into a conventional system.

Electronic health records (EHR) are the most common application of big data in medicine [1]. Each patient has his or her digital record, which includes demographic data, medical history, allergies, laboratory test results, etc.

Records are transmitted via secure information systems. Each record consists of one variable file, which means that doctors can make changes over time without paperwork and without the danger of data replication [2].

EHR can also trigger warnings and reminders when a patient has to undergo new laboratory tests or keep track of prescriptions to see if the patient has performed the doctor's prescriptions [3; 4].

Although electronic health records are a great idea, many countries have not yet entirely switched to using them.

Other examples of big data analytics in healthcare have one important function — real-time alerting. For instance, in American hospitals, Clinical Decision Support (CDS) software analyzes medical data on-site, providing advice to physicians when making prescriptive decisions.

Big Data analysis is needed to optimize personnel work. After analyzing the data on visits and determining when a large number of visitors are expected in health care facilities, additional staff can be attracted, which will lead to a reduction in patient waiting times and improving the quality of care.

With regard to patient health data, the latest wearable devices are capable of continuously collecting patient health data and sending this data to the cloud.

For example, if a patient's blood pressure rises alarmingly, the system will send a warning in real time to the doctor, who then takes action to contact the patient and takes measures to reduce pressure.

Another example is Asthmapolis, which began using inhalers with GPS trackers to identify asthma trends at the individual level as well as when looking at large populations. This data is used in conjunction with the CDC data to develop more effective treatment plans for asthmatics.

Of course, predictive analytics in healthcare is one of the most significant trends in business intelligence.

The goal of business intelligence in healthcare is to help physicians make data-based decisions and improve patient care within seconds. This is especially useful in the case of patients with a complex history of the disease, suffering from multiple diseases. New tools will also be able to predict, for example, who is at risk for any diseases, and therefore, additional examinations are recommended.

Of course, as in other industries, there are many obstacles to introducing the latest technologies using Big Data, including incompatible data systems and patient privacy issues. But it is believed that analytics can improve security. In addition, it helps to simplify the processing of insurance claims.

Big Data can be found in the field of telemedicine. This term refers to the provision of remote clinical services using technology.

Telemedicine is used for the initial consultation and initial diagnosis, remote patient monitoring and medical education for medical professionals [5].

Clinicians use telemedicine to provide personalized treatment plans and prevent hospitalization or re-hospitalization [6; 7].

This use of medical data analytics may be associated with the use of predictive analytics, as shown earlier. This allows doctors to predict acute medical events in advance and prevent the patient from worsening. Patients can avoid queues, and doctors do not waste time on unnecessary consultations and paperwork.

Telemedicine also improves access to medical care, since patients can be monitored and counseled at any place and at any time.

Healthcare applications for smartphones and other mobile devices also operate on Big Data [8; 9]. They act as personal assistants.

With this in mind, it is not surprising that all-important mobile device companies integrate tools and features into their devices that help users keep track of their daily physical activity, such as the number of steps taken during the day, heart rate and other vital functions, the amount of calories burned for running, walking or using an elliptical trainer and much more.

Mobile devices and applications are crucial to the health revolution for big data. Big data applications in healthcare send all digital health-related information recorded by mobile devices to cloud servers, directing it to the Big Data database to create reports and support data analysis, including trend recognition.

A person’s digital information can be compared and analyzed with thousands of other users, thereby identifying threats, trends, and problems using patterns. This can lead to a complex prognostic model based on data from numerous patients with similar conditions, genetic factors, and lifestyle choices.

Mobile healthcare applications are an integral part of devices designed to access big data medical information.

Recently, some applications are gaining special popularity. All of them are based on aggregated data and input made to the application.

CareAware Connect is a mobile application that manages clinical communications on a single device for groups that collaborate to better coordinate medical care. Users can view patient data, learn about various health indicators.

MyChart is an application that allows patients to view health data after previous visits to the doctor. Users can see test results, medications, and health status as data provided by a health care provider.

Healthtap is a website and mobile app that serves as an interactive platform for healthcare that initially started as a question and answers service, allowing patients to send health questions to proven doctors. Thanks to it, the company can offer services that include tips on health, telemedicine, and doctors' reviews of specific medicines.

Big data analytics can be used directly in a particular hospital [10]. The medical information panel provides the necessary data. By collecting at one point all the data about each department of the hospital, attendance, its nature, costs incurred, etc., you can get a general picture of the institution, which will be useful for its efficient and smooth operation.

Here you can see the most critical indicators that relate to various aspects: the number of patients who were admitted to the hospital, how long they were and in which department, how much their treatment costs, as well as the average waiting time in emergency departments.

Such a holistic view helps the hospital management to identify potential bottlenecks, identify trends and patterns, and generally assess the situation.

In general, in these examples of using big data in health care, we looked at the main trends in improving the quality of patient care, the general health of the population and the decrease in total costs.

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Blockchain Technology in Healthcare

Serik Smagulov,

Viktoriya Smagulova MD

Abstract

This article discusses the possibility and validity of the use of blockchain in health care. When it comes to managing public health the biggest problems that have so far been encountered are data security, sharing and compatibility. If patient information is isolated and stored in several systems that do not allow for the smooth exchange of information, the population health data sets for different patient sets will be insufficient. Blockchain, according to the author, provides a reliable solution to this particular problem. The article discusses in detail the three basic principles of the blockchain: cryptography, distributed books and authentication. The distributed blockchain technology with such properties as immutability, reliability and decentralization, provides the healthcare sector with opportunities to detect fraud, reduce operating costs, smooth processes, eliminate duplication of work, and apply transparency in the health ecosystem. If used correctly, the blockchain will improve security, data exchange, compatibility, data integrity and update, and real-time access. The author of this article points out the importance of using the blockchain for data security in clinical trials, which always require a huge amount of data sets.

Keywords: blockchain, cryptography, distributed books, authentication, data, security.

In the health sector, critical patient data and information remain scattered across different departments and systems. Because of this, important data is not available and easily accessible if necessary.

The misuse of available data prevents health organizations from providing appropriate patient care and high-quality services to improve health. Even though these organizations are quite useful from an economic point of view, they cannot meet the needs of patients.

Many medical institutions today still rely on outdated patient record keeping systems. These systems support the functionality of maintaining local patient data records. This can make it difficult for the doctor to diagnose, which is time-consuming and tedious for patients. Due to this, the cost of a patient-centered work increases significantly.

Another time-consuming and tedious process that leads to high costs in health care is the exchange of medical information. Since patients have no control over their data, the likelihood of identity theft, financial data offenses, and spam increases every day.

Compatibility is a huge problem in the healthcare industry [1]. Well-communicating systems can improve operational efficiency, reducing time spent on administrative tasks like manually entering data received from faxes [2]. Among the main problems, there are the problem of identifying patients and the problem of blocking information.

In this regard, Blockchain is a solution for many of the problems listed here.

Blockchain technology is one of the most important and destructive technology in the world. Many industries are adopting blockchain technology for innovation in their work. One of the sectors that are seeking to take the blockchain is the healthcare industry [3].

In the simplest sense, the blockchain is a series of permanent data records with timestamps that are managed by a cluster of computers that do not belong to any single entity. Each of these data blocks is protected and linked to each other using cryptographic principles.

The reason why the blockchain has become so popular is that it does not belong to one person; therefore, it is decentralized [4]. Also, data is cryptographically stored inside. The blockchain is immutable, so no one can interfere with the data that is inside the blockchain. The blockchain is transparent so that you can track data.

The work of the blockchain is based on three basic principles that have existed for a long time. The compiled work of these principles allows the blockchain to provide safe and secure digital relationships.

- *Cryptography with a private key.* In cryptography with a private key, the secret key is used as a variable along with the encryption and decryption algorithm. The key is kept secret, even if the algorithm is not. In the blockchain, a link to secure digital identification is created, but transactions are carried out in an open network.

- *Distributed books*. A distributed register, also known as a general register, is called a consensus of general records. In the DLT, the ledger is updated in real time, and no central authority is responsible for its maintenance. Instead, network members update the register. Any changes made to the ledgers are reflected within a few seconds.

- *Authentication*. Authentication is a process that proves authenticity. In the blockchain, all transactions are authenticated before being added to the chain. This process takes place with the help of algorithms that check and verify all transactions. Once the information is encrypted, digitally signed and saved, the authenticity is sealed.

Blockchain can also help create a patient information exchange market [5; 6]. Thus, it will be possible to stimulate the exchange of information between different institutions to prevent any blocking information.

Because the blockchain is immutable and traceable, patients can easily send entries to anyone without fear of data corruption or tampering.

Similarly, the medical card that was generated and added to the blockchain will be fully protected.

A patient may have some control over how his medical records are used and transmitted by the institutes. Any party who wants to obtain medical data about a patient can check with the blockchain to obtain the necessary permission.

Various medical institutions around the world conduct their research and clinical trials of multiple new drugs and medicines. The blockchain will help create a single global database to collect all this data and put it in one place.

According to a study conducted by IBM, about 16% of health managers have decided on their plans to implement the blockchain solution in their work this year, while about 56% expect to perform the blockchain by 2020.

Blockchain allows you to create and distribute a single common health database.

This system will be available to all persons involved in the process, regardless of which electronic medical system they use. This provides a higher level of safety and transparency, allowing physicians to devote more time to patient care and treatment. Also, it will also allow for a better exchange of research statistics, which, in turn, will facilitate clinical trials and treatment of diseases [7]

Participants can share and track their data and other activities taking place in the system without having to search for additional options to ensure integrity and security.

In accordance with the requirements and access permissions for network participants, two types of block chains can be used: allowed blockchains and block chains without access rights, which would enable anyone to create their address and start interacting with the network.

The distributed blockchain technology, with properties such as immutability, reliability, and decentralization, provides the healthcare sector with opportunities to detect fraud, reduce operating costs, smooth processes, eliminate duplication of work, and apply transparency in the health ecosystem [8].

The existing health care system and organizations work through a single central database. A single entity manages this database in the organization. With this approach, the point of failure is also reduced to a single point.

In such cases, if a hacker or an antisocial element attacks the system, a person can access the entire database and put at risk both the patient and the organization [9].

Blockchain can be used to prevent an organization's internal infrastructure. A large organization with several independent entities with different levels of access in the register of blockchains with encryption built into the blocks will save organizations from external threats and attacks.

If a blockchain network is correctly implemented in a health organization, this will prevent such redemption attacks, as well as other problems, such as data corruption or equipment failure.

Blockchain can also be used for data security in clinical trials. Therefore, a vast number of data sets are required for a clinical trial. Researchers focus on these datasets and conduct regular tests under various circumstances to generate reports, statistics, and performance ratios [10].

Based on these reports, data is analyzed, and further decisions are made. Research documents can be stored as smart contracts on the blockchain, acting as digital fingerprints.

With regard to the security of personal data, the blockchain system for managing patient data can create a hash for individual blocks of patient health information, and the collective system will be a patient identifier on a theoretical basis.

The blockchain system will allow patients to disclose the necessary data to third parties while maintaining their identity in secret. Patients can also control the timing and access rights for exchanging data with third parties.

As we see, the use of blockchain in health care is more than justified [11]. The only problem now is to force medical workers to implement blockchain systems on a larger scale.

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