Impact of Digital Technologies on the Efficiency of Healthcare Delivery

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1 Introduction

Informatization and automation of the healthcare sector worldwide, as well as in the Russian Federation, is a complex process consisting of many interdependent elements. Within its framework, several certain trends are monitored. Firstly, it is an active introduction of the Internet of Things products (IoT technologies) for various tasks. Secondly, it is an advanced analytics for the purpose of optimizing the activity of the clinic and the basic business processes of the enterprise (relevant for private medicine), and thirdly, it is an introduction of innovative expert systems for early diagnosis of diseases, as well as assistance to the expert.

Modern medicine has risen to previously unattainable levels in recent decades.

Today, the healthcare sector is a high-tech industry where transplantology and traumatology, plastic surgery and oncology, neurosurgery, ophthalmology, gynecology, dentistry, and other fields are successfully developed, which allow saving lives of previously hopeless patients.

Technical equipment of medical centers has been significantly improved, and it is now possible to diagnose the disease at the earliest stage and quickly restore the efficiency of patients. Minimally invasive procedures with the use of endoscopic equipment, microsurgery and laser correction of vision, transplantation of organs and tissues, correction of congenital and acquired defects have become usual.
Still, some problems are still existing, and to solve them, the Internet of Things (IoT) should be taken into account. IoT is one of the most popular innovative technologies in last years. The ability to implement practical solutions through the concept of the Internet of Things gives advantages in many areas of human activity.

Today, the development and introduction of Internet technologies is particularly important for the healthcare system. In this regard, experts are developing the conceptual apparatus and conditions for the practical application of the Internet of Things.

In the healthcare system during the pandemic, the technology of the Internet of Things has played an important role and assisted in monitoring the well-being of patients, tracking the location of infected patients and measuring temperature and pressure, as well as tracking indicators of the medical institution and its internal structure.

The purpose of this work is to conduct a comprehensive analysis and assessment of the main trends digital technologies’ implementation in the healthcare system in two main areas—global (most innovative world achievements) and local (national trends) and assess the impact of digital technologies on the efficiency of healthcare delivery. In the course of the study, the authors consider the process of implementation of digital technologies in healthcare system on the example of international and domestic experience. In the context of modern processes of digital transformation, the healthcare system is being modernized in the main areas stimulating technological progress - the use of medical information systems (MIS), the introduction of Internet of Medical Things (IoMT) products, advanced analytics of large data (Big Data), and the practical application of expert medical systems. The results indicate that digital technologies make it possible to protect doctors and patients from forced contacts and avoid infection with dangerous infectious diseases. The traditional “patient–doctor” model is losing its relevance, and today’s reality forces it to change significantly. Digital technology, together with medical devices, is ushering in a new era in digital health care, and the digitalization of the healthcare system itself is leading to improved delivery of health services, better quality control, and lower costs. The structure of the chapter is the following: to describe the methodology of the research, review the literature, discuss the results, and summarize the findings.

2 Methodology

The first point of our analysis will be medical information systems (MIS), which are the framework of the entire IT infrastructure of the enterprise. There are multiple interpretations of the definition of MIS. MIS can be defined as a set of software and hardware tools, databases, and knowledge designed to automate various processes running in the health clinics [1, 2]. This definition seems to be too narrow. Moreover, several crucial aspects of application are overlooked. Therefore, the authors consider other variant. MIS is a system of automation and document management for health clinics, which combines a system of support for medical decision making,
electronic medical records of patients, research data in digital form, patient monitoring data from medical devices, means of communication between employees, financial and administrative information [3–5]. This definition is much closer to the practical implementation of the functions of a medical information system. However, it discloses too widely some of the details not required at this stage of abstraction.

In the opinion of the authors, the most appropriate definition of a MIS is a set of software and hardware tools, databases, and knowledge aimed at automating and digitizing document flow and providing the information needed to meet the needs of health clinic staff at all levels of its implementation. If we move away from the peculiarities of the implementation of specific systems, the architecture of MIS can be presented as in Fig. 1.

In most cases, the medical information system for the patient begins with the registration of the visit. Moreover, it can be done in many different ways such as by phone, through the Internet portal, by appointment of the previous visit. Already at this stage, MIS has a significant impact on the functioning of the company. With the help of call-tracking systems and analytics tools of the Internet portal, by the time of the call the operator is already informed about the identity of the patient (if he is a registered client), or is aware of his problem in general (with the help of ID numbers and logs we understand what advertising led him to us). Consequently, there is a process of referral and/or registration to a specific specialist, which is also noted in the system.

**Fig. 1** Architecture of medical information systems
The application of MIS in Western countries started earlier than in Russia [6]. The foreign market has managed to form and mature, which means it has become more demonstrative for research. Therefore, the authors will review the main players and the platforms they use to build MIS. Based on the analysis carried out by Capterra [7], it is believed that the most popular MIS is designed for the Windows operating system and presents their software as a cloud solution. The third place by market share is occupied by the cross-platform EMR system, also partially functioning in the format of cloud subscription. Pure cloud solutions are also quite popular. However, these systems can be implemented only in small businesses, where the requirements for fault tolerance are much lower (e.g., no surgery). Currently, Microsoft Windows is the largest MIS development and operation platform, but at the same time, cloud solutions have a significant market share—17%, which is 4% more than MIS deployed on the basis of iOS [8, 9].

The MIS market in the Russian Federation is steadily growing, but to a large extent the activities of both developers and integrators, as well as users, are limited in regulatory terms. On the Russian market, the situation is quite similar to the global trends. The Microsoft is seriously ahead of its competitors by numerous indicators of prevalence [10]. Unfortunately, at present there are no relevant data on the implementation of cloud systems. However, almost of the leading Russian developers of MIS also offer a cloud version of the product, which means that this market has a share of consumers who prefer cloud technologies (partly or completely). Separately, it is worth mentioning the problems faced by developers of medical information systems in Russia. The main obstacle is a weak legal framework that does not keep pace with the pace of modernization in terms of technical progress. The activities of MIS fall under a multitude of regulatory and legal acts that have not been sufficiently developed to stimulate the further process of informatization. In particular, the federal laws 152-FZ “On Personal Data,” 149-FZ “On Information, Information Technology and Information Protection,” 323-FZ “On the basics of health protection of citizens in Russia,” and Government Decree No. 1815-r “On the State Program of the Russian Federation Information Society (2011–2020)” [11, 12].

The results of the literary review showed that the problems of introducing digital technologies into medical management are not sufficiently developed and are very poorly covered, including in the following areas to the normative literature. The proposed methods are mainly aimed at the use of technical gadgets, or high-tech medical technology. In this regard, a new architecture of medical information systems and three-level system of decision making in health clinics are proposed. In two sources [13, 14] it is possible to find answers to questions of introduction of the Internet of Medical Things (IoMT). But in general, this question is not sufficiently developed: There is no economic substantiation, administrative characteristics, all conditions and possibilities of application are not designated.
3 Results

Before talking about the IoT and medical devices embedded in the overall information technology (IT) architecture, it is necessary to highlight the correct definition that most fully reflects the essence of the phenomenon under consideration. So, according to Gartner, the Internet of Things is a methodology of computational network of physical objects ("things"), equipped with built-in technologies for interaction with each other or with the external environment, considering the organization of such networks as a phenomenon capable of reconstructing economic and social processes, excluding the necessity of human participation from a part of actions and operations [15, 16]. IoT is the most used abbreviation, however, when we narrow down the discussion of phenomena to purely medical subjects, and the abbreviation IoMT—Internet of Medical Things—is also used.

In fact, all such subdivisions of the Internet of Medical Things are relative, but here we will try to consider their impact on the provision of medical services. In order to understand what these technologies can do for maximum benefit, it necessary to know what are the main weaknesses and vulnerabilities in the medical field that can be improved by using IoMT devices.

Firstly, it is the lack of qualified specialists. The modern hardware component with high-resolution webcams, equipped with a Wi-Fi module and a high-speed communication channel. In such conditions, specialists work in the USA state the lack of professionals in this field. As a response to this call, a special center for monitoring the condition of patients was created by a doctor on duty [1, 17]. The algorithm of actions is simple. The heaviest patients constantly wear a bracelet that reads the basic indicators of vital activity, and if the intensive care physician suspects certain violations, he calls the patient an ambulance (if he is at home) or communicates with the hospital stay, examines, and gives specific recommendations for care to staff. This is an established practice that has saved many lives [1].

As of the current period in the USA, approximately 30% of initial visits to a doctor are made using telemedical services [18]. This indicates the degree of their prevalence in general. Among those close in spirit, but slightly different in performance, we can name another device for tracking the health of elderly relatives living separately. The principle is the same. The main indicators are recorded online, and in case of deviation from the norm, an automatic call to the ambulance is made simultaneously with the notification of relatives. Another device for elderly people is a smart box of medicines, which controls their timely receipt with reminders [2].

Secondly, medical enterprises suffer from the problem of dirty hands. The possibility of error is genetically embedded in a person, so the most skillfully performed operation can be spoiled by not thoroughly washed hands [19]. To combat this disease, a special sensor was proposed, which reads and compares the amount of soap spent in certain types of rooms and the frequency of their visit by doctors or other involved medical personnel (with a chip in a badge or special card). As a result, the number of accidental hospital infections drops by a factor of several, and the managers monitor adherence to medical hygiene standards in general. Another critical problem solved
by means of the Internet is the integration and communication of hospital equipment. The existing standardized medical communication protocol DICOM (Digital Imaging and Communications in Medicine) is far from perfect and is not supported by some equipment. The IoT can solve this problem by correctly linking all hardware components of health clinics [11, 19].

The Russian Federation is characterized by some lagging behind global trends in the field of healthcare informatization. However, the use of Internet devices for medical purposes is incorporated in Russia. Moreover, the introduction of expert medical systems and strategic plans for advanced Big Data analytics has been conducted. These experiments are local in nature, which is explained by the lack of flexibility in the economic and legal spectrum [2]. The same law governing the industrial Internet (and IoMT devices in particular) is being considered and prepared for adoption as early as mid-2016 [14]. Nevertheless, the interest from different levels of the vertical power cannot but gladden. It is a positive signal that makes it clear that the need to follow the current trends of digital transformation is being understood at the top. At the same time, there is a trend of growth of strategic initiatives, often duplicating each other. These initiatives have not had time to fully implement the concept of Unified State Information System (USIS), as well as an equally ambitious project Health Net, implemented by the Agency for Strategic Initiatives, which aims to connect most Russian citizens to the system of collection and analysis of data on health by 2035 [1]. This project directly assumes use of devices of the Internet of Things. However, it is not clear up to the end in what kind. The formulation itself is rather blurred. For data gathering, “bracelets, native gauges, contact lenses, implanted devices” will be used. It sounds very futuristic, but already in 2017, the first applied research on the development of implantable ECG monitors and drug dispensers is planned to be conducted [14].

In 2021, it is planned to introduce a single health passport for Russian citizens. According to a representative of a state agency, the Russian health care will expand the share of online medicine in the next five years [20].

However, a single health passport with the integrated electronic medical records is not yet implemented. This limits the experience of the Russian Federation in this area. There are specific examples of the introduction of Internet devices of things. Several hospitals in the capital use special bracelets for the most severe patients, in online mode transmitting information on the main indicators of vital activity. By 2021, it is planned to introduce special bracelets for quick access to the patient’s history [21]. Moreover, in Langepas hospital (Khanty-Mansi Autonomous Okrug) bracelets with a special alarm button are used [22], and automatic appointment systems are introduced [19]. As an experiment in Moscow is tested by a medical expert system [23] which diagnoses lung diseases. However, the widespread use of such experiments in not funded nor the regulatory framework [24, 25].

After reviewing the most relevant components of which all medical information systems of the future will be (or are already being) built, it is necessary to determine the order and algorithm of their interaction. As for MISs, we proposed a thesis about the fundamental importance of such systems as a basis for further integration of IoMT devices, analytical systems, and medical expert systems. Taking into account
the already described functions of technologies of the digital transformation period, we can distinguish a three-level system of decision making in health clinics (Fig. 2).

As we can see from the scheme we offer, the hardware and analytical methods we describe may be relevant not only to physicians but also to managers. The scheme suggests a different approach to decision making, based on concrete, and most importantly, on proven facts [14]. There is always a share of probability that unexpected events will occur. But the minimization of that is the main purpose of IoMT devices, analytical systems and medical expert systems, which open new horizons in the sphere of medical services provision [26, 27].

The current situation in the world shows that the traditional model of face-to-face healthcare delivery is changing significantly, and digital technologies will open up new opportunities in healthcare.

It is the medical sector as a whole that is becoming a driver of growth in digital and information technologies.

The market for digital innovations will grow thanks to the introduction of Internet technologies. These technologies make it possible to quickly and efficiently improve the quality of medical services, reduce the cost of treatment and consultation for patients, allow patients to seek advice from leading doctors, and have access to innovative treatment methods, especially in regions where high-tech medical facilities are not yet available.

The main problem to be solved when developing new medical technologies is the problem of processing the large volumes of data generated by IoT gadgets. Digital technologies, which are used today, allow scanning the entire human body instantly. Survey results in the form of images and signals are sent to a medical database and

**Fig. 2** Three-level system of decision making in health clinics
take up many gigabytes [19]. In other words, a medical facility must contain huge databases, which is economically inefficient. The size of the information received should be reduced.

The difficulty of processing large volumes of data can be solved by using digital tools that allow processing the incoming examination results and presenting them in the form of reports, graphs, and tables.

The use of digital tools for analytics of large databases would save the healthcare institution significant costs by reallocating the costs of innovative equipment, medical consultations, and prescription.

This is particularly relevant in terms of total health system financing by country. Table 1 presents countries that exceed the global average for health expenditure, and it is only top 15 of the total number of countries. Is that only 9% of the total number of countries. The top of this list for all three years is the USA. It is remarkable in this group of countries to single out Cuba. This country has maintained a high level of health expenditure over the years. If a correlation is drawn between health expenditures and the level and quality of health services provided, it can be concluded that the correlation is direct. The health systems of leading countries confirm this. Armenia and Afghanistan are in the leading countries in financing the healthcare system. These countries showed significant cost increases over the past year, which led to a rise in the list of countries. This fact will remain a topic for further research projects. The rest of the countries are far behind the world average trends.

Table 1  Current health expenditure (% of GDP), total 15 countries

| Country       | 2015   | 2016   | 2017   |
|---------------|--------|--------|--------|
| World         | 9.83   | 9.99   | 9.90   |
| United States | 16.84  | 17.20  | 17.06  |
| Switzerland   | 11.88  | 12.22  | 12.35  |
| Afghanistan   | 10.11  | 10.96  | 11.78  |
| Cuba          | 12.81  | 12.22  | 11.71  |
| France        | 11.46  | 11.48  | 11.31  |
| Germany       | 11.09  | 11.13  | 11.25  |
| Sweden        | 11.00  | 10.98  | 11.02  |
| Japan         | 10.89  | 10.83  | 10.94  |
| Norway        | 10.11  | 10.52  | 10.45  |
| Austria       | 10.37  | 10.42  | 10.40  |
| Armenia       | 10.12  | 9.95   | 10.36  |
| Belgium       | 10.28  | 10.30  | 10.34  |
| Andorra       | 10.25  | 10.32  | 10.32  |
| Denmark       | 10.23  | 10.18  | 10.11  |
| Netherlands   | 10.32  | 10.30  | 10.10  |

Source www.worldbank.org, ranging by 2017
Average global healthcare costs, as we can see from the Table 1, has decreased from 9.99 to 9.90. This decline was short-lived, and future data, especially for 2019–2020, will show us the increase in costs due to the spread of the pandemic. If we convert the data from the table for the enlarged groups, we can conclude that countries with high levels of health financing have higher living standards and quality of life, lower mortality rates and, most importantly, effective health service delivery (see Tables 2 and 3).

If we compare current health expenditure per capita (current US$) (Table 2) and current health expenditure (% of GDP) (Table 3) to each other, it can be seen that high-income countries have highest both indicators. Furthermore, the current health expenditure (% in GDP) (Table 3) shows that percentage of all countries besides high income are approximately at the same level. However, in current US$ (Table 2), this indicates as many times lower. We can conclude that gap in health expenditures in current US$ per capita much more than in % of GDP. This tendency can be explained by high-technologic medical care in high-income countries (especially in the USA and Western Europe).

The legislative framework for the development of telemedicine in most countries has not yet been adopted. However, in high-income countries this already happened in 2018 [2]. Technologies for using wearable electronics for remote monitoring of health have also not yet received widespread use around the world, while in the USA and Western Europe, this is already a daily occurrence [2, 11]. All these things will now be given serious acceleration if necessary measures are taken, including regarding emergency changes to the legislation. For example, in America, the FDA (Food and

### Table 2  Current health expenditure per capita (current US$)

| Country rank          | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  |
|-----------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| High income           | 4605  | 4953  | 4969  | 5041  | 5187  | 5025  | 5196  | 5369  |
| Upper middle income   | 344   | 400   | 429   | 460   | 474   | 448   | 439   | 490   |
| Middle income         | 198   | 228   | 243   | 260   | 266   | 253   | 249   | 274   |
| Lower middle income   | 62    | 69    | 72    | 79    | 79    | 79    | 79    | 83    |
| Low income            | 34    | 34    | 35    | 35    | 38    | 36    | 34    | 34    |

*Source* www.worldbank.org

### Table 3  Current health expenditure (% of GDP)

| Country rank          | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  |
|-----------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| High income           | 11.57 | 11.60 | 11.73 | 11.86 | 12.02 | 12.43 | 12.62 | 12.53 |
| Upper middle income   | 5.45  | 5.37  | 5.40  | 5.45  | 5.53  | 5.61  | 5.66  | 5.84  |
| Middle income         | 5.07  | 5.01  | 5.07  | 5.16  | 5.19  | 5.24  | 5.27  | 5.39  |
| Lower middle income   | 3.71  | 3.68  | 3.78  | 4.02  | 3.89  | 3.96  | 3.93  | 3.86  |
| Low income            | 5.91  | 5.57  | 5.47  | 5.36  | 5.48  | 5.40  | 5.46  | 5.24  |

*Source* www.worldbank.org
Drug Administration) introduced an accelerated procedure for registering medical devices, primarily to accelerate the launch of coronavirus tests on the market [19]. In particular, the Abbott test, which allows testing for coronavirus in five minutes, was already approved by the accelerated procedure [11]. The widespread penetration of telecommunication technologies in recent years can be seen the complete transformation of the taxi market, the delivery of ready meals and products, goods, services, and payments. The same thing is happening with medicine. The traditional face-to-face reception will not disappear, but the current situation will accelerate the process of convergence of offline and online medicines, when the patient chooses an effective format in a particular case, convenient and affordable for himself. This format of medical care is already free to choose in high-income countries, but not spread widely in other countries. The unconditional effectiveness of timely obtaining information about the patient’s condition using wearable equipment not only increases the efficiency of treatment, but also reduces the expenditures of more complex operations in advanced cases per capita.

The general trend of increasing funding for the global health system is still evident today. As we can see from Fig. 3, the USA remains the leader in health financing. It is the leader of high-income countries. These statistics indicate that these countries are at the forefront of medical developments and invest in the construction of MIS and implementation of IoMT devices.

Currently, healthcare facilities face the challenges, such as the safety of the staff, the need for continuous recruitment to improve performance, the ongoing monitoring of regulatory climate indicators, and the monitoring of patients’ physical performance. The problems have a common reason which is the lack of a comprehensive solution that will continuously and continuously measure and monitor the processes,

Fig. 3 Current health expenditure (% of GDP) by country rank
staff’s behavior, quality of the service, environment, status and condition of patients, medical and other appointment.

These modern technologies and automated monitoring of environmental parameters will have a relevant impact on management, quick service, patient safety, and climate monitoring (Fig. 4).

**Management**: Real-time monitoring of the location of doctors and patients with the ability to call for emergency assistance in case of need and emergency (surgical operations or daily procedures such as hemodialysis), tracking the type, volume and condition of medical equipment, ensuring inventories and reporting.

**Quick service**: Automate equipment maintenance and repair process. A large video screen displays collected information about the condition of the medical facility. It is fully integrated with all equipment management systems, and reports are generated to improve the daily/periodic maintenance process.

**Patient safety**: Safety of the medical facility, staff and patients are the most important factor of reliability in patient care. Staff can use information about the patient’s location and condition to ensure timely delivery of medical services, mobilizing waiting times. To help automate and maintain medical procedures, improve patient care and health, status information can be incorporated into current software systems.

**Climate monitoring**: The comprehensive solution will provide automatic monitoring of temperature, humidity, pressure, carbon dioxide concentration and other meteorological data, recording of events, collection of all necessary information in accordance with established requirements, displaying it on a single information
screen, automatic notification in case of an emergency, ensuring the collection and archiving of data for any period of time and generating analytical reports.

The digital technologies in healthcare are a broad concept, and it can be interpreted in many ways. The “smart” bracelets, watches, and trackers transmit the maximum number of indications directly to the user’s doctor. Moreover, the ideal to which everyone aspires is artificial intelligence that would analyze data about the patient and immediately give him recommendations on drugs and the necessary physical activity. However, today there are no such advanced gadgets, which could work online [28]. Furthermore, in the USA, UK and China doctors can remotely guide a patient, issue prescriptions, recommend treatment, and even prescribe electronic prescriptions [24, 25].

At present, telemedicine in Russia is underdeveloped. In 2019, the Russian market for telemedicine was about 2 billion rubles. Moreover, the world market is $45 billion. It is growing by 19.3% annually [7].

In several countries, doctors can perform diagnostics remotely. Several gadgets can be used for these purposes and can be divided into two types of services

- **Mobile applications and online services.** There are three groups: online clinics and aggregators, where you can find a doctor and get consultation, and specialized services for self-diagnostics;
- **Stand-alone devices:** Universal, for measuring individual indicators (glucometer), ultrasound and ECG. Typically, they also transmit data via a smartphone or laptop.

Moreover, telemedicine systems incorporate algorithms to remind patients of their medications, regularly interview them about their well-being and monitor the most important indicators. Using artificial intelligence, medical records are filled in, saving doctors up to 50% of their time. Artificial intelligence and data help to select a doctor and even make a diagnosis and to identify eye diseases or rare genetic diseases from a photograph.

Telemedicine as a publicly available medical practice is only just beginning to develop, although for a country with vast distances and underdeveloped transportation, telemedicine services are of particular social and economic importance.

Furthermore, telemedicine can be used for assistance in emergencies, assistance to military and astronauts, as well as for training and professional development of doctors.

Similar products are already available in Russia. For example, the service of remote medical consultations Yandex.Zdorovie in Russia, where the user can choose to consult a doctor at any time of day and chat with him. Or the telemedicine platform “Doctor at work” can be used by third-party companies to implement remote consultations with doctors [11].

There are two types of telemedicine: “doctor–doctor” and “doctor–patient.” While the first one has long and actively been used in Russia, the second one faces serious challenges. In general, the patient can already now consult with a doctor remotely and send the results of tests after an initial in-person examination or consult with a famous specialist from another city on Skype [11].
The problem is that the legal status of such consultations is not fully defined. The patient cannot be sure that the doctor will be held responsible for the wrong advice and doctors cannot diagnose or prescribe treatment [11, 19].

4 Telemedicine Challenges

The first problem is the availability of modern technologies to the population. Not all Russia has gas and electricity, not to mention high-speed Internet and high-quality audio and video equipment. If you connect a polyclinic to a reliable Internet connection and reduce telemedicine to a conversation with a doctor from a local regional center or the capital, the question of efficiency will inevitably arise. Moreover is relevant to evaluate how will this doctor treat a patient if he is 100 km away. Moreover, it is also significant to check if this doctor simply would not duplicate a local paramedic, which is unnecessary at already modest medical expenses.

There is no certainty that older people can easily use the same software applications. Moreover, it is critical to evaluate the consequences if the connection is interrupted. On the one hand, these risks outweigh the possible benefits of telemedicine. On the other hand, the best solution will be found in the near future. Moreover, the patient may not always be able to buy the necessary equipment. Many modern devices for diabetics, people with chronic heart disease are not certified in the country, and local analogs do not always match the level of development or affordability.

There are many factors that do not allow for rapid development of telemedicine. Several limitations of the law on telemedicine, skepticism of patients and doctors, lack of IT infrastructure in clinics, lack of transparent and understandable standards for consultations. However, in large cities and regional centers, telemedicine can already save money both for patients and doctors.

The second problem is safety issues. It would be very convenient to create a full-fledged unified medical base all over the country with the possibility of access to it by any doctor. However, it is necessary to make sure that this base is well protected, and the data in it is securely encrypted.

Through a regular video call, a doctor can find out confidential information. Therefore, it necessary to ensure that it is used correctly and there are no cases when “black realtors” come to pensioners with mental disorders. Moreover, these are isolated risks, but they can become a serious problem if telemedicine is used everywhere.

The third challenge is doctors’ willingness to work with telemedicine. Doctors have been reluctant to accept the computerization of polyclinics. Many specialists had a hard time learning how to use computers, which led to delays in patient care and deteriorating quality of appointments. A doctor cannot pay enough attention to a patient if half of an appointment requires entering passport data into a computer. Telemedicine technologies are more difficult to use, and the risks of making the wrong decision increase [8].
Consequently, it is not clear whether doctors will want to make a massive switch to IT when it comes to diagnosis and treatment, especially if it’s not about advanced centers.

It should be noted that it is necessary to form a special center to conduct telemedical consultations with doctors. Furthermore, it is created in order to work out in real conditions the details of implementing information systems and telemedicine technologies in everyday medical practice. It is expected that the center will also play a role in training physicians to effectively use telemedicine.

The social consequences of the introduction of telemedicine for doctors are also important. Theoretically, it can lead to the reduction of the already small number of polyclinics in remote regions, which means that some doctors may find themselves unemployed [20].

It should be noted that conservatism in relation to telemedicine is typical for both doctors and patients. It may take a long time to ensure confidence in telemedicine technologies, and it will be necessary to thoroughly analyze the performance of medical providers and develop clear quality standards. The expert notes that the work on changing consumer patterns is always the most time consuming, and leaders will “rock the market” from scratch.

Fourthly, patients’ trust in telemedicine is also a relevant challenge. People are used to classical medicine. Especially if we take into account that polyclinics are often visited by conservative people with distrust toward new technologies. Conservatism of the population at the first stages of telemedicine development is inevitable, as well as at the moment of mobile banking and other technologies, which change the usual way of life [10].

Patients’ trust in telemedicine can be won by showing by a real example that there is value in online consultation, and it is real to get answers to health questions remotely. The more often people will receive quality care from high-class doctors, and the faster telemedicine will be a worthy alternative to searching for symptoms on the Internet.

The legalization of telemedicine without serious control over it can lead to the blossoming of alternative specialists. Moreover, telemedicine should not be perceived as incomplete medical consultations or “medicine for the poor” [16]. Otherwise, the queue for face-to-face receptions will only grow, because everyone will think that it is more reliable.

The fifth problem is legal regulation and the law on telemedicine. The absence of a law on telemedicine hinders the development of those medical centers that already wanted to work in the new format of telemedicine, but so far could only provide information recommendatory, rather than medical consultations [17].

It is expected that a Unified State Information System in health care will be created. For example, in Russia, the law 149-FZ “On Information, Information Technology and Information Protection” defines the operator of this system, the composition of the data processed in it, the legal basis for its functioning, and information interaction with other information systems. The law also defines the providers and users of data stored in the system.
The law allows for the provision of medical assistance and remote patient consultations using telemedicine technologies. It also authorizes the issuance of prescriptions for narcotic or psychotropic substances on paper or in electronic form using an enhanced qualified electronic signature of a doctor and the relevant medical facility.

5 Telemedicine Market

The development of telemedicine is worth pursuing in three areas such as the protection of patients’ personal information, the availability of the Internet anywhere in the country, and the involvement of high-class doctors in consultations. According to our forecasts, it will take about 6–10 years to fully implement this approach to patient care. Communication with a doctor will be more therapeutic and consultative in nature [2, 11].

It should be noted that over the past few months, telemedicine has been undergoing a period of ultra-high attention, which has led to a rapid growth of various services to provide telemedical services. The market is overheated and will grow more slowly than many optimistic expectations that some players are likely to be upset and leave the market.

The market will gradually overcome the skepticism and mistrust of both patients and doctors. At the beginning of its journey, telemedicine will be carried out by commercial organizations and focused on a fairly narrow layer of early adopters of new technologies, but in a few years the market may mature to a larger-scale implementation of the world scale.

Particular attention is required to the role of artificial intelligence in telemedicine—first as a decision-making support mechanism and second as a number of services that directly help the patient. Artificial intelligence will be especially important in the construction of MIS.

While doctors in hospitals are busy with COVID-19 patients, the need for treatment has not disappeared, but has increased somewhere else. The fear of being infected when visiting clinics has led many to seek advice online. As the technical aspects of telemedicine develop, the range of diagnostic possibilities will increase. For example, already now in some clinics there are special devices with modules allowing the patient to measure the temperature himself, take high-resolution photographs to diagnose skin problems, to examine external hearing. Therapists have become the leaders in the number of remote medical consultations - 38% of clients use their services. The second place is occupied by pediatricians (24%), followed by urologists/gynecologists (9%), neurologists (7%), and ultrasound and CT consultations (6%). In response to the pandemic COVID-19, demand for psychotherapy services increased (16%). The data is based on the statistics of the clients of IC Sberbank Life Insurance, who use telemedicine as a free additional option (Fig. 5).

In March 2020, according to a study by Frost and Sullivan, the number of requests for video consultations increased by 50%, and individual providers of telemedicine reported that they received 15,000 requests per day more than before the pandemic.
Forrester analysts believe that this year due to coronavirus the number of requests for video consultations with a doctor in the USA may exceed 900 million [7, 27].

Video consultations with doctors are a way to help small private practitioners. In regions that are more heavily affected by the COVID-19, it is more appropriate to reduce the number of unnecessary face-to-face visits. That’s why they are replaced by videoconference appointments. This is literally a lifeline for small private medical practitioners, as well as a lifeline for patients who would otherwise not have received help [22].

In Russia, a law on telemedicine has been in force since 2018 [11]. According to the document, doctors can consult patients remotely, but it is still prohibited to make a diagnosis and write prescriptions. A doctor is not allowed to make a diagnosis without a face-to-face examination. Consequently, he cannot prescribe treatment. However, it can correct it, if the patient has already been diagnosed, he began to treat, and something went wrong. It is possible to write electronic prescriptions. However, this has little to do with telemedicine: to get such a prescription, you or your relative must go to the doctor in person.

Furthermore, if there are no technologies in clinics, it does not mean that they cannot show up at your home. For example, the American company ButterFly Network sells the device with mobile ultrasound in 20 countries already [29]. It costs $2000, and another $50 will have to pay for a monthly subscription to a telemedicine application in iOS. Through the software, the doctor can get in touch with the patient directly and manage his actions.

In this chapter, the authors analyzed the main trends and successes in the development of informatization of health care around the world in general and in the...
Russian Federation in particular. The main findings showed that digital technologies have a significant impact on medicine and the quality of medical services. The share of telemedicine is growing. Moreover, there is a widespread introduction of the Internet in medical institutions, there is a shift in demand for face-to-face visits to hospitals toward remote visits, and there is a lack of funding in the industry, which reduces the speed of creation and implementation of effective work of the medical institution. The presented three-level system of decision making in health clinics helps to improve the delivery of medical services and safe the costs.

6 Conclusion

The world technological progress provides medicine with the whole set of both hardware and software means which facilitate work of the doctor and the managing personnel of health clinics and at the same time reduce expenses for medical aid rendering. However, there are currently a number of obstacles that prevent the aforementioned tools from being put into operation everywhere. The most important are directly the lack of financial resources, as the lack of intellectual development of expert medical systems. Moreover, the threats associated with hacker attacks to IoMT devices store extremely important information, in most cases being in the process of providing the necessary information.

In most of countries at present, there is a clear lack of funding for state projects in the area of informatization of health care at the regional level, as well as duplication of some of the most important initiatives. The overall lagging behind the world leaders of the region is also characterized by an insufficient institutional and regulatory framework, which lags far behind technological progress. The proposed three-level system of decision making, based on the achievements of this period, will create a theoretical basis for a specific situation and minimize the risks of suboptimal outcomes.

The main limiting factor for research in telemedicine and the implementation of the Internet of Medical Things, and even more so in the digitalization of health care, is the uncertainty of public policy in this area. Several states around the world were seeking to improve the quality of health care while reducing non-productive costs in order to better manage health care. Benchmarking in this area allows the selection of global best practices for public policy development, which is a major factor of uncertainty and a limiting factor for research. The present study is based on best practices today, so their use in the development of public health policy is justified. The usage of the research results is goaled at increasing the effectiveness and quality of services in the health system. However, new experiences on a supranational scale, the development of new practices, may lead to the need to adjust public health policies, as digital technologies are changing very rapidly, and their implementation has mixed results.
References

1. Oborin, M.S., Osipov, V.S., Skryl, T.V.: Strategy for sustainable growth of SPA clusters based on the elements of network interaction. J. Environ. Manag. Tourism 9(8), 1768–1777 (2018)
2. Osipov, V.S.: Digital Future: Economic growth, Social Adaptation, and Technological Perspectives. AISC, vol. 1100, pp. 272–292 (2020)
3. Patan, R., Pradeep Ghantasala, G.S., Sekaran, R., Gupta, D., Ramachandran, M.: Smart healthcare and quality of service in IoT using grey filter convolutional based cipher physical system. Sustain. Cities Soc. 59 (2020)
4. Patel, R., Sinha, N., Raj, K., Prasad, D., Nath, V.: Smart Healthcare System Using IoT, vol. 642, 149–156 (2020)
5. Raja, B., Firdous, A., MohammedShak, A., Anand, M.: Internet based modern health care monitoring system using body sensor network. J. Adv. Res. Dyn. Control Syst. 11(2 Special Issue), 602–608 (2019)
6. Rauscher, J., Bauer, B.: Safety and security architecture analyses framework for the internet of things of medical devices (2018)
7. Sam, D., Srinidhi, S., Niveditha, V.R., Amudha, S., Usha, D.: Progressed IoT based remote health monitoring system. Int. J. Control Autom. 13(2 Special Issue), 268–273 (2020)
8. Shamayleh, A., Awad, M., Farhat, J.: IoT based predictive maintenance management of medical equipment. J. Med. Syst. 44(4) (2020)
9. Bakar, N.A.A., Ramli, W.M.W., Hassan, N.H.: The internet of things in healthcare: an overview, challenges and model plan for security risks management process. Indones. J. Electr. Eng. Comput. Sci. 15(1), 414–420 (2019)
10. Sharma, R., Mahapatra, R.P., Agarwal, P.: Transforming healthcare through various technique in Internet of Things. Intell. Syst. Ref. Libr. 165, 171–190 (2020)
11. Skryl, T.V., Osipov, V.S., Paramonov, A.S.: Study of practical implementation of IoMT: creating a web application for distant high-risk group patient’s heart-rate tracking. Espacios 39(45), 2018
12. Syed, L., Jabeen, S., Manimala, S., Alsaeedi, A.: Smart healthcare framework for ambient assisted living using IoMT and big data analytics techniques. Future Gen. Comput. Syst. 101, 136–151 (2019)
13. Asish Vardhan, K., Thirupathi Rao, N., Naga Mallik Raj, S., Sudeepthi, G., Divya, Bhatcharyya, D., et al.: Health advisory system using IoT technology. Int. J. Recent Technol. Eng. 7(6), 183–187 (2019)
14. Vithya Vijayalakshmi, A., Arockiam, L.: A Secured Architecture for IoT Healthcare System. Lecture Notes on Data Engineering and Communications Technologies, vol. 31, 904–911 (2020)
15. Toor, A.A., Usman, M., Younas, F., Fong, A.C.M., Khan, S.A., Fong, S.: Mining massive e-health data streams for IoMT enabled healthcare systems. Sensors (Switzerland) 20(7) (2020)
16. Ur Rahman, G.M.A.E., Chowdhury, R.I., Dinh, A., Wahid, K.A.: A smart sensor node with smartphone based IoMT, pp. 92–95 (2019)
17. Kotha, M.M.: Tech Care: An Efficient Healthcare System Using IoT, vol. 1054, pp. 655–667 (2020)
18. Visconti, R.M., Morea, D.: Healthcare digitalization and pay-for-performance incentives in smart hospital project financing. Int. J. Environ. Res. Public Health 17(7) (2020)
19. Bogoviz, A.V., Elykomov, V.A., Osipov, V.S., Kelina, K.G., Kripakova, L.A.: Barriers and perspectives of formation of the e-healthcare system in modern Russia. Stud. Comput. Intell. 826, 917–923 (2019)
20. Yaacoub, J.P.A., Noura, M., Noura, H.N., Salman, O., Yaacoub, E., Couturier, R., et al.: Securing internet of medical things systems: limitations, issues and recommendations. Future Gen. Comput. Syst. 105, 581–606 (2020)
21. Yassein, M.B., Hmeidi, I., Al-Harbi, M., Mrayan, L., Mardini, W., Khamayseh, Y.: IoT-based healthcare systems: a survey (2019)
22. Zakaria, H., Abu Bakar, N.A., Hassan, N.H., Yaacob, S.: IoT security risk management model for secured practice in healthcare environment. Procedia Comput. Sci. 161, 1241–1248 (2019)
23. Dominguez, D., Morales, L., Sanchez, N., Navarro-Pando, J.: IoMT-Driven eHealth: A Technological Innovation Proposal Based on Smart Speakers. LNBI, vol. 12108, pp. 378–386 (2020)
24. Fouad, H., Hassanein, A.S., Soliman, A.M., Al-Feel, H.: Analyzing patient health information based on IoT sensor with AI for improving patient assistance in the future direction. Measurement 159 (2020)
25. Greco, L., Percannella, G., Ritrovato, P., Tortorella, F., Vento, M.: Trends in IoT based solutions for health care: moving AI to the edge. Pattern Recogn. Lett. 135, 346–353 (2020)
26. Gupta, A., Chakraborty, C., Gupta, B.: Medical information processing using smartphone under IoT framework. Stud. Syst. Decis. Control 206, 283–308 (2019)
27. Hamza, R., Yan, Z., Muhammad, K., Bellavista, P., Titouna, F.: A privacy-preserving cryptosystem for IoT E-healthcare. Inf. Sci. 527, 493–510 (2020)
28. Newaz, A.I., Sikder, A.K., Rahman, M.A., Uluagac, A.S.: HealthGuard: A Machine Learning-Based Security Framework for Smart Healthcare Systems, pp. 389–396 (2019)
29. Joseph, S., Francis, N., John, A., Farha, B., Baby, A.: Intravenous drip monitoring system for smart hospital using IoT, pp. 835–839 (2019)