LEGAL RESTRICTIONS AND THE PERSPECTIVE OF INTERNATIONAL LAW IN THE INTERACTION BETWEEN MEDICAL PERSONNEL AND INTELLIGENT SYSTEMS

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Abstract

In the field related to medical personnel and intelligent systems, ethical norms have no guarantee of implementation in international law, but if these norms become binding legal rules, they will benefit from the guarantee of the implementation of said rules. The role of ethics, which is becoming more and more prominent due to the adjustment of governments' sovereignty and the increasing role of non-governmental actors in international law, in areas such as international law, international humanitarian law, international criminal law, international responsibility law and law International treaties are clearly visible. The process of intellectualization in healthcare is a revolutionary technology, changing the methods of diagnostics, treatment and follow-up of patients. The diversity of stakeholders determines the various interests and expectations in relation to its digitalization. The personnel of medical institutions increasingly apply digital achievements in their activity, in particular, such as electronic medical records, artificial intellect systems, telemedicine services, etc. Under the pandemic, minimization and restriction of personal (physical) visits of citizens to medical institutions resulted in the dramatic increase of the significance of digital and virtual medical services, including with the use of artificial intellect. At the same time, the legal issue of digital literacy of the doctors using these technologies remains disputable, as well as their preparedness to actively master the latter. The research objective is to reveal the interconnection between the characteristics of the medical personnel from various clusters of the region and their preparedness to use intelligent medical decision support systems. The authors researched a representative sample of medical personnel from the Republic of Tatarstan (1004 people from 17 state and private medical institutions) before the COVID-19 pandemic, and their literacy in using the intelligent medical decision support systems (MDSS) and attitude towards the modern info-communication technologies. The methods used were: the structured author-designed questionnaire on the behavior of the medical personnel and their attitude towards using the intelligent systems in professional activity. Conclusions: the majority of medical personnel marked the positive influence of digitalization on the quality of medical services. The personnel's preparedness to use intelligent systems in diagnosing and treatment was mostly influenced by their realization of the need to develop digital competences. The second factor was the preparedness of citizens for the introduced digital technologies and developing digital healthcare. Satisfaction with their work was the third important positive factor of the preparedness of medical personnel for innovations. The main obstacle of healthcare digitalization, from the point of view of medical personnel, is the low level of both the material-technical equipment of medical institutions and their own digital literacy.

Keywords: Criminal Law, international law, law, legal issue, personnel, healthcare, regional healthcare, electronic healthcare, healthcare efficiency, medical institutions, intelligent medical decision support systems, digitalization of healthcare.

Introduction

Today, the global coronavirus pandemic is, primarily, the crisis of healthcare, which apparently influences all spheres of social and economic life of the society. This global crisis transforms the existing values of everyday life and the behavioral strategies of the population, changed the latter's attitudes to realizing the importance of health, and made healthcare a matter of ultimate significance for everyone. Experts predict that the global expenditures for healthcare will continue growing after the coronavirus pandemic. By 2022, governments and corporations plan to assign $10 billion annually for these issues, which is 20% higher than today's expenditures.[1]

Caused by the pandemic, minimization and restriction of personal (physical) visits of the population to medical establishments resulted in a sharp increase in the significance of digital and virtual medical services, including using the artificial intelligence. [1,2,3,4] Hence it is not surprising that 70% of consumers globally see the increase of their interaction with digital and virtual technologies as the ruling trend for the three-year period of post-COVID reality.

As people strive to assume stability in the opening world, they more than ever turn to health. For example, according to a research report Accenture-2020, only about 19% of consumers in the USA acquired virtual medical aid before the pandemic, while there were a lot more people willing to do so – 54%.[2] These data are echoed by polls of healthcare administrators in the USA (2020), 85% of which had to admit that digital technologies would become an indispensable part of life in the nearest future.

Social distancing of people, retaining in the post-COVID life, has shifted consumers' focus from convenience of virtual and digital medical services to their acute necessity. Minimizing their direct contacts, people have to activate their interaction with robotized technologies and artificial intelligence. For example, a Russian company PROMOBOT, the Europe largest producer of service robots, designed a model which is able not only to accurately measure health indicators but also to carry out a primary questioning of a patient, memorize and recognize faces, communicate and answer questions, get connected to external services, print diagnostic results and recommendations or send them to a doctor. All stages of a dialogue between a person and a medical robot – from determining the topic to choosing an answer – are built on neuron networks.[3] Intellectual automation of medical and organizational processes increases the efficiency of the personnel's performance and their interaction with the patients, increases the speed of servicing, accuracy of diagnosing and, consequently, loyalty of the latter.

In the first half-year of 2020, the most largely financed areas in digital healthcare were: telemedicine – $1.7 bln, big data and analytics – $826 mln, healthcare applications for mobile phones – $794 mln and support of clinical decision-making – $545 mln.[4]

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[1] 2021 Global Health Care Outlook. Accelerating industry change. URL: https://www2.deloitte.com/global/en/pages/life-sciences-and-healthcare/articles/global-health-care-sector-outlook.html (access date: 14.01.2021).

[2] How can leaders make recent digital health gains last? URL: https://www.accenture.com/us-en/insights/health/leaders-make-recent-digital-health-gains-last (access date: 10.01.2021).

[3] Far East High Technologies Fund invested 200 mln rubles into Promobot. URL: https://www.rusnano.com/about/press-centre/news/20200410-rosnano-dfvt-investiroval-200-mln-rub-v-promobot (access date: 11.02.2021).

[4] Report on financing, mergers and take-overs in digital healthcare for the 1st half-year and 2nd quarter of 2020. URL: https://mercomcapital.com/product/1h-q2-2020-digital-health-healthcare-it-funding-ma-report/ (access date: 01.02.2021).

In an annual monitoring of the global digitalization trends, Rostelekom declared the absolute leadership of artificial intelligence among the digitalization trends in 2020.[1] Among technological trends, electronic healthcare moved from the fifth position in 2019 into the third one in 2020.

At the same time, the foreign colleagues mark the following global trends in the sphere of digital medicine: broader use of artificial intelligence in medicine; differentiation of telemedicine services; growing popularity of concierge services; development of value-oriented healthcare; growing demand for niche products – for individual age groups and categories of the population.[2] The promising areas of using the artificial intelligence are linked with the increase of diagnostics quality (image analysis), elaboration of new medications, estimating the risks for patients with various diseases, development of virtual assistants (chat-bots).

The scale of introducing the artificial intelligence in the global market is so large that, according to experts, in 2020-2027 it will grow by 44.0% each year on average. [5] In 2019, in the global market of medical diagnostics, the artificial intelligence was estimated as $3,639.02 mln and, according to experts, will reach $66,811.97 mln by 2027. In our opinion, such impressive growth rate of this market is due to the following reasons. First, artificial intelligence is largely used in healthcare, mainly, for identifying and diagnosing diseases. Second, investments to startups in healthcare with artificial intelligence have significantly increased. For example, according to Mercom Capital Group analytics, in the first half on 2020, financing of medical startups all over the world amounted to $6.3 bln. The amount of investments increased by 24% compared to the same period of 2019. However, the coronavirus crisis somewhat reduced the growth rate and in the second quarter of 2020 the deals totaled $2.8 bln, which is by 23% less than in the first quarter.[3]

As for the Russian market of medical startups, one can state a significant lagging from the global leaders. For example, in the first half-year of 2020, the sum of financial resources invested to healthcare was $17.1 mln. At that, healthcare was second by the total amount of venture financing. The largest deals were: investment of $15 mln into “Doktor ryadom” by VEB Ventures; “Medsi” buying 12.5% of the company “Platforma Tretye mneniye” (PTM), which works over using artificial intelligence in healthcare; investments of the Russian Direct Investment Fund (RDIF) into the company “Medpromresurs”, created for promoting the Russian-Japanese system of coronavirus diagnosing.[4]

Thus, the measures of episodic emergency reaction of the healthcare system to COVID-19 spread are taking the form of a stable demand in rapid rendering of high-quality medical aid. To this end, it is essential to transform the standard servicing model into an intellectual one, using new operational approaches to managing medical establishments and creating a flexible and safe working environment, capable of instantly reacting to an upsurge in disease incidence.

Theoretical background of the research

Intellectual automation of absolutely all spheres, and to the largest extent healthcare, is a natural consequence of the coronavirus pandemic.[5] The automation potential is implemented, first and foremost, through improved

[1] Monitoring of digitalization global trends of 2020. URL: https://www.company.rt.ru/upload/iblock/6e0/ROSTELECOM_TRENDS2020_INTERACTIVE_FINAL.pdf (access date: 01.02.2021).

[2] Our healthcare report gives a data-driven look at global healthcare technology investment trends, top deals, active investors, and corporate activity in Q3 2019. URL: https://www.cbinsights.com/research/report/healthcare-trends-q3-2019/ (access date: 01.02.2021).

[3] Report on financing, mergers and take-overs in digital healthcare for the 1st half-year and 2nd quarter of 2020. URL: https://mercomcapital.com/product/1h-q2-2020-digital-health-healthcare-it-funding-ma-report/ (access date: 01.02.2021).

[4] Investors forked out only for distant learning and health. URL: https://www.rbc.ru/newspaper/2020/09/24/5f6b31d49a7947dee548156d (access date: 01.02.2021).

[5] Kuzminov, Ya. Virus revolution: how pandemic will change our world. URL: https://www.rbc.ru/opinions/society/27/03/2020/5e7cd7799a79471ed230b774 (access date: 06.02.2021).

analytics, robotization, and artificial intelligence. This process actively involves blockchain technologies; machine learning; computer vision; software bots automating routing procedures; cognitive systems of data analysis and transfer; virtual consultants, etc.

A large number of recent foreign publications analyze the current concepts of using the artificial intelligence to boost the efficiency of comprehensive clinical research and improve their quality. [6,7,8] However, there is a significant gap between digital business objectives of the programmers and providers and the possibilities for their introduction and broad use, especially from the viewpoint of personnel's skills. In 2018, only 52% of healthcare organizations had a program of digital skills development within their strategy of digital transformation.[1]

From this viewpoint, the process of intellectual transformation of healthcare plays a twofold role. On the one hand, it helps to implement the capabilities of the new technologies and the relevant organizational culture and management style in order to boost the quality and reduce the cost of medical services; on the other hand, it creates additional problems for the modern healthcare system and, first and foremost, its personnel. At that, transformation of the culture of innovations appears to be more important than technologies. "…transformation thinking is necessary…. One cannot just 'live in a digital world', one should 'create a digital world'. Revision of personnel is mo less important than revision of technologies…".[2]

Digital technologies cannot substitute human care and responsibility. [9] The ability of medical personnel to adapt and successfully use intellectual technologies determine the possibilities of reducing the costs and increasing the quality of healthcare. [10] Participation of medical personnel in technologies design is of utmost importance for creating a safe professional environment in a digital hospital. [9] That is why evaluation and optimization of the "correlation" between the technology and the personnel's clinical work is critical for ensuring the expected advantages of introducing the digital technologies. [11]

A comprehensive research of the global healthcare development up to 2027 highlights the trends which are, one way or another, related to the efficiency of using intellectual systems for diagnosing and support of medical decisions. [12] At the same time, it evokes great apprehension and actualizes the problems related to integration of the artificial intelligence systems into everyday clinical practice and to accounting for the alternative costs of its use for managing patients' health. [13] Today, doctors need to increase their knowledge in the sphere of mathematical concepts, bases of artificial intelligence, data science, related ethical and juridical issues. To this end, it is necessary to elaborate stimuli for their mastering, which are either not yet elaborated at all or insufficient. [14] Additional duties increase, such as management instead of personal observation of a patient, etc., which may aggravate professional burnout of a doctor. [15]

Hence it is not surprising that many researchers associate the main barrier of healthcare automation with the characteristics of medical personnel, their level of technical literacy and attitude to intellectual communicative technologies, as well as with the ambiguity of legal and normative provisions of medical software. [12]

The objective abilities and subjective attitudes of the personnel in the epicenter of this fundamental process are the conceptual direction of scientific search for the factors, forms and mechanisms of maximal implementation of their potential, promoting the efficiency of ICT introduction. This issue is disputable and cannot be unambiguously solved in theoretical and practical aspects, as it requires elaborating new forms of interaction between medical personnel (for example, computer anxiety, motivation), technology (for example, convenience of use, functionality, productivity), and attributes of clinical tasks and processes (for example, organization, tasks complexity). [15] According to some economists, building of such interaction is the

[1] How Healthcare Providers Can Succeed in Digital Transformation. URL: https://www.gartner.com/smarterwithgartner/how-to-succeed-in-healthcare-digital-transformation/ (access date: 30.01.2021).

[2] Three trends driving digital transformation in 2019. URL: https://www.ey.com/ru_ru/digital/three-trends-driving-digital-transformation-in-2019 (access date: 10.02.2021).

fundamental basis for the new model of healthcare intellectualization, formed in the post-COVID environment.[1]

The ability of medical personnel to adapt to the intellectual transformation of healthcare, their level of innovative activity determines deep personal and professional changes. Some of them find it extremely difficult to effectively cope with ICT demands. [16] Lagging behind in the sphere of digital knowledge and skills impedes healthcare workers sticking to professional standards in using ICT and may cause problems in professional activity, especially in aged specialists. [16]

In this respect, not surprising are the conclusions in a research by A.J.E. De Veer, M.A.H. Fleuren, N. Bekkema, and A.L. Francke, in which only half of the polled medical workers positively estimated the introduction of digital technologies. [17] At that, the factors impeding their effective use were difficulties in mastering the technologies, faults and defects in their functioning, relevance and risks for patients.

Similar results were obtained in a nation-wide research of competence of working-age medical personnel in mastering intellectual technologies in Finland: inconvenience of use, faults and low reliability. At the same time, the factors of low competence of the personnel in mastering intellectual technologies are the low level of digital literacy, lack of time, and, as a consequence, the high level of psychological stress. [18]

The Netherlands scholars J.A. De Leeuw, H. Woltjer, and R.B. Kool made ambiguous conclusions in their research of graduate nurses. [18] For example, despite the active use of electronic devices and digital systems in their professional activity, most of the nurses perceive them as not user-friendly, taking much time and not supporting the everyday professional practice. Most of the respondents characterized digital work as “not at all funny”, “working in a false world”, “stressful” and “annoying”. The negative attitude to using a computer was due to the complete or partial lack of general digital knowledge and skills in the medical personnel. Hence their feeling of increased incompetence and postponing or rejecting the use of intellectual and digital systems both in personal and professional sphere.

At the same time, researchers mark that the positive influence of the working environment was produced in case of creating conditions for continuous training at work and support of the colleagues competent in digital technologies.

A group of German scholars researching this issue have come to similar results showing a great lack of literacy of medical personnel in the sphere of electronic healthcare and a lack of knowledge (over 80% of the polled doctors) about the safe introduction of these technologies into the everyday clinical practice. [19]

A group of American scholars, who applied a combined research method, including observation of medical personnel, semi-structured interviews and electronic polling of in-patient hospitals, have come to the following conclusions. [20] The personnel of a medical establishment is very diverse in the level and practice of using digital technologies, which is often due to the varied level of training of the personnel and the convenience of using digital technologies. Thus, for example, the available electronic records are not used for information exchange between doctors and impede their interaction in rendering high-quality medical aid. The functional opportunities of the working procedure organization in the medical-technological environment are also not fully used, which, according to the researchers, creates a safety problem for patients. [20]

Different results were obtained by S. Gürdaş Topkaya and N. Kaya, regarding the medical personnel’s high digital literacy and positive attitude to digital technologies. [21] At that, the opinion was expressed about the need for, primarily, organizational support of the medical personnel in order to deepen their digital skills and competences.

Indeed, the global pandemic, having accelerated the intellectual automation of healthcare, poses the issues of the chances for its further progress in the post-pandemic reality, of the potential risks and growth limitations, etc. Moreover, multiple subjects and stakeholders have various interests and expectations regarding the intellectualization of modern healthcare. Still, demographic development has led to an aging, multiple-pathology society with increased needs and efforts in the sphere of medicine and care. [19] Healthcare system remains being divided into the in-patient and out-patient sectors which are not properly linked with each other. A huge amount of medical data generated every day is still stored in different data storages of

[1] Three trends driving digital transformation in 2019. URL: https://www.ey.com/ru_ru/digital/three-trends-driving-digital-transformation-in-2019 (access date: 10.02.2021).

incompatible systems. [22] The lack of functional compatibility impedes exchange, analysis and interpretation of clinical results, hence, the advantages of digital medicine cannot be used to the full.

Without going into the detailed analysis of the key characteristics and factors influencing the innovative activity or passivity of medical personnel in mastering digital technologies, we would like to highlight the following. The results of most research show that salary has a very low influence on innovative activity, while the payment for medical services – the highest. [23] At that, one should mark a high heterogeneity of the medical personnel's behavior. Thus, internally motivated medical personnel appear to be almost insensitive to financial stimuli. But when the quality of work brings immediate good to patients, the subjects increase the quality of their services, retaining the productivity level. [23]

Thus, the multidimensional and broad process of the healthcare intellectual transformation entails many disputable and controversial aspects. That said, scholars and experts are unanimous in the issues of acute objective need to increase the digital competences of the personnel. Often, opinions differ on the issues of functional opportunities of organizing the working process in the new technological environment, mechanisms and forms of effective interaction between workers and IT systems, forming high-quality sets of data to be processed by people and machines, as well as stimulation and motivation of the personnel's innovative activity.

Research methodology

Previously, using the software IBM SPSS Statistics, we carried out a multidimensional classification of medical establishments in 45 municipal entities of the Republic of Tatarstan based on 22 indices of performance efficiency by the specified main components [24,25]. As a result, we grouped four clusters of medical establishments: cluster I – medical establishments of 11 municipal entities, cluster II – 15, cluster III – 11, and cluster IV – 8. Accordingly, cluster I comprises effective medical establishments, cluster II – relatively effective, cluster III – relatively ineffective, and cluster IV – ineffective medical establishments.

Based on the polling of medical personnel of the Republic of Tatarstan medical establishments (1004 employees from 17 state and private medical establishments), a representative sample was formed. We compared the polling results with the specified clusters and formed the corresponding samples for each of them (Table 1).

Table 1 Structure of personnel

Groups	**Types of clusters**			
	cluster I - effective	**cluster II – relatively effective**	**cluster III – relatively ineffective**	**cluster IV – ineffective**
Gender				
Men	58(21.4)	18(18.0)	18(8.6)	36(8.5)
Women	213(78.6)	78(78.0)	192(91.4)	375(88.9)
No answer	0(0.0)	4(4.0)	0(0.0)	11(2.6)
Total	271(100)	100(100)	210(100)	422(100)
Age				
21-30	59(21.8)	12(12.0)	35(16.7)	28(6.6)
31-40	81(29.9)	19(19.0)	52(24.8)	90(21.3)

41-50	63(23.2)	28(28.0)	81(38.6)	151(35.8)
Older than 51	64(23.6)	38(38.0)	38(18.1)	137(32.5)
No answer	4(1.5)	3(3.0)	4(1.9)	16(3.8)
Total	271(100)	100(100)	210(100)	422(100)

Cluster I comprises the polling results of 271 people. The age structure of the personnel is rather evenly distributed. In cluster II, over 2/3 of the personnel are older than 41 y.o., which significantly increases the risks of staff shortage in the nearest future. In cluster III of relatively ineffective medical establishments, a similar prevalence in the 31-50 y.o. age group was observed. In cluster IV (422 people), the share of specialists younger than 30 y.o. was also very low (6.6%), which may create the risks of staff shortage. The share of men in cluster I was higher than in other clusters. The most optimal, in terms of personnel development and rotation, is the structure of personnel in medical establishments of cluster I.

Research results and analysis

Let us consider the structure of personnel of each cluster in terms of age groups and gender (Table 2).

Table 2 Level of preparedness of medical personnel for using intelligent medical decision support systems in various age groups

Groups	**Types of clusters, % in a group**			
	cluster I - effective	**cluster II – relatively effective**	**cluster III – relatively ineffective**	**cluster IV – ineffective**
Age				
21-30	55/59(93.2)	9/12(75.0)	27/35(77.1)	16/28(75.0)
31-40	67/81(82.7)	18/19(94.5)	42/52(80.8)	75/90(80.0)
41-50	55/63(87.3)	26/28(92.9)	64/81(79.0)	115/151(60.9)
Older than 51	56/64(87.5)	33/38(86.8)	25/38(65.8)	98/137(71.5)
No answer	2/4(50.0)	3/3(100.0)	2/4(50.0)	6/16(37.5)
Total	235/271(86.7)	89/100(89.0)	160/210(76.2)	304/422(73.5)
Gender				
Women	183/213(95.9)	71/78(91.0)	147/192(76.6)	282/375(75.2)
Men	52/58(89.7)	14/18(77.8)	13/18(72.2)	25/36(69.4)
No answer	4/4(100.0)			3/11(27.3)

The effective and relatively effective clusters showed approximately the same level of preparedness of the medical personnel for using intelligent medical decision support systems (about 87-89%). In each age group,

except older than 51, the level of preparedness of the medical personnel for using intelligent medical decision support systems in cluster IV appeared to be lower than in other clusters, including the average value in the cluster. Preparedness of women for using intelligent medical decision support systems appeared to be higher than that of men in all studied clusters.

Undoubtedly, provision of high-quality medical instrumental examination precedes the use of intellectual medical decision support systems. Hence, we built a table of correlation in order to study the interrelation between the quality of instrumental examination and the preparedness of the medical personnel for using intelligent medical decision support systems in the four clusters (Table 3).

Table 3 Preparedness of the medical personnel for using intelligent medical decision support systems under various conditions of performing medical instrumental examination in medical establishments of the researched clusters

		cluster I - effective				**cluster II – relatively effective**				**cluster III – relatively ineffective**				**cluster IV – ineffective**			
		Preparedness for using intellectual medical decision support systems															
		Prepared	**Not prepared**	**No answer**	**Total**	**Prepared**	**Not prepared**	**No answer**	**Total**	**Prepared**	**Not prepared**	**No answer**	**Total**	**Prepared**	**Not prepared**	**No answer**	**Total**
Estimation of correlation between instrumental examination in a medical establishment and the modern level of medical science and technologies	Correlates	194	22	2	218	50	4	0	54	129	31	2	162	158	22	2	182
	Does not	35	6	2	43	38	5	0	43	28	13	2	43	141	72	10	223
	No answer	6	0	4	10	1	0	2	3	3	0	2	5	11	1	5	17
	Total	235	28	8	271	89	9	2	100	160	44	6	210	310	95	17	422

Analysis showed that the highest degree of correlation between instrumental examination in a medical establishment and the modern level of medical science and technologies can be seen in cluster I (80.4%), the lowest– in cluster IV (43.1%). In cluster II this indicator amounted to 54%, in cluster III – 77.1%. By the personnel's estimations, the low level of material-technical provision of medical establishments does not allow rendering quality medical services and, consequently, ensuring high efficiency.

Most of the medical personnel of cluster I medical establishments prepared for using intelligent medical decision support systems (82.6%) think that the medical instrumental examinations performed in them comply with the modern requirements; in cluster II – 56.2%, in cluster III – 80.6%, in cluster IV – 50.9%. Special

attention should be paid to cluster IV, where 75.8% of the employees from the group of those unprepared to use intelligent medical decision support systems consider the quality of instrumental examinations to be low. A high-quality examination of a human body with the use of various appliances, devices and instruments is the necessary condition and prerequisite for further use of artificial intelligence for making medical decisions.

In the course of the research, it was essential to identify the level of digital literacy of the medical establishments' personnel and their perception of the influence of digital technologies on the efficiency of medical services rendering. We assessed positive answers of the medical personnel to the question "Has the implementation of healthcare digitalization program increased the quality of medical services in your establishment?" in each of the studied clusters (Fig. 1). Also, we found the share of those who considers the low level of their digital literacy to be the main barrier in using digital technologies.

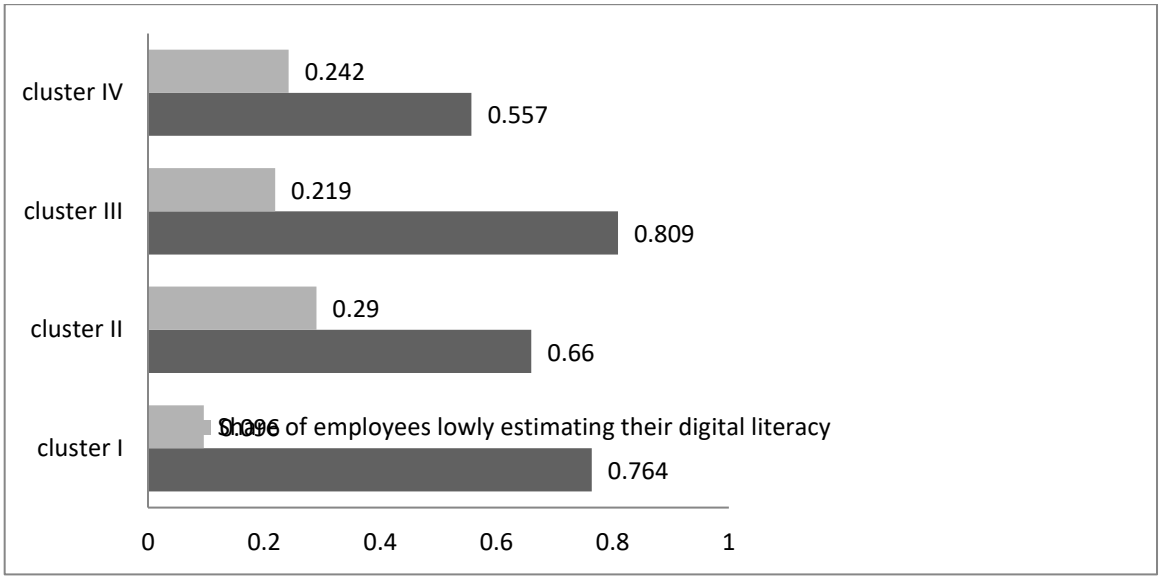

Fig. 1. Share of employees positively estimating the influence of digitalization on the quality of medical services

The majority of personnel in the medical establishments of all studied clusters marked the positive influence of digitalization on the quality of medical services. At that, in cluster I only about one tenth of the personnel (9.6%) estimated the level of their digital literacy as low, making it hard to use digital technologies. In cluster IV of ineffective medical establishments, the awareness of the digitalization advantages was rather low, and every fourth employee admitted their level of digital competences to be low, impeding the active use of digital technologies.

The degree of influence of various factors on the preparedness of the medical personnel for using intelligent medical decision support systems in clusters is shown in Table 4.

Table 4 Influence of factors on preparedness of the medical personnel for using intelligent medical decision support systems in various clusters of medical establishments

Factors	**Symbol**	**Correlation coefficients**			
		cluster I	**cluster II**	**cluster III**	**cluster IV**
Personal preparedness for introducing and using the digital technologies	will_use_it	-0.015	-0.025	0.285	0.200

Preparedness of the population for the digital technologies introduced into healthcare	will_popul	0.702	0.566	0.184	0.592
Satisfaction with labor	satisf_job	-0.016	-0.032	0.199	0.386
Salary corresponding to labor efforts	satisf_wage	-0.037	-0.019	0.127	0.351

The most significant factor of the preparedness of the medical personnel for using intelligent medical decision support systems (will_use_MDSS) is the preparedness of the population for the digital technologies introduced into healthcare. The population's demands for active development of the digital ecosystem of healthcare, the increase of the digital literacy of the medical personnel stimulates them for acquiring the necessary competences for using intelligent medical decision support systems, especially in effective clusters. The following coefficients have very weak and weak correlation with the variable will_use_MDSS (preparedness of the medical personnel for using intelligent medical decision support systems):

- clusters I and II: will_use_it, satisf_job, satisf_wage.

- cluster III: will_use_it, satisf_job, satisf_wage, will_popul.

- cluster IV: will_use_it, satisf_job, satisf_wage.

Below we build the multiple regression model for each cluster (Table 5).

Table 5 Regression analysis of the preparedness of medical personnel for using intelligent medical decision support systems in clusters of medical establishments of the region

Factors	**Coefficient**	**Standard error**	**t-statistics**	**P-value**	**R^2**	**P**	**F**
cluster I							
const	0.589	0.173	3.415	0.0007***	0.239	9.55e-14	19.202
will_use_it	0.322	0.059	5.389	1.67e-07***			
will_popul	0.271	0.055	4.947	1.41e-06***			
satisf_job	0.148	0.055	2.679	0.0079***			
satisf_wage	−0.055	0.046	−1.200	0.232			
cluster II							
const	1.152	0.239	4.818	6.55e-06***	0.187	0.002	4.712
will_use_it	0.257	0.086	2.986	0.0037***			
will_popul	0.059	0.066	0.904	0.369			

satisf_job	0.121	0.083	1.461	0.148			
satisf_wage	−0.099	0.058	−1.706	0.0919*			
cluster III							
const	0.848	0.253	3.356	0.0010***	0.106	0.0003	5.519
will_use_it	0.252	0.105	2.403	0.0172 **			
will_popul	0.157	0.073	2.157	0.0323**			
satisf_job	0.206	0.103	1.998	0.0471**			
satisf_wage	−0.001	0.066	−0.0106	0.9916			
cluster IV							
const	0.462	0.157	2.945	0.0034***	0.216	2.99e-19	26.266
will_use_it	0.269	0.049	5.393	1.22e-07***			
will_popul	0.245	0.042	5.867	9.66e-09***			
satisf_job	0.096	0.048	1.988	0.0476**			
satisf_wage	0.076	0.044	1.720	0.0863*			

Analysis of the obtained models showed that there are no autocorrelation and heteroscedasticity, the data are normally distributed.

Preparedness of the medical personnel of cluster I for using intelligent medical decision support systems can be described with the following linear equation:

$$will_{use_{MDSS}}I = 0.589 + 0.322 \cdot will_{use\_it} + 0.271 \cdot will_{popul} + 0.148 \cdot satisf_{job} - 0.055 \cdot satisf_{wage} \quad (1)$$

As can be seen from the equation, the factor most of all influencing the preparedness of the personnel to use intelligent medical decision support systems during diagnostics and treatment is their desire to develop digital competences and use digital technologies in all spheres of life. Another significant factor is the medical personnel's perception of the attitude of the population to the introduced digital technologies and to the development of digital healthcare: the higher preparedness of the population, the higher activity of doctors in mastering and applying the intelligent medical decision support systems. Satisfaction with labor was the third most important positive factor. Interestingly, satisfaction with salary had a slight negative influence.

Similar influence of the factors on preparedness of the personnel for using intelligent medical decision support systems can be observed for the personnel of medical establishments of cluster II:

$$will_{use_{MDSS}}II = 1.152 + 0.257 \cdot will_{use\_it} + 0.059 \cdot will_{popul} + 0.121 \cdot satisf_{job} - 0.099 \cdot satisf_{wage} \quad (2)$$

However, the obtained value of the determination coefficient (0.187) shows a significant influence of other factors, not included into the built model. Such influence can be also seen in the model built for cluster III:

$$will_{use_{MDSS}}III = 0.848 + 0.252 \cdot will_{use\_it} + 0.157 \cdot will_{popul} + 0.206 \cdot sat\_sf_{job} - 0.0007 \cdot satisf_{wage} \quad (3)$$

$$will_{use_{MDSS}}IV = 0.462 + 0.269 \cdot will_{use\_it} + 0.245 \cdot will_{popul} + 0.096 \cdot satisf_{job} + 0.076 \cdot satisf_{wage} \quad (4)$$

In cluster IV, the most significant factor was preparedness of the medical personnel for forming digital competences and using digital technologies, as well as preparedness of the population for the digital technologies introduced in the healthcare system.

Conclusion

The medical personnel, having found themselves "in the thick of things", are actively involved into the process of the intellectual transformation of healthcare. Most of them perceive digitalization as technologies and methods enabling to increase the quality and accessibility of medical services. The level of preparedness of the medical personnel for using intelligent medical decision support systems is estimated as rather high. Doctors and paramedics, to a certain extent, attempt to correspond to the challenges of time and requirements of patients. However, a significant barrier for the efficiency of this process is the low level of digital literacy of the personnel and poor material-technical provision of medical establishments. Thus, we associate the promising ways of healthcare intellectualization with the need to increase the digital knowledge and competences of the personnel, forming high-quality sets of medical data and their functional compatibility in the process of interaction between the personnel and technical-technological systems.

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