Mini-Review

The opportunities and challenges of telemedicine during COVID-19 pandemic

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1. Abstract

At the end of 2019, patients with pneumonia of unknown etiology appeared in the city of Wuhan (China). After a short time, this infection affected not only the people of China but also the whole world. On March 11, 2020, the World Health Organization declared the disease a pandemic. A viral agent was identified - severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2), and the disease itself was named "2019 novel coronavirus infection" (COVID-19). Telemedicine technologies are a form of medical care and training that can counteract the spread of a COVID-19 epidemic by eliminating direct contact of both medical workers with patients and medical workers and patients with each other. Lack of personal protective equipment, the suspension of clinical clerkship and supervision, and a reduction in the number of elective surgical cases inevitably affect medical and surgical education. Interesting solutions using virtual learning, video conferencing, social media, and telemedicine could effectively address the sudden discontinuation of medical education. In fact, it is currently the ideal combination of teleworking and study. Telemedicine can play an important role in this pandemic by minimizing the spread of the virus, leveraging healthcare providers' time, and alleviating the challenges of medical education. The aim of this study was to identify the role of telemedicine services in the management and controlling of diseases as well as on medical education during the COVID-19 outbreak.

2. Introduction

On March 11, 2020, the World Health Organization (WHO) announced the beginning of a pandemic of new coronavirus infection, internationally called new coronavirus infection 2019 (COVID-19) in the world. The consequences of the spread of the pandemic in the world have become a large-scale economic crisis that has affected the world's largest economies. Russia is no exception, since May 2020, the country has already taken 2nd place in the incidence of COVID-19 [1, 2]. The spread of COVID-19 infection has become a challenge for health systems around the world. Doctors face an unprecedented work-

load, and digital solutions to ease it are more relevant than ever. Telemedicine as a service is based on the use of digital technologies to provide health care and education at a distance and to connect doctors with each other [3]. The capabilities of this technology are known and have been developing for a relatively long time. It allows you to expand the list of available healthcare services in remote regions, provide patients with remote consultations in non-urgent situations, conduct online consultations - and these are just a few of its advantages [3]. The introduction of telemedicine in Russia is one of the priorities of the National Healthcare Project [4]. The COVID-19 pandemic has forced to look at telemedicine from a new angle and significantly accelerate its implementation around the world. Limiting social contacts has become the most important condition for containing the virus. Technology allows people with moderate symptoms to stay away from the doctor and get help remotely. It is equally important to use digital technologies to exchange data between doctors inside and outside medical institutions, as well as in the training of students and junior doctors.

Telemedicine technology can become a basic need for the general population, including training, healthcare providers, and patients with COVID-19, especially when people are in quarantine, allowing patients to receive real-time advice through contact with a healthcare provider about their concerns with health. Therefore, the purpose of this mini-review is to identify the role of telemedicine technologies in the prevention, diagnosis, treatment, control of disease, including psychotherapeutic care, and training of medical students or junior doctors during the COVID-19 pandemic. Additionally, in this study, we would like to demonstrate several projects in Russia related to telemedicine technologies and COVID-19.

3. Telemedicine technologies and medical education

The main purposes of using the use of computer and telecommunication technologies, that is, telemedicine technologies in medical education, include: (1) to provide and facilitate the acquisition of basic skills/knowledge; (2) improve the process of making conceptual decisions; (3) improve the perception of variations or 3D modeling in anatomy lessons; (4) ensure improved coordination of skills in teaching; (5) practice those skills that may include both rare and emergency situations; and (6) provide group training [5, 6]. These goals can be incorporated into curricula and integrated with educators' existing clinical experiences in a pandemic to provide students with the clinical skills they need through telemedicine technology. Through meaningful and sustainable remote patient care in a wide variety of clinical settings, led by different educators with specific professional skills, students can learn how telemedicine technologies can be used to assist pa-

tients and acquire clinical thinking skills remotely. Historically, most medical schools have already incorporated telemedicine into the curriculum of medical students. However, preclinical education is also an opportunity for teaching and demonstrating telemedicine technologies during didactic lectures or small group discussions. In other words, video conferencing technologies can help provide thematic discussions, presentations, and real-time assessments to educate medical students, young doctors, and practitioners in other parts of the country or globally [7]. Given that medical students may not be directly involved in patient care at such an early stage in their education, it is important to introduce them to the various telemedicine technologies and teach them how to incorporate telemedicine into their future careers. There are many telemedicine applications available today. Modern medical schools have an excellent opportunity to focus on how they can consider formalizing the impact on medical students in four important key areas: (1) the field of surgery (telesurgery), (2) telerehabilitation, (3) telemedicine in the intensive care unit (remote intensive care unit) and (4) chronic disease management [8].

It is no longer a secret that the current pandemic has rapidly accelerated the transition to telemedicine and provided medical schools with the opportunity to prepare medical students to participate and develop the skills for this transition (Fig. 1). Perhaps a faster transition to telemedicine in medical education will help future doctors prepare for the current era of COVID-19 and the upcoming pandemics. COVID-19 has challenged healthcare providers to deliver quality remote healthcare and demonstrated what types of healthcare are more accessible virtually. The inclusion of telemedicine in the curriculum of medical schools will not only introduce medical students to relevant technologies but will also increase their understanding of the complex ethical, regulatory, and legal issues associated with such cases. It is important to note that patients must give their consent for students to participate in this particular type of care. Patient privacy in a telemedicine education program, where information is transferred between devices and accessed by multiple students and doctors, can force patients to opt-out. Since informed consent is a core competence of health care providers in teaching, this should be communicated to students and, in turn, to their patients [9]. Telemedicine curricula should include the limitations of telemedicine platforms, especially in the provision of emergency care. Patients using on-demand telemedicine may experience reduced continuity of care, as the same provider may not be available during different unscheduled visits. Insufficient or uncoordinated efforts to provide high-quality telemedicine education can lead to unstable quality of care and risks to patient safety. It can also pose an additional burden for medical students who are already overwhelmed with existing coursework [10].
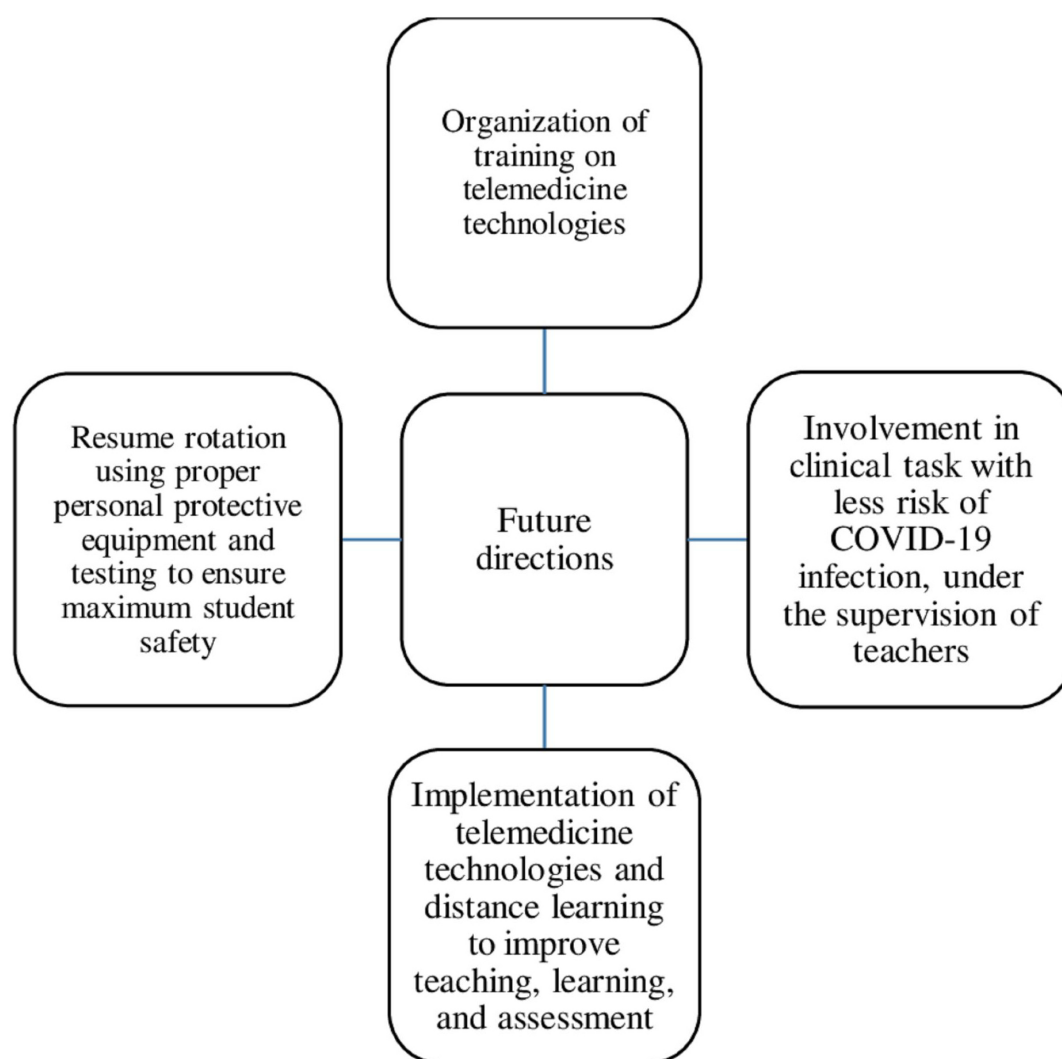
Fig. 1. Future directions in medical education during COVID-19 pandemic.

4. Role of telemedicine in psychotherapeutic care during COVID-19 pandemic

In the context of the COVID-19 pandemic, it is extremely important prevention and therapy of psychopathological disorders associated with fear of getting sick or fear of re-infection and a situation of prolonged exposure to the stress caused not only by the spread of a new coronavirus but also by the forced stay in self-isolation mode and the transition to a remote work format [11]. According to a survey of the USA population by the American Psychiatric Association (APA), almost 50% of those surveyed experienced severe levels of anxiety, while 40% fear that they or their loved ones could get COVID-19 severe form and even die [12]. According to a study by the All-Russian Public Opinion Research Center (APORC), the vast majority of Russians (84%) are worried about the economic crisis associated with the COVID-19 pandemic [13]. Under these conditions, telemedicine is an extremely significant factor in preserving and maintaining the mental health of the population, while psychiatry, and especially psychotherapy, became the first in the history of medicine, where telemedicine technologies were successfully and extensively applied to provide counseling and psychotherapeutic assistance to patients. In the current situation, the introduction of quarantine on the territory of many countries, a psychiatrist/psychotherapist is obliged not only to provide the patient with the opportunity to receive advice via video communication but also to provide qualified psychotherapeutic assistance. In this regard, it is extremely important for us to improve the qualifications of psychiatrists, as well as training in the peculiarities of remote counseling. At present, recommendations for the provision of psychiatric care have already been developed, which also indicate the main goals and objectives of psychotherapeutic work in a COVID-19 pandemic [14]. In particular, it is recommended to provide assistance remotely using modern instant messengers and webinars, such as teams, zoom, and WeChat). In addition, other help consists, first all, in creat-
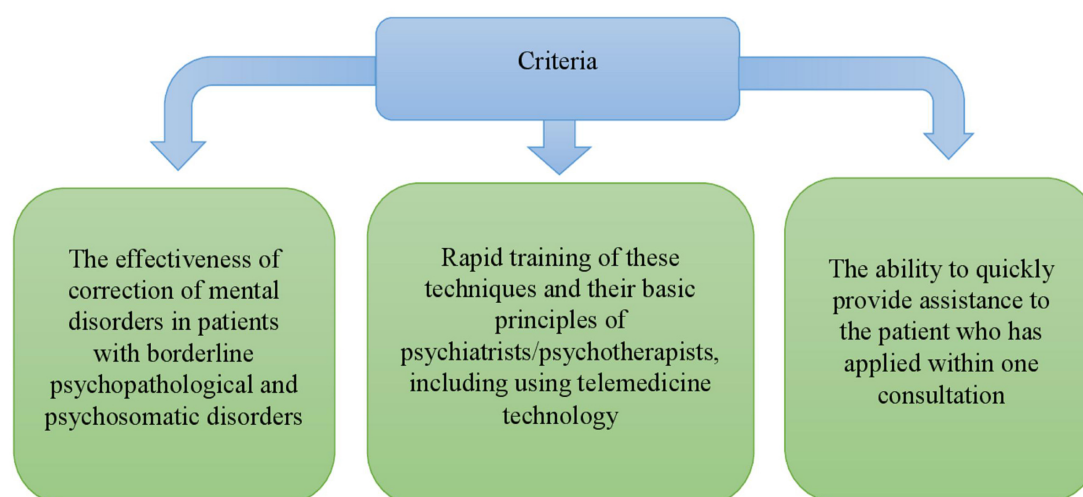
Fig. 2. Criteria for choosing psychotherapy techniques most suitable for effective work in telemedicine mode.

ing a controlled situation, that is, in the formation of a subjective feeling of control over their lives in patients, while providing support in carrying out psychological and educational activities and, if necessary, in prescribing appropriate pharmacotherapy. In addition, the development of patterns of rational behavior and strategies for overcoming the current life situation in order to resolve problems together with the patient is significant. The main goal of psychological support should be to increase the patient's personality resistance and resilience to crises, including destructive suicidal and aggressive behavior.

One of the most important conditions for the provision of assistance using telemedicine technology is the short-term nature of psychotherapy. Independent work of the patient is extremely important in remote counseling of patients with borderline psychopathological conditions, and it is possible to recommend as such a practice of cognitive-behavioral therapy, in particular, switching the type of activity. Since the patient with anxiety develops a mental stereotype of thoughts, emotions, and actions, of which an anxious thought or anxious emotion is the trigger for an anxious state, interruption of this stereotype is invokes a state of subjective relief. Accordingly, one of the most important ways to solve this problem is the work of psychologists, psychiatrists, and psychotherapists with patients in telemedicine mode (Fig. 2).

5. Advantages and disadvantages of application of telemedicine technologies

Scientists from many countries are engaged in the possibility of using telemedicine technologies during the COVID-19 pandemic, re-evaluating its strengths and weaknesses, analyzing the modern infrastructure of the electronic means used. Thus, telemedicine has already demonstrated its effectiveness in many areas of medicine, including the treatment of diabetes mellitus and cardiovascular diseases, allowing for high-quality remote treatment [15, 16]. Its important advantages are timesaving and contactless communication. Thus, telemedicine is rapidly becoming the main tool for reducing COVID-19 transmission.

While recognizing the need to apply telemedicine technology during the COVID-19 pandemic, it is important to address its weaknesses. Even before the pandemic, research has shown that the cost of implementation and uncertainty over the return on investment are key barriers to widespread adoption of online solutions across medicine [17, 18]. Among other barriers, it should be noted, in particular, the characteristics inherent in various groups of the population. Therefore, old age, low educational level, lack of experience in using digital technologies (for example, elderly people who are most vulnerable to COVID-19) reduce the benefits of existing digital technologies. Legal aspects play a negative role, for example, the absence of legislative acts establishing the degree of responsibility in the event of damage to health or in case of illegal actions, problems related to personal data and confidentiality [19]. However, all this does not diminish the importance of telemedicine technologies in general and during the COVID-19 pandemic, in particular. Thus, it is possible to control the symptoms of the disease and the recovery process using calls and video chats, which enables patients with a low risk of developing complications and symptoms of mild severity to stay at home.

The exponential increase in the incidence of COVID-19 has demonstrated the urgent need for the rapid tracking of infected patients, and ideally the people in contact with them. However, the timeliness of obtaining information is a weakness of traditional monitoring systems, while crowdsourcing monitoring of morbidity eliminates this disadvantage. In crowdsourcing, relevant health information is provided by a large number of people, mainly

through various internet solutions. The population can be stimulated either to actively collect data, for example, by using online systems for receiving and distributing information using applications for smartphones and fitness bracelets, or using passive sources of information, for example, messages in instant messengers and social networks [20]. An example of a successful application of an active crowdsourced monitoring system is the Flutracking platform, which is being implemented in Australia and New Zealand. Flutracking is a simple and fast monitoring system that responds to messages of large enough the number of volunteers who report cases of influenza. This system is currently being adapted for COVID-19; it is used to conduct additional monitoring, instantly providing data and warnings on the location of outbreaks of disease, which makes it possible to use it both for prevention purposes and for scientific purposes [21].

The real power of crowdsourcing platforms is related to their ability to provide information in near real-time, which makes preventive measures more flexible, cheaper, faster, and of better quality, positively affecting the reduction in the growth of morbidity. However, crowdsourcing, along with the ability to positively influence the course of the current COVID-19 epidemic, is not free from shortcomings and is subject to certain risks. One of the drawbacks is associated with the demographic characteristics of the population. The sample of people who know how to use digital devices and are willing to share their health information is often very different from the population of typical users. They are usually younger, better off, healthier, and better educated than those in more vulnerable populations (for example, the elderly people). It should be borne in mind that the Internet and social networks are a good medium for the rapid spread of false signals and fake information. Research confirms that certain events or topics that dominate public discourse (for example, underestimation of statistics on the incidence of COVID-19) lead to increased interest in them, activity in searches on the Internet and in social networks of such messages [22]. Distribution of such information without data analysis, without appropriate processing, filtering and cross-validation can lead to false alarms about outbreaks in the absence of such. However, it is in the current situation that telemedicine technologies, including crowdsourcing of morbidity, can reach their full potential and demonstrate their relevance to the needs of the healthcare system and people. Table 1 delineates some of the key benefits and limitations of telemedicine to clinical medicine.

6. Telemedicine in the Russia

The Ministry of Health of the Russian Federation and the Department of Health of the city of Moscow strongly recommend resorting to telemedicine, including remote counseling, in all situations where direct contact between a doctor and a patient can be avoided. On March 23, the Moscow City Health Department launched an around-the-clock remote consultation service via video and audio communication. Doctors assess people who apply to them according to established criteria and assist more than a thousand patients with COVID-19, whose symptoms can be treated at home. The center's specialists process more than 6000 calls every day. Non-profit organizations also do not stand aside. The Cancer Prevention Foundation has launched the "Just ask about COVID-19" referral service (https://defeatcovid.ru). The project's website contains useful information for doctors, volunteers, and people who would like to learn more about the virus. In addition, on the platform, you can get personal advice on methods of prevention, treatment, and possible complications in COVID-19.

In many patients, the COVID-19 raises the risk of complications in the form of severe pneumonia. In this regard, people often require hospitalization, many are transferred to the ICU. The number of such cases around the world has exceeded the expected magnitude. The authorities are seriously concerned not only with the fact that the number of beds and items of life-saving equipment is limited. Staff shortage and employee burnout are no less critical. Digitalization can help here. Intelligent information systems for ICU allow resuscitators to provide remote support to colleagues who work directly in the department. For solution uses high definition cameras, telemetry, predictive analytics, data visualization, and automated reporting [23]. Special algorithms track possible deterioration of the patient's condition. Thanks to this, specialists quickly begin to take action in critical cases. Such solutions make it possible to provide care to more patients with COVID-19. Clinics around the world are currently implementing and testing similar systems and support each other in this process. For example, Northwell Health, the largest healthcare provider in New York, hosted a webinar in which doctors shared their experience of using digital ICUs in the context of the spread of COVID-19 [23]. The telemedicine solution for ICU allows for the optimization of some of the processes in overloaded clinics.

Digital resuscitation is not the only telemedicine technology important in the fight against coronavirus. For a high-quality diagnosis of COVID-19, ultrasound, computed tomography (CT), and X-ray examinations are needed. Therefore, radiologists also face an increased workload. If the medical institution does not have enough staff, teleradiology comes to the rescue. For example, when the main focus of the COVID-19 epidemic was in Wuhan, China, local hospitals used a smart solution (smart system of disease management (SSDM)) that recognizes signs of COVID-19-related pneumonia on computed tomography of the lungs [24]. Artificial intelligence software has helped screen patients and prioritize direct examination of patients with anxiety symptoms. The app itself cannot diagnose.

Table 1. Benefits and limitations of telemedicine-based health care versus office visits in a health facility during COVID-19 pandemic.

Telemedicine in clinical medicine		Office visits in a health facility	
Benefits	limitations	Benefits	limitations
1. Avoids potential exposure to COVID-19	1. Unable to perform a physical examination	1. Can perform physical examination	1. Risk of exposure to COVID-19
2. Nurses check-in is not necessary	2. Laboratory testing is not possible	2. Carrying out therapy directly by the hands of medical personnel	2. Requires use of personal protective equipment
3. Can easily involve other family members in discussions on the patient's request	3. Billing for medical services may vary	3. Laboratory testing can be performed in the facility	3. Requires traveling to a hospital location
4. Savings on travel to hospitals	4. Technical problems related to users, devices, or servers	4. Reliable billing for medical services	4. Requires screening for COVID-19
	5. Requires internet and/or phone connectivity	5. Some patients prefer the traditional medical treatment in hospital	5. Requires adequate social distancing
			6. Disinfection of hands and surfaces for patients medical personnel

However, with its help, doctors can isolate the patient in time and also make a diagnosis faster. Teleradiology helps to minimize contacts between doctors [25]. For example, in the Sakhalin region, a platform (using IntelliSpace Portal solution) has been introduced and is actively used, which accumulates and processes medical images obtained in the departments of radiology diagnostics throughout the region (https://kdc.sakhalin.gov.ru). IntelliSpace Portal is a single solution that combines tools such as specialized 3D processing tools, stand-alone workstations, remote access, and web viewers. This solution will help clinicians analyze, interpret and present information where needed, including a diagnostic room, using the PACS archive and remotely. A single repository was created with the ability to access all the results of mammography, CT, magnetic resonance imaging (MRI) and X-ray examinations from one workstation. During an epidemic, such a system allows doctors to seek remote consultations from colleagues in the competence center, contact them only remotely, obtain a "second opinion" and gain more confidence in the diagnosis.

Patients with COVID-19 who are treated in intensive care units need special attention from doctors. They often require bedside examinations such as ultrasound. However, now the access of specialists in ultrasound diagnostics to the ICU may be limited [26]. Many clinics around the world are already using telemedicine technologies that can optimize the process. For example, even before the epidemic, the Lumify mobile ultrasound system was tested in the ICU of the V.A.Almazov National Medical Research Center, which allows solving several problems at once, including in the current situation (http://www.almazovcentre.ru/?p=60336). First, it is not possible to deliver a stationary ultrasound machine to the bed of an ICU patient. The compact transducers of a mobile ultrasound device connected to a compatible tablet or smartphone and can fit in a doctor's

pocket. In addition, the small size of the device simplifies the disinfection process. Secondly, with its help, ICU doctors can simultaneously scan directly at the patient's bedside and, using telemedicine technology, broadcast the procedure or transmit ultrasound images to colleagues at a distance. In this way, doctors can provide remote consultations without contacting infected patients. Finally, the solution is valuable for patients suffering from cardiovascular diseases, which are a particular risk group among people with coronavirus. During testing at the V.A.Almazov National Medical Research Center, doctors confirmed the applicability of the system for echocardiography in combination with the IntelliSpace Cardiovascular system. In the context of COVID-19, thanks to telemedicine technologies, doctors will be able to conduct ultrasound of the lungs and heart, consulting with cardiologists at a distance.

7. Discussion and implications

The use of telemedicine technology for education and health care delivery is not new. Previously, telemedicine was used to communicate with rural areas and remotely provide medical care to patients with illnesses who did not need urgent care [27]. Telemedicine was also used for training students and young professionals, as well as for holding conferences. Telemedicine technology is widely available, inexpensive, and widely used in the field of education and medical care. With the advent of COVID-19, with the general population locked out, the use of telemedicine by institutions, doctors, and patients as a teaching and therapeutic approach has become necessary. Telemedicine is still an essential step in the right direction as it is an innovative approach to managing the COVID-19 situation.

However, due to the progression in the publication of studies in this area of research, it is likely that some of the published studies were not included in this review. In addition, the search terms used may not be sufficient to get more research related to telemedicine. Future work will include searching for additional publications on how to improve the use of telemedicine, especially in the COVID-19 pandemic. Telemedicine provides safe, affordable, and convenient medical and educational assistance. While telemedicine faces many challenges such as the necessary lack of funds, lack of experience, infrastructure, etc. This review provides an insight into how medical institutions and physicians are using telemedicine to build resilience to future health crises.

8. Conclusions

Emerging suddenly and rapidly spreading across the world, the COVID-19 pandemic has shown the importance and significance of the development of telemedicine. In developed countries, the COVID-19 pandemic has already accelerated the adoption of telemedicine technologies as a tool in education and health care delivery. However, only the first steps have been taken. Further work is needed to improve the telemedicine system in order to fully unleash its potential and to best meet the needs of modern healthcare. To solve these problems, it is necessary, in particular, to develop high-quality guidelines and algorithms for the use of digital technologies, adapt them, teach people to use them belonging to various categories of the population. New laws and regulations are also needed to regulate responsibility in the field of remote treatment, as well as guidelines regarding the use of crowdsourced disease monitoring in addition to traditional epidemiological surveillance systems. In addition, it is necessary to develop and implement methods for validating information obtained remotely, as well as resolve the issue of protecting personal data and maintaining confidentiality. Thus, despite the problems and certain barriers, the introduction of telemedicine technologies into daily activities in the context of the COVID-19 pandemic is an inevitable new step into the future, which we will have to take one way or another.

9. Author contributions

IG, AG and OB—Conceptualization, Writing – original draft, Writing – review & editing; EV, AA, VP and AI—Data curation, Methodology, and Validation; SZ—Formal analysis and Resources; IG—Supervision. All authors read and approved the final manuscript.

10. Ethics approval and consent to participate

Not applicable.

13. Conflict of interest

The authors declare no conflict of interest.

14. References

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