Обзорные статьи

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Digitalization of healthcare and health status of medical workers

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The labor activity of modern doctors of various specialties is inextricably linked with pronounced mental, nervous and emotional stress, as well as the complex impact of physical, chemical and biological factors, the simultaneous influence of which can lead to the development of a wide range of occupational diseases. The intensive introduction of digitalization in healthcare also leads to a significant negative impact of modern technologies on the health of doctors and medical personnel. The analysis of the literature made it possible to identify priority areas for the introduction of digitalization in healthcare: improvement of the regulatory framework for the use of information systems, creation of specialized training centers for employees, development of convenient and well-optimized information systems and interface, scientific justification and development of preventive measures aimed at preserving the health of health workers. In this regard, it is advisable to take measures to develop the skills of safe use of electronic devices, leading a healthy lifestyle, which will further minimize the potential risks of negative impact of information and communication technologies on the health of medical workers.

Keywords: *digitalization of healthcare; information and communication technologies; health of medical workers; professional burnout syndrome*

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Introduction. The steady deterioration of the health of medical workers is one of the most significant and at the same time underestimated problems in modern healthcare. According to research data, the work activity of modern doctors of various specialties is inextricably linked with severe mental and nervous and emotional stress, impaired motor activity (inactivity, excessive static loads), as well as the complex effects of physical, chemical and biological factors, the simultaneous impact of which can lead to the development of a wide range of occupational diseases [1–5].

At the same time, relatively recently, the domestic healthcare system has begun a gradual transition to the active use of information technologies in the professional activities of medical workers. This process has led to a number of serious problems associated with the use of electronic devices and systems by medical professionals, as well as with the introduction and constant use of relatively imperfect and unoptimized information systems [6, 7].

Despite a large number of foreign studies devoted to the study of the impact of information and communication and computer technologies (ICT) on the health and labor performance of doctors, there is no consensus on the negative impact of computer technologies used on the health of employees. In our country, there are few or no studies on the impact of ICT on the physiological and hygienic characteristics of the working conditions of doctors of therapeutic specialties, and there is also no systematic information that allows to objectively assess the negative impact of ICT on the health of medical workers. The purpose of the review is to analyze the data of the scientific literature and evaluate the interim results in the course of digitalization of healthcare, the introduction of information and communication technologies and their impact on the health of medical workers.

1. Using search engines for review. The sources of scientific literature indexed in the international databases Web of Science, Scopus, PubMed and in the Russian RSCI database served as the material for the analysis. The authors selected sources using keywords and phrases: information and communication technologies, medical information systems, digitalization of medicine, doctors+digitalization of medicine, digitalization+health of medical workers. The search depth was eleven years (2012–2022). In this review, scientists used 83 sources of information. Their selection was mainly based on the results of research in Russia, presented in journals included in the core of the RSCI. When choosing foreign publications, the authors preferred journals indexed in Web of Science and Scopus (Q1–Q2).

A bibliographic search for the keyword "information and communication technologies in healthcare" revealed 9831 foreign and 10,181 domestic publications. A further search in foreign sources for the keyword "information and communication technologies, health of medical workers" showed 802, and for the keyword "health of medical workers" — 1233 publications. In the RSCI database in 2012–2022, the number of publications on the keyword "health of medical workers" amounted to 14,944, and on the keyword "digitalization+health of medical workers" — 1062. Of the articles identified by the keywords "information and communication technologies, health of medical workers", the issues of ICT and doctor's health were studied in 10% of the studies. Thus, the conducted search showed a growing, but insufficient interest in Russia in the problem of studying the impact of modern information and communication technologies on the health of doctors and medical personnel of various profiles.

2. The importance of digitalization of medicine for the population and health workers. The Digital

Revolution is one of the powerful global trends that have caused unprecedented penetration of information and communication technologies in all sectors of the economy, including healthcare. There is no doubt about the need to introduce and master digital technologies in this area. Digitalization implies global changes that affect the entire healthcare system, from infancy to public administration of this industry. Expectations of improving the quality of medical care, its accessibility and economic efficiency are associated with the development of this direction [8, 9].

The domestic healthcare system has relatively recently begun a gradual transition to the active use of information technologies in the daily activities of medical workers[1,2,3].

The coronavirus pandemic has become one of the main factors in the transition to digital means of communication, especially in the healthcare system.

However, the euphoria from the first steps of the "digital revolution" is currently being replaced by a realistic analysis of the opportunities and conditions for realizing the truly colossal potential inherent in the information transformation of healthcare. A more balanced and conscious understanding of the features of innovative processes in the industry and, most importantly, significant barriers that make it difficult to introduce new ideas and practices due to the complex interweaving of social, economic, ethical, psychological factors. Taking into account the specifics of this industry, it becomes obvious that digitalization in healthcare cannot be a quick revolution, it will take place in several stages and will probably take more than not a single decade.

ICT is a set of technologies that ensure the production, processing, storage and transmission of information [1]. Currently, ICT includes telephone communication (mobile and stationary), various media services and related platforms, computer technologies, the Internet, electronic databases and information systems, as well as various equipment related to the above types of technologies (projectors, equipment for remote interaction and online conferences) [1, 10, 11].

With proper implementation and use of ICT, they can significantly increase the efficiency of labor processes in healthcare (both at the clinical and administrative level), reduce the time spent by specialists, and improve the quality of medical services [1, 12–19].

In domestic healthcare, it is necessary to highlight the high efficiency of ICT in the organization of high-quality medical care in sparsely populated areas remote from large cities, where, for various reasons, it is impossible or difficult to create full-fledged medical institutions with a fully staffed staff of specialists. Therefore, the introduction of digitalization in healthcare also includes the creation of innovative services and platforms that allow using remote communications with patients, doctors, medical and pharmaceutical services, monitoring therapeutic and preventive processes in medical organizations [20].

In foreign countries, the transition to information technology occurred much earlier, in this regard, certain positive and negative experiences of digitalization of medicine have been accumulated. A number of foreign authors have formulated areas of medical activity within which it is possible to effectively solve practical problems using ICT [21–23]. These include:

1. Implementation of preventive measures and early diagnosis of diseases, timely provision of medical care to patients;
2. Rational use of available resources in healthcare, including equipment for high-tech care, expensive pharmacological drugs, donor materials and drugs based on them;
3. Informational and reference support in the process of making clinical decisions, ensuring prompt access to complete and reliable information about the patient's health as a result of the introduction of electronic health cards, the introduction of automated procedures for verifying compliance of the selected treatment with the standards of medical care, checking the compliance of prescribed medicines with existing contraindications;
4. Accessibility of medical care and consultations to persons who are unable to visit medical organizations;
5. Providing modern high-quality education and continuous training, conducting effective scientific research, active interaction of various medical and pharmacological specialists;
6. Increasing patients' adherence to prescribed treatment, monitoring the implementation of recommendations;
7. Provision of collection, storage and operational access to information databases with medical and administrative information;
8. Improving the level of medical literacy of citizens.

The use of ICT really improves the quality of medical care and improves the health indicators of patients, significantly facilitates the work of medical personnel, reduces the time spent on the administrative activities of a clinician (maintaining a patient card, tracking patient management) [24–27].

At the same time, it is difficult to assess the economic consequences and reliably determine the benefits of using ICT, which is important for modern healthcare. This is due to the fact that methods for assessing the economic effect are currently insufficiently developed [28, 29].

The economic efficiency of the introduction of medical information technologies mainly consists in saving money in certain areas of their expenditure. Therefore, to assess the economic efficiency of the introduction of ICT, researchers consider the range of advantages of using digital technologies. According to the conducted studies [28–30], the most significant positive results of the introduction of medical information systems are:

1. Reducing the number of unnecessary manipulations with medical records, the ability to copy and store records;
2. Reducing the cost of medicines, as well as laboratory and radiological studies;
3. Reduction of hospital stays, improvement of bed turnover indicators;
4. Administrative advantages obtained when working with payment documents.

Foreign studies have shown that the introduction of electronic medical records reduces the frequency of prescribing excessive laboratory and X-ray examinations by

[1] Order of the Ministry of Health and Social Development of the Russian Federation No. 364 dated April 28, 2011 "On approval of the concept of creating a unified state information system in the field of healthcare".
[2] Order of the Ministry of Health of the Russian Federation No. 28 dated 27.01.2021 "On approval of the departmental program of digital transformation of the Ministry of Health of the Russian Federation for 2021 and for the planning period of 2022 and 2023".
[3] Decree of the Government of the Russian Federation No. 3980-r dated December 29, 2021 "On approval of the strategic direction in the field of digital transformation of healthcare".

9–14%. In addition, it allows you to reduce additional research costs by up to 8%, reduce the number of hospitalizations, estimated at an average of 16 thousand dollars each, by about 2% and reduce excess drug consumption by 11%.

The full-scale introduction of medical information technologies in the United States can lead to savings of up to $77 billion per year [31–33]. In Norwegian clinics, the introduction of electronic medical records led to a 10% reduction in nurses' time [1]. In this regard, a medical professional can use the time saved to improve the quality of medical care for patients, to increase the number of patients served without reducing the quality of services provided. In addition, the introduction of ICT can serve to reduce the number of medical personnel to reduce the costs and costs associated with personnel.

The domestic healthcare system has relatively recently switched to the active use of information technologies in the professional activities of medical workers, therefore, at the initial stage, a number of quite serious problems arose related to the introduction and constant use of imperfect and unoptimized information systems by medical workers [2, 6, 7].

First of all, it is necessary to highlight the lack of material and technical support, since for the successful implementation of medical informatization programs, it is necessary to equip healthcare institutions with modern telecommunications equipment. According to statistics, on average in Russia there was one computer per ten employees of state and municipal healthcare institutions, less than 5% of medical and preventive institutions are equipped with telemedicine facilities. A significant part of the existing computer park of medical organizations was used in administrative and accounting activities, as well as for automated accounting of services rendered in the interests of the Federal Compulsory Medical Insurance Fund and Private Insurance companies, and only about 20% — in the process of providing medical care.

At the same time, the creation of a unified information system in the field of healthcare requires a stable connection, high-speed Internet, since medical information in most cases requires very fast transmission with large volumes of it (for example, when it comes to remote consultation during emergency operations). However, the laying of fiber-optic cables is currently not possible in all localities of the Russian Federation, which ultimately creates certain risks in the implementation of medical informatization programs.

A number of authors note that due to the large number of proposals and methods of using medical information systems, there is no single approach to their deployment in a medical and preventive institution, which contributes to the need for additional research on the informatization of medicine. On the other hand, the effectiveness of the use of ICT depends not only on material and technical support, on the methods and forms of application of these technologies, but also on how well the medical staff knows how to work with the electronic resources used [34, 35]. The use of ICT in the healthcare system presupposes the availability of specialists with the necessary qualifications who are able to work with equipment and support the operation of the information system itself.

However, in the domestic healthcare there is an insufficient level of awareness and computer literacy, which further leads to certain difficulties in creating working groups of doctors and programmers, as well as to a kind of "downtime" of expensive high-tech equipment [30].

The majority of doctors used a computer and other digital equipment, but a significant part of nurses (47.0%) did not use them. In comparison with other specialists, doctors have a very limited remote format of work, which is caused by both industry specifics and lack of opportunities. About 30% of doctors and nurses experienced a lack of digital competencies, which reduced their job satisfaction. With basic computer literacy and the ability to use the Internet, the lack of knowledge and skills concerned medical information systems and individual digital tools. Medical specialists were mainly engaged in its replenishment independently, and not through specialized training [36].

A certain risk in the introduction of ICT is the difficulty of maintaining the confidentiality of patients' personal data in the presence of electronic medical records, and, consequently, the continuing risks of leakage of personal data and information about the health status of patients that constitute medical secrecy [1].

Thus, based mainly on the experience of foreign countries, as well as Russian experience in the field of digitalization of medicine, it can be argued that the competent implementation of digital information and communication technologies in clinical and administrative health care activities is highly effective. In Russia, digitalization processes are undergoing certain difficulties in implementing a number of technological and organizational aspects of this process. Therefore, at present, the priority areas are the continuous improvement of the regulatory framework for the use of information systems in healthcare, increasing the confidence of patients, medical professionals and administrative staff in the gradual digitalization of the industry, the creation of specialized training centers for employees, informing the public about the positive results of the digitalization of medicine. A significant aspect of the effective implementation of information technologies in various areas of healthcare is the development of convenient and well-optimized information systems and user interface.

At the same time, the possible risks of developing negative effects in doctors during the active introduction of ICT into everyday professional activities remain poorly studied and ambiguous, which is what the next section of the analytical review is devoted to.

3. **The state of health of medical workers using information and computer technologies.** Despite the many positive aspects associated with the introduction of ICT, their use in healthcare can worsen the working conditions of medical workers, especially doctors and certified nurses [3]. Since the state of health of medical workers is one of the priority components of the functioning of the health system, the study of the potential negative impact of modern ICT on the mental and somatic health of medical workers and its prevention can significantly improve the effectiveness of the entire health system as a whole [37–42][4],[5].

The impact of ICT on human health, according to researchers, can be divided into direct and indirect effects [44, 44]. In the case of direct exposure, a person is a direct user of ICT, while in the case of indirect exposure, they are not. An example of a direct impact is the use of computers

[4] Bolshakova T.V. Personal determinants and organizational factors of mental burnout in medical workers: abstract. diss. cand. psychological sciences. Yaroslavl; 2004: 24.

[5] Rybina O.V. Psychological characteristics of doctors in a state of psychological stress. Autoref. diss. cand. psychological sciences. St. Petersburg, 2005: 24.

and smartphones to search for information about disease prevention, medications, medical institutions, an appointment with a specialist or a study. The indirect impact of ICT can be attributed to the use of ICT in healthcare institutions when organizing remote consultations, consultations, the use of electronic medical records [1, 45–48].

The results of studies on the negative impact of ICTs used by doctors are very contradictory, however, a certain part of researchers is inclined to the presence of negative factors associated with the use of ICTs, which can significantly worsen the mental and somatic health of medical workers [1, 49–52].

A number of authors consider modern information and communication technologies used by medical professionals as a significant risk factor for the development of a number of pathological conditions and diseases (mainly psycho emotional disorders), as well as serious pathologies of the cardiovascular system [53–56].

Nevertheless, scientists claim that the most relevant work at present is the study of the cognitive component of the psychological readiness of doctors for digitalization in practical healthcare as one of the priorities in medicine. In a number of works, a survey was conducted of primary health care doctors about their readiness to use digital technologies in the practice of outpatient polyclinic services. A connection was established between the professional burnout of primary care physicians and their readiness to use digital technologies in professional practice. At the same time, professional burnout of doctors was described using indicators of emotional and physical exhaustion [57, 58].

The most significant psychological aspect of digital medicine is a fundamental change in the nature of the interaction of subjects "doctor – patient", which determines its positive and negative sides. The use of digital healthcare contributes to the formation of new communication models, requires the psychological readiness of doctors, regardless of age characteristics, work experience, as well as the transition to a patient-centered approach in the provision of medical services. This communicative interaction of medical workers largely determines the effectiveness of treatment, adherence to medical prescriptions, the degree of patient satisfaction from visiting a doctor and a medical institution, and ultimately the level of satisfaction of society with the existing healthcare institution [59–61].

In clinical practice, the use of ICT is implemented mainly in the form of medical information systems. The active use of ICT in illiterate implementation significantly increases the time costs of doctors, reduces the efficiency of labor and time spent on direct clinical activity, and also significantly reduces motivation and forms high risks of developing psycho emotional, and later somatic diseases of health care workers [11, 20, 32].

Despite the above-described positive aspects of the introduction of ICT in the work of doctors, the majority of interviewed doctors and nurses in a significant number of studies note a negative experience of interaction with EMS [41, 47, 57, 62, 63]. There are cases when, in order to prescribe an antihypertensive drug, a doctor needed to perform more than sixteen different manipulations related to interaction with a medical information system (MIS).

Primary care physicians spend on average about two hours working with MIS for every hour of contact with a patient, including 4.5 hours during the working day and an additional hour and a half in the evening. Even with a direct examination of the patient, doctors spend 37.0% of the time interacting with MIS [11, 20, 32, 36]. Other scientific papers report that the majority of the surveyed health workers have a positive attitude to ICT, provided that their implementation will be safe and optimized [64]. The general practitioners and psychiatrists in their clinical practice are at a higher risk of professional burnout due to the significant time spent on interacting with electronic medical systems and processing electronic medical records of patients, as well as prescribing research, diagnostic procedures and additional treatment [47, 48].

There are statements in the literature that high risks of professional burnout syndrome are associated not only with the professional activities of medical workers in a general sense, but also, quite possibly, with the introduction of ICT in the activities of doctors [65–69].

According to available data, professional burnout syndrome includes the following psycho emotional disorders and conditions — emotional exhaustion, cynicism and low personal achievements [70]. The frequency of mental disorders is up to 59.0% of all cases of occupational diseases of medical workers, including doctors of therapeutic profile [71–74].

Medical workers, like most people in other professions, use various electronic devices uncontrollably from the moment they start training and throughout their further professional activities. Often they do not pay attention to environmental factors that can aggravate the negative impact of ICT on the health of a doctor (low illumination, an unequipped workplace or its absence, viewing materials at the time of movement with an additional load on the organs of vision). Along with this, people who use electronic devices and systems uncontrollably may experience a lack of motor activity, a deterioration in the quality of night sleep, a violation of work and rest, stress, etc. [2, 75–77].

In the context of the negative impact of excessive use of ICT, we can consider the data that 61.0% of nursing staff have different degrees of obesity. The average values of the body mass index exceeded the WHO recommended values, while more than half of the respondents (51.4%) assessed their condition as "good", despite awareness of the health risks of excess body weight and obesity [2]. Since medical staff, as a rule, is a role model for the patient, medical workers with an increased body mass index will be less trusted by patients when conducting weight loss consultations and promoting a healthy lifestyle [78].

According to the results of a study devoted to the study of the subjective assessment by medical professionals (practitioners, teachers at medical universities) of risk factors associated with the use of electronic devices, teachers at medical universities assessed them most adequately, demonstrated skills of safe use of electronic devices in everyday life, and also paid more attention to motor activity and nutrition. Nurses and paramedics showed themselves to be the least prepared contingent in relation to the safe use of electronic devices and maintaining a healthy lifestyle in this study [2]. It is important to emphasize that studies concerning the direct impact of information and communication technologies on the somatic and psycho-emotional health of medical workers are presented in small numbers in both foreign and domestic literature.

When analyzing Russian studies, it can be noted that most of the work carried out is focused on studying the impact of electronic devices and ICT on the health of

children, adolescents and students. Thus, according to research data from Rosstat and UNICEF, in 2011, the number of diseases of the central nervous system increased by 85.0% in children and adolescents using a cell phone for more than ten years, and by 82.0% in the blood and immune mechanism. In 2015, the number of neoplasms, eye and skin lesions increased by 38.0%, which is confirmed by a number of foreign works. It should be noted that the most significant part of domestic research is devoted to the study of visual disturbances, and to a lesser extent affects both other somatic problems (including those described earlier in foreign works) and psycho-emotional disorders, which are among the most frequent in the uncontrolled use of electronic devices [76].

Conclusion. *The professional activity of doctors is associated with the impact of a number of negative factors that can lead to the development of pathological health conditions, primarily of a psycho-emotional nature. At the present stage of development, additional negative factors for the health of medical workers are the gradual introduction and widespread use of information and computer technologies in healthcare.*

The literature data presented in the analytical review indicate that there is no scientific evidence of the contribution of ICT to the complex of negative factors of professional and household spheres of activity affecting the health of doctors, which is the subject of further research. Perhaps this is due to the fact that the processes of digitalization in our country began to be introduced quite recently, and therefore there is no evidence of their negative impact on the health of doctors. Nevertheless, it is obvious that digitalization is positive and important for the effective treatment of patients, the successful professional activity of medical workers and, in general, for the satisfaction of society with the existing healthcare institution.

Along with the improvement of the regulatory framework for the use of information systems in healthcare, the creation of specialized training centers for employees, the development of convenient and well-optimized information systems and user interface, it is necessary to scientifically substantiate and develop preventive measures aimed at preserving the health of medical workers. In this regard, it is advisable to take measures to develop the skills of safe use of electronic devices, maintaining a healthy lifestyle, which will further minimize the potential risks of the negative impact of ICT on the health of medical workers.

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