Critical Factors and Challenges of Healthcare Digital Transformation

Igor Ilin, Victoria M. Iliashenko, Alissa Dubgorn, and Manfred Esser

Abstract The focus of countries is currently aimed at ensuring high-quality medical care and optimizing the cost of its provision. The last decades were characterized by rapid progress in the introduction of new technologies, many of which are capable of significantly improve the prognosis regarding serious illnesses. Healthcare organizations are seriously considering how to evaluate the effectiveness of the introduction of new technologies and how to correctly correlate it with the cost treatment and optimize costs within the health care system. This article analyzes modern trends in the field of healthcare, such as value-based medicine, personalized, and value-oriented. Within this framework, the authors make an overview of the current state of digitalization of healthcare not only in the Russian Federation but also in the world arena. The key factors in the development of digital healthcare are discussed, as well as the risks in the implementation of digital solutions.

Keywords Healthcare · Digital technologies · Value-based medicine

1 Introduction

At the present stage of the development of society, the main goal in the field of public health is not just an increase in life expectancy but an extension of a high-quality and healthy life. The problem of preserving and strengthening the health of the population has been declared one of the priority directions of the socio-economic policy of Russia. That is why the most important strategic direction of the socio-economic development of Russia as a whole is the preservation and augmentation of human capital, which cannot be imagined without improving the health care

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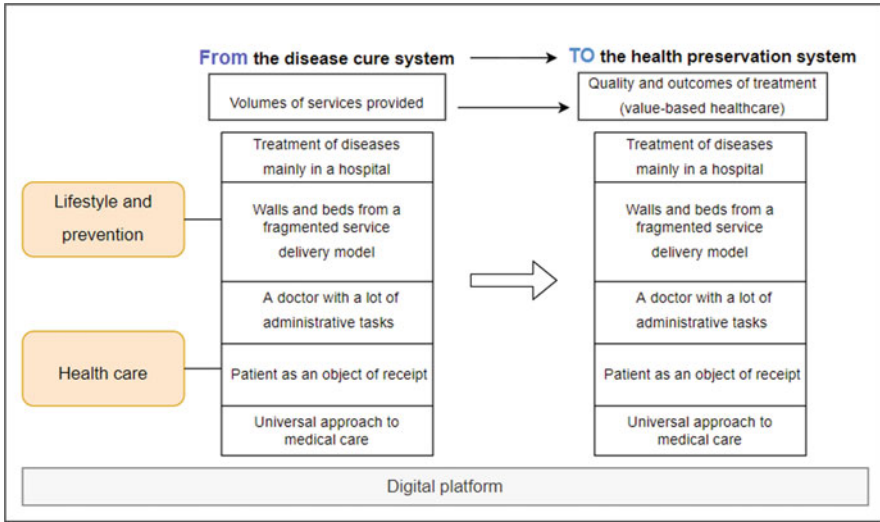
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Fig. 1 Scheme of the transition to a new trajectory of health values (source: authors' creation)

system—pinions (Maydanova & Ilin, 2019). According to the definition of the World Health Organization (WHO), health is a collection of all organizations, institutions, and resources, the main goal of which is to improve health.

Creating a truly modern a health system that would correspond to the highest international standards implies an improvement in both the quality and accessibility of medical care, which in the context of tense financial situation, large area, limited resources and changing demographic situation requires new technological solutions (Wong, 2015). Most of the developed countries of the world, like Russia, see a way out only in the further technologization of all processes of providing medical help. In modern conditions of the dominance of information technology (IT), target the state of the industry is called "digital medicine" and "digital health."

The structure and level of morbidity are the most important components of a comprehensive, integrated assessment of the health of the population. Its study is necessary to substantiate management decisions at the federal, regional, and municipal levels of healthcare management. Only on its basis is it possible to correctly plan, predict the development of a network of healthcare institutions, its needs for various types of resources, including information technology (Ilin et al., 2019) (Fig. 1).

The main prerequisites for the development of digital health are (Karpov et al., 2019):

– Scientific and technological progress—advances in the development of science and technology in medicine, molecular biology, computer science, and an increase in computing power. New effective methods and tools diagnosis and treatment.

– Global informatization and mobility—people are no longer limited by geographic barriers in communication; they are actively using the Internet, mobile devices, social networks, and communication apps at a convenient time.
– Patient-centered—modern a person leads a healthy lifestyle, but how the patient makes decisions on voluntary health monitoring, actively participates in the collection of data, familiarization with information resources, selects the attending physician and treatment strategies.
– Data centricity—an abundance of data on the health status of citizens, on the basis of which analytical tools are created for decisión-making.

A number of factors can be identified that affect the speedy transfer of medicine to a digital format—these are huge distances, a highly educated population, a large number of small settlements where primary health care is provided by Feldsher-midwife stations or with the involvement of households.

Below in the article, the authors describe in detail the key trends in health care development, development factors and the main risks that medical institutions face.

2 Modern Trends in Healthcare Development

Technologies of the future, special attention of people to their health, scientific research and discoveries—all this sets trends in the development of the industry. Among them, there are several main directions in which the health care of the future will move (10 technologies, etc.). One way or another, each of them is aimed at improving the lives of patients and facilitating the work of the doctor (Fig. 2).
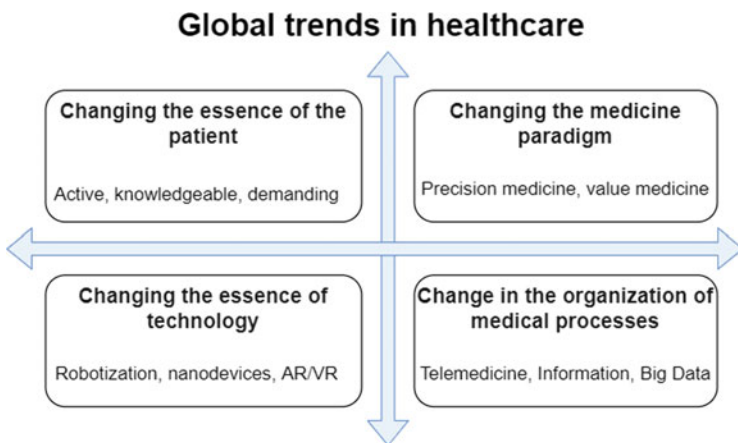

Global trends in healthcare

Changing the essence of the patient	Changing the medicine paradigm
Active, knowledgeable, demanding	Precision medicine, value medicine
Changing the essence of technology	Change in the organization of medical processes
Robotization, nanodevices, AR/VR	Telemedicine, Information, Big Data

Fig. 2 Global trends in healthcare (source: authors' creation)

2.1 Digitalization

Digital technologies are laying the foundation for increasing the efficiency of health systems, expanding the ability to track health indicators, and improving the quality and safety of treatment through the use of artificial intelligence and personalized medicine (Mitchell & Kan, 2018).

The market for digital technologies in healthcare is growing by a quarter every year. According to Global Market Insight, its volume will reach $116 billion by 2024. The rapid growth rates are due to active support from the states, because digitalization can help to reduce health care costs in general significantly.

Today in medicine, developments related to artificial intelligence are most in demand. AI is actively used in diagnostics, drawing up a personal treatment plan and selecting the optimal formula for drugs (Iliashenko et al., 2019).

The Internet of Medical Things (IoMT) is also in demand—various devices with the function of exchanging data over a global network. They are mainly used for patient monitoring. According to experts, by 2020, about 30 billion IoMT devices will be used in the world (Dilawar et al., 2020).

Telemedicine also belongs to digitalization. Despite the fact that it is no longer something innovative, this trend is not slowing down. There are still many areas in the world where medical care remains difficult to access. Video and audio chats with doctors are still the most popular telemedicine technology.

2.2 Patient Centricity

At the head of this model is not a medical institution and individual doctors, but the needs of the patient, the quality of his treatment, the comfort of his stay and the achievement of specific goals of his treatment. In fact, this is a separate area of health care development. In it, the patient is a fully valuable personality in whom it is important to see not only the state of health but also psychological and social characteristics.

Personalized medicine is, first of all, integral medicine, which includes the development of personalized treatments, testing for disease susceptibility, prevention, as well as combining diagnostics with treatment and monitoring of treatment (Vogenberg et al., 2019).

Communication occupies a special place in this model. Patients pay special attention to how health workers communicate with them, and on the basis of this, they assess the activities of the institution and the health care system as a whole. The patient becomes more and more an active participant in the treatment process, having the greatest interest in the result.

The basic principles of personalized medicine (Translational 7P medicine) include (Ishikawa, 2020):

- Ability to "predict" the disease (predictiveness).
- Taking specific measures to prevent the disease (prevention).
- Individual treatment of each (personalization).
- Training of new personnel for health care through transdisciplinary medical education (providing).
- The possibility of direct participation of the patient himself in the process of prevention and treatment (participation).
- The ability to conduct interdisciplinary research on the distant horizon (proactive).
- The possibility of forming the evolution of the patient's contact with medicine not only in the hospital but also outside it (point of patient care).

2.3 Datacentricity

The active digitalization of medicine has led to the availability of huge data on patients, specific cases of diseases and treatment histories. Thus, it is predicted that by 2025 the volume of medical data will be 1 ze-tabyte (trillion gigabytes). The presence of such a large amount of data provides a good basis for the analysis and output of statistics. Big Data will make it possible to make informed decisions both on the choice of the most effective methods of diagnostics and treatment of a particular patient and for the preparation of medical forecasts and the method of organizing care in general (Povorina & Kosinova, 2020).

Tech giants Microsoft, Amazon, Google, and Salesforce are trying to cement their place in the trillion-dollar market. Improving the use of electronic health records is considered a priority, as research has shown that doctors spend more time taking medical records than working with patients. Cloud service Google Cloud already generates Google $8 billion in revenue per year. Clients of Google Cloud include the private medical and research center Mayo Clinic, pharmaceutical company McKesson and insurance company Kaiser Permanente.

2.4 Values-Oriented Healthcare

This concept was originally proposed by the American economist Harvard Business School professor Michael Porter (Musina et al., 2020). The model is based on the focus on the values of patients, their expectations from the health care system. Further allocation of resources is carried out in accordance with the results obtained by the institutions of the health care system with the use of drugs or technologies. The model is based on the focus on the values of patients, their expectations from the health care system. Further allocation of resources is carried out in accordance with the results obtained by health care institutions using drugs or technologies.

The difference between classical health care systems is that in the traditional system, more attention is paid to planning, control and payment of processes and volumes of medical care. The value-based model determines the amount of payment for medical services, based on the results of treatment, the quality of life of patients and the level of satisfaction of their needs.

Value-Based Healthcare is based on six pillars and is about improving patient outcomes while optimizing costs for the healthcare system (Achieving value-based health):

1. Organization of integrated medical care for each nosology.
2. Monitoring outcomes and costs at the individual level.
3. Development of batch payments for the treatment cycle.
4. Interdisciplinary system of medical care.
5. Expansion of geographical coverage.
6. Development of an IT platform to support the health care delivery system and record results.

As part of a value-based approach to healthcare, practices such as:

1. Providing a "second opinion" and supporting informed decision-making by the patient.
2. Diagnostics and prevention of conditions preceding the disease.
3. The use of information technology for the accumulation of data about the patient and further monitoring of the state of health.
4. The use of telemedicine as an auxiliary tool to support the patient's health.
5. Measurement of satisfaction and analysis of patient needs.

In those countries where a value-based health model is already being implemented, studies have been carried out which have shown that the use of this approach allows (Shlyakhto & Conradi, 2019):

1. Reduce the number of planned and emergency hospitalizations to 20%.
2. Reduce the costs of the health care system by 6–15%.
3. Improve the quality of life of patients.

If we talk about Russia, the transition to value-based health care will require significant reorganization and restructuring of the functioning system. However, in my opinion, this model is the best way to improve the quality of medical care.

Speaking about the factors of health care development, one can single out:

– Increase in life expectancy
– Prolongation of a quality and healthy life

For the high-quality use of modern solutions in the field of health care, it is necessary to focus on three main points:

– High-quality data collection.
– Deep analytics of the received data.
– Integration of information systems and received data into a single digital circuit.

Effective digitalization of the healthcare system is built on the basis of a platform that unites all participants in the system into a single circuit. The cornerstone of the platform is the creation and development of digital twins (patient, doctor, medical organization). In addition, the creation of a single digital circuit will increase the efficiency of management, the accuracy of statistics and the quality of medical care—the data will make it possible to analyze in detail the incidence on a national scale (Shlyakhto et al., 2020).

For its creation in the period from 2019 to 2024, 177.7 billion rubles were allocated in the federal budget of the Russian Federation. The digital contour is, first of all, the regulation of business processes, a tool for effective interaction between participants in the healthcare system.

3   Digital Transformation of Healthcare: Global Experience, Key Factors, Difficulties

The widespread introduction of digital technologies, in turn, solves several important problems at once that have held back the growth of the market:

- Information about new goods and services, new technologies in the field of healthcare is easier and faster to reach the consumer.
- Information about the patient, his medical history becomes more accessible to doctors. This simplifies the diagnosis, reduces the risk of errors, speeds up the exchange of information between medical institutions.
- Mobile digital technologies simplify health monitoring, make complex wearable devices more accessible, such as, for example, heart monitors.
- The use of digital technologies makes it possible to develop new drugs more efficiently, faster and cheaper.
- Blockchain technologies reduce the risks of counterfeiting medical and biologically active drugs (Moosavi et al., 2017).

Medical organizations are already converting information into digital format, business processes are being automated, and centralized systems are being created in all subjects. The use of information technologies is aimed, among other things, at improving the quality of medical care provided through the latest diagnostic and treatment methods, systems for interpreting the results of medical research. All this should lead to a reduction in the number of medical errors, a decrease in the time spent waiting for medical assistance, and an increase in the effectiveness of treatment.

3.1   World Experience

Strategic geographic location, combined with a modern IT infrastructure and a favorable climate for innovation, creates all the necessary conditions for the accelerated development of digital health in Southeast Asia. Therefore, in this part of the article, we will present the world experience from these countries.

South Korea Experience

Using the example of South Korea, one can see a clear plan for the development of digital vision in the health sector.

South Korea's health care system is regulated by the Ministry of Health and Welfare (MoHW) and funded by the Compulsory Health Insurance System (NHIS), which covers 97% of the population. There are about 70,000 medical institutions in Korea, of which almost half are located in Seoul and the Gyeonggi province surrounding the capital, which explains the predominance of the national health industry in Seoul.

To combat rising costs, the government is implementing various measures aimed at developing the digital health industry. These include increased investment in the development of new technologies and improved regulatory policies for digital health products and services (Digital Health South Korea Market Intelligence Report).

The digital health ecosystem is made up of government agencies, regulators, industry associations, healthcare centers, large corporations, blockchain-based healthcare providers, and a range of startups. Key players in digital health include leading clinics such as the National University Clinic and Asan Medical Center, large conglomerates such as Samsung and LG Electronics, telecom providers (SK Telecom and KT), system integrators (LG CNS, SK CNC) as well as startups (H3Systems, Lunit and Insung) (Fig. 3).

Korea's well-developed ICT infrastructure serves as the foundation for digital healthcare, with the adoption rate of electronic health records (EMR) systems in Korea reaching 93.6% in 2017 in hospitals. Wide coverage is associated with universal digitization of patient data, digital storage of clinical images, electronic databases of hospital administrations and increased use of remote sensing technologies.

South Korea leads the world in terms of smartphone ownership (94% of adults own smartphones and use the Internet). This high penetration rate of smartphones makes it possible to integrate the use of wearable devices quickly.

Korea's largest consumer electronics giants—Samsung Electronics and LG Electronics—are investing heavily in medical applications and wearable devices such as the S Health app and smartwatches. In addition, SK Telecom and Seoul National University Hospital have formed a joint venture Health Connect, which develops mobile solutions. For hospital management and diabetes management in Korea, also intended for the market China. Products in the mobile consumer health market

Fig. 3 South Korea's digital healthcare ecosystem (source: IntraLink Ltd, 2021)

include wearable devices such as sweat rate sensors in the form of watches, patches for non-invasive blood glucose monitoring and painless drug delivery, biosensor smart contact lenses capable of measuring glucose levels in diabetic patients. Insulin delivery systems These include functions such as drug dosage control, glucose monitoring and emergency signaling.

Singapore Experience

The strategic geographic location, combined with a modern IT infrastructure and a favorable climate for innovation, creates the necessary conditions in Singapore for the accelerated development of digital health in this country in the Asia-Pacific region.

The country's health care system is designed to provide everyone with timely, cost-effective and unimpeded access to various levels of health care. The Singapore government controls and finances the bulk of the healthcare system; more than 80% of the hospital fund in Singapore is concentrated in government clinics, government subsidies shape patient and provider decisions and affect pricing (Digital health ecosystem in Singapore).

Singapore's health financing structure is structured around the "three Ms:" Medisave, Medishield and Medifund (Fig. 4).

Medisave—is a mandatory health savings account; each employee contributes from 8% to 10.5% of their monthly salary (depending on age group) to a personal
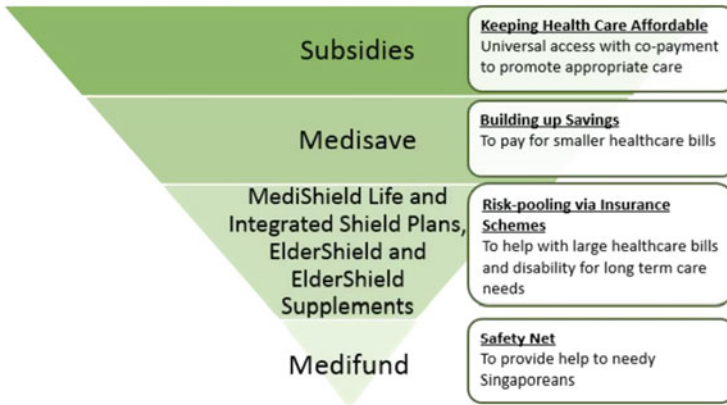
Fig. 4 The structure of the public health insurance system in Singapore (Source: https://ec.europa.eu/health/sites/default/files/ehealth/docs/ev_20180515_co23_en.pdf)

Medisave account. Patients can only use their Medisave accounts to buy pre-approved drugs, and the government subsidizes many medical bills directly. Medishield—is a nationwide emergency insurance program with higher deductibles. Medifund, $3 billion fund, helps citizens who cannot afford medical care through Medishield and Medisave tools.

The National Electronic Health Record (NEHR) is the backbone of digital healthcare in Singapore and is used by over 14,000 doctors in 280 healthcare facilities.

The main features of NEHR include (Fig. 5):

– A system for the exchange of patient data throughout the national health network.
– Management of the patient's medical record, collection of clinically significant information based on the results of contacts with medical workers throughout life.
– Ensuring secure access to the patient's medical record by authorized clinicians and healthcare professionals.
– Ensuring greater coordination and informed decision-making, supporting more accurate diagnosis, better treatment and comprehensive patient-centered care.

Singapore's policy to expand the use of mHealth wearable digital devices focuses on the following main objectives:

– Health promotion and disease prevention—related programs are based on SMS notifications.
– Diagnostics—used for ophthalmological examinations, as well as in the field of dermatology and stroke.
– Treatment—providing patients with recommendations for rehabilitation.
– Monitoring—allows you to monitor chronic diseases.
– Support of medical services—registration for an appointment for full-time visits to specialists.

Fig. 5 NEHR System (2021)

China Experience

The concept of telemedicine is relatively new in China, although the first applications of these technologies in the country began in the 1980s. As in many countries, the outbreak of COVID-19 has changed approaches to digitalizing healthcare, especially in the area of telemedicine. China currently has over 1000 telemedicine technology companies, and the growth is expected to continue exponentially. The PRC government and digital health service providers are united by a common goal—to accelerate the development of telemedicine technologies in the country (Li et al., 2020).

Despite the fact that the size of the Chinese healthcare market is the second largest in the world after the USA, the country's healthcare system is faced with many problems, including complex relations between doctors and patients, lack of access to services in rural areas, high costs, and poor quality of medical services, slow and inefficient hospital operations.

As in many other countries, telemedicine in China faces challenges such as current government regulatory policies that need to be improved and potential cybersecurity threats. In Ki-tai, doctors cannot establish an initial diagnosis or prescribe treatment using a digital platform; during a session, the patient receives only consultations. But the regulatory enactments in China have been improving

lately. Digital healthcare platforms must strictly adhere to government requirements, especially in terms of data security, to prevent and limit emerging threats.

The COVID-19 outbreak has been a catalyst for the widespread adoption of online telemedicine consultation. The Chinese government quickly took steps to create conditions for medical institutions to cooperate with private companies (Ping An Good Doctor). China sees the rise of digital health as an opportunity to fix the imperfect aspects of the country's health care system. Given that the growing population of a country with a general tendency to increase life expectancy is looking for new ways to access health services, telemedicine in China will continue to develop rapidly. This process is also associated with the development of a communication network, especially in remote areas of China.

Russia Experience

In the Decree of the President of the Russian Federation "On the national development goals of the Russian Federation for the period up to 2030" one of the priority directions of the country's development is the digital transformation associated with the achievement of "digital maturity" of key sectors of the economy and social sphere, including number of health care. The task has been set to increase the share of mass socially significant services available in the electronic form to 95% (Izmailova et al., 2021).

The national priority project "Healthcare" defines the digitalization of the healthcare system of the Russian Federation as one of the key tasks, which is being implemented within the framework of the federal project "Creation of a single digital health care circuit based on the Unified State Health Information System."

Within the framework of this federal project, it is necessary to solve the tasks of transforming the country's healthcare system through automated information support, as well as monitoring and analyzing the use of healthcare resources and providing medical care to citizens.

The main patient-oriented service that provides a wide range of services to citizens is the My Health super service (Healthcare in Russia). Currently, it is possible for citizens:

– Making an appointment with a doctor and for undergoing medical examination and professional examination.
– Attachment to a medical organization; filing an application for the choice of an insurance medical organization.
– Obtaining information about the provided medical services and their cost.

The "road map" of the service also provides for citizens' access to medical documents in electronic form. Available in 2020:

– Medical certificate of admission to driving a vehicle.
– Referral for hospitalization, rehabilitation treatment, examination, consultation.

– Medical record of a patient receiving medical care on an outpatient basis.
– Medical professional advisory opinion.

The super service "My Health" will have electronic prescriptions, which will become a key element of the federal register of preferential drug provision, which allows you to keep track of, analyze, plan, and provide for the needs of the population in drugs.

Also, projects of the Ministry of Health of Russia in the field of digital health include:

– Introduction of a system of mandatory labeling of medicinal products from July 1, 2020.
– The launch of the federal register of preferential drug provision from January 1, 2021.
– Development of a network of national medical research centers (NMRC) and the introduction of innovative medical technologies, which includes the introduction of specialized vertically integrated medical information systems for individual profiles of medical care: oncology, cardiology, etc.; development of telemedicine technologies.

3.2   Key Factors in the Health Care Development

If we talk about the impact on the health indicators of mankind, there are four main factors of influence:

– Lifestyle and prevention
– Medical assistance (quality, availability)
– Socio-economic factors
– Environment

The main trends in the digitalization of healthcare are:

– Improvement of the regulatory framework.
– Setting the task of using digitalization for strategic management of the industry.
– Coming into the sphere of the country's leading IT companies.
– Increasing the importance of information security issues in health care.
– The formation of tasks for the intellectualization of management and the treatment process from public policy, the functioning of an institution to diagnosis and treatment.

3.3   The Challenges of Digital Healthcare Transformation

The research of the main trends in the development of digitalization of healthcare at the global and local levels showed that global technological progress provides medicine with various hardware and software tools that facilitate the work of specialists and reduce the cost of providing medical care. However, despite serious positive transformations in the field of digitalization of healthcare, for the full implementation of this practice throughout the Russian Federation, it is necessary to overcome a number of obstacles:

– Lack of financial resources
– Lack of personnel in specialties, ensuring the transformation of digitalization of medicine
– Underdeveloped digital health infrastructure
– Threats to information security
– Low level of development of intelligence of expert medical systems

Thus, the digitalization of healthcare is considered by the highest state power in Russia as one of the priorities for its development, which, however, requires additional and careful management work to make specific decisions. Nevertheless, positive trends and innovations are obvious, which will move from the category of experimental innovations and will be introduced into the healthcare sector for its normal functioning during the period of digital transformation of attributes.

4   Conclusion

Healthcare today is undergoing an incredible digital transformation that is changing virtually every aspect of the industry. It is obvious that in the coming years, this sector will constantly develop, including through the emergence and implementation of new technologies. In this regard, cooperation between major market players and startups is very important. And here, not only the financial component plays a role, but also the mentoring of industry experts who help bring innovation to life.

The digital transformation strategy of Russian healthcare is aimed, first of all, at creating conditions for increasing the efficiency of activities in the provision of medical services through the introduction of digital technologies. Optimization of the development of digital transformation is carried out by ensuring equal access to the Internet and cellular communications of the population of the country, reengineering of public services and services for receiving medical services, taking into account the possibilities of digital technologies, development, and implementation of industry platforms. Changes at the national level, creating a single space for the exchange of medical data of patients at all stages of service provision, modernizing the unified state information system in the field of health care (hereinafter referred to as the Unified State Health Information System) to create the possibility

of quick access to primary health care, increasing high-speed information exchange in medical organizations.

Within the framework of this article, the authors made an overview of the current state of digitalization of healthcare not only in the Russian Federation but also in the world arena. The key factors in the development of digital healthcare were given, the risks in the implementation of digital solutions were analyzed.

In the future, it is planned to implement the concept of a single digital circuit for a large geographically distributed medical organization.

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