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TELEREHABILITATION. CURRENT OPPORTUNITIES AND PROBLEMS OF REMOTE PATIENT MONITORING

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Summary

In the last five years, against the background of the appearance of COVID-19 in the world, the direction of remote telerehabilitation is intensively developing, which requires the improvement and implementation of new approaches to the patients conditions' synchronous monitoring with the involvement of the latest technical developments.

The purpose of the study. *To explore the latest publications on the possibilities of remote monitoring of patients during rehabilitation examinations and synchronous telerehabilitation procedures.*

Research material and methods. *Publications of foreign scientists in the fields of clinical, physical and rehabilitation medicine, biometrics, digital technologies on the implementation of synchronous monitoring technologies for the condition of patients with various pathologies*

The results. *Research of modern publications has shown that conducting synchronous sessions of remote examination of patients allows with a high degree of probability to conduct a general examination of the patient, conduct anthropometric and some functional studies. Among the latest –studies of changes in heart rate, blood pressure, respiratory rate, oxygen saturation, ECG and EEG data. Their results can be transmitted for direct evaluation by a doctor. There are certain problems during synchronous performance of tests with physical load to failure due to the impossibility of observing safety conditions. Technical solutions have been found for the transmission of bimetric signals during the telerehabilitation procedure. Thus, the combination of virtual reality or augmented reality with devices such as robots, sensors and wearables can be used for remote monitoring, assessment and diagnosis. These advanced methods pave the way for the transition from traditional to personalized rehabilitation by identifying the needs of each patient and tailoring the rehabilitation process to their individual characteristics.*

Conclusions. *The development of modern technologies and digital medicine has led to the emergence of the remote provision of services in the rehabilitation system, which on the one hand significantly increases the possibilities of access to the rehabilitation system, and on the other hand significantly increases the requirements for their implementation. First of all, this concerns the safety of telerehabilitation procedures. Adherence to basic safety requirements should be given due attention, which can be achieved, first of all, with the use of remote synchronous monitoring of the patient's condition, when the PhRM doctor can objectify changes in the patient's body under the direct influence of telerehabilitation tools.*

Key words: *Telerehabilitation; Telerehabilitation examination; Remote Synchronous Monitoring.*

The functioning of the body and the patient's quality of life are the fundamental goals of the practice of physical and rehabilitative medicine [1, 2]. Achieving these goals poses the problem of patient adherence to treatment and rehabilitation plans. Also problematic is the patient's ability to control his or her condition not only in the hospital and outpatient clinics, but also at home, in professional settings, and in public places.

In recent decades, the healthcare industry has undergone a significant transformation with the advent of digital technologies that have improved the quality of life, health and well-being of people around the world. The World Economic Forum estimates that global healthcare costs will reach approximately $25 trillion by 2040 [3]. Globally, the basic healthcare model provides medical services through hospitals, rehabilitation centers and outpatient clinics. In addition, the basic healthcare model is supported by a variety of intervention programs. New computer technologies not only facilitate the development of communication processes, but also significantly improve the practice of health care, including the application of mobile health technologies and artificial intelligence in electronic medical records, medical images, etc. Bioengineering, which is constantly improving and developing new portable devices used for diagnosis, monitoring, prevention, treatment of various diseases, as well as in the rehabilitation process, does not stand aside.

Public health and rehabilitation services have been significantly affected by the COVID-19 pandemic, especially for the elderly, people with physical and cognitive disabilities, children with autism and attention deficit hyperactivity disorder, and individuals with various acute and chronic physical and mental health disorders. It played an important role and brought new directions in the use of digital technologies in health care [5].

One area of application of digital technologies in health care is telehealth (which includes telemedicine, telerehabilitation, teleconsultation, and remote non-clinical services), a method of health care delivery that expands access to health services and can support and facilitate patient-centered care [1, 6].

Telemedicine refers to the use of telecommunications devices and other forms of technology to provide services outside the traditional system of delivering medical care, including rehabilitation care, during a face-to-face appointment.

In Ukraine, telerehabilitation (TR) services are regulated by a number of regulatory documents and legislative acts issued from 1993 to 2024. The industry regulatory document on its use in Ukraine is the Order of the Ministry of Health of October 19, 2015 No. 681 «On approval of regulatory documents on the use of telemedicine in the field of health care» [7]. The increasing use of TR creates

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new challenges and opportunities for its implementation in clinical practice, especially in war conditions [8]. The day before, a large joint study of the Institute of Cybernetics named after V. M. Hlushkov NAS of Ukraine, the National Cancer Institute of the Ministry of Health of Ukraine, Shupyk National University of Health of Ukraine, Ternopil National Medical University on the development of a cloud platform for patient-oriented telerehabilitation of cancer patients with mathematical modeling was completed, in which domestic scientists presented their own development of telerehabilitation technology, which is a significant contribution to the realization of the possibilities of providing remote rehabilitation services in the health care system of Ukraine. [9].

Recently, the American Academy of Physical Medicine and Rehabilitation (AAPM&R) convened an expert panel to review telehealth innovations in physical medicine and rehabilitation. The document developed summarized the issue of the possibility of using TR, highlighting the current knowledge, shortcomings, and technological limitations [10].

TR involves the use of audio and visual communication synchronously between a Rehabilitation Specialist (RS) – a Physician of Physical and Rehabilitation Medicine (PhRM), a Physical Therapist, an Occupational Therapist, a Speech Language Pathologist and the patient using a telehealth platform. An important goal of TR is to overcome barriers and ensure access to rehabilitation. It can help overcome barriers to face-to-face consultations related to RS reception schedules and logistics, transportation difficulties, financial problems, adverse weather conditions, disasters, pandemics, etc. [11].

There are several forms of TR. The traditional forms of TR include synchronous and asynchronous forms [12]. The synchronous form involves interactive communication using video technologies between the patient and the RS. It can be used for initial consultation, diagnosis and treatment. It requires a high-speed and permanent Internet connection, as well as the availability of appropriate hardware and software. Asynchronous – involves the collection of information at the patient's location and its subsequent transmission for evaluation by the RS located at another location. This form does not require a permanent connection, allows the use of various communication channels (smartphones, tablets, PCs), but is more difficult to manage because there is a delay in communication between the patient and the RS. There is also a hybrid form that uses synchronous and asynchronous communication during TR [4, 13].

There is increasing evidence of the positive effect of TR on clinical outcomes in patients with certain types of cancer [14, 15], neurological disorders [16, 17], musculoskeletal injuries and disorders [18], heart disease [19, 20], chronic pain [21, 22], and chronic obstructive pulmonary disease (COPD) [23]. At the same time, TR is provided in different formats: applications for smart phones, web activity trackers (pedometers), video conferencing and text messaging to monitor conditions, perform exercises and educational strategies [24].

In the above-mentioned document [10], the results of providing TR support were analyzed according to the levels of evidence – A (recommendations based on consistent and qualitative evidence); B (recommendations based on conflicting evidence or evidence of limited quality); C (recommendations based on disease-specific research, routine practice, opinion, or consensus); unrated (recommendations that lack sufficient evidence but may have preliminary evidence).

Level A evidence demonstrates:

- That the elements of the virtual examination agree with the separate assessments of the musculoskeletal system and neurological diseases obtained during the direct examination;
- The effectiveness of TR in osteoarthritis of the knee joint and after cerebrovascular accident is proven;
- To demonstrate the usefulness and effectiveness of TR in the post-acute period of cardiovascular diseases and chronic heart failure (with technological support), which is compared with the help in a specialized rehabilitation center.

Level B evidence:

- The effectiveness of correction of neurobehavioral dysfunction after concussion is established;
- Preoperative and preprocedural assessment of spinal and vertebral disorders;
- Interventions to improve quality of life, physical function, and adherence to physical activity recommendations in oncology patients;
- Effectiveness and acceptability of TR models in neurological practice.

Level C evidence:

- The feasibility of integrating TR into the telemedicine system is assumed from the point of view of the effectiveness of rehabilitation in many chronic diseases;
- It is assumed that TR can be effective in a number of diseases of the musculoskeletal system and the nervous system;
- It is shown that diagnostic limitations, which cannot be reached during TR, do not allow its use in complex diseases of the musculoskeletal system;
- At the same time, oncological patients with stable course of the disease can receive TR consultations and corrections of drug treatment;
- It is probable to perform TR in pediatrics;
- limited data indicate the possibility of improving the physical and functional condition of elderly people without heart disease and preventing their hospitalization;
- TR and monitoring are probably effective in persons with disabilities.

One of the means of telemedicine is Remote Patient Monitoring (RPM), the main task of which is the collection, transmission and accumulation of physiological medical data (such as vital signs, blood pressure, heart rate, etc.) to monitor changes in the patient's body activity under the influence of everyday life, various treatment and rehabilitation factors, transmitted via electronic communication technologies to health care professionals using personal health care technologies, including wireless devices, wearables and a sensor, an implanted health monitor, a smartphone, a mobile phone and applications. [25].

RPM must support the continuous monitoring of the patient's state during the treatment and rehabilitation of chronic diseases and can be synchronous or asynchronous, depending on the needs of the latter [26]. In general, the use of the latest technologies, including artificial intelligence and machine learning, can provide better monitoring of diseases, their early detection, improve diagnostics, support personalized medicine and rehabilitation [27].

An important component of the RPM process is the implementation of control as part of the management process to achieve the goal of providing patients with quality rehabilitation care by determining the level of compliance of the specified components (characteristics) of rehabilitation quality with the accepted requirements. In this case, control as a management function includes [28]:

– Collection of data on the initial state of the patient with determination of necessary and possible means of TR;

– Determination of criteria for the effectiveness of their application in a specific patient, considering the prognosis of the course of the disease and restoration of function;

– Implementation of the control of the TR process according to the actual characteristics of the quality of rehabilitation based on its monitoring according to the defined criteria;

– Comparison of received data with requirements of regulations, standards, protocols, instructions;

– Detection of deviations (inconsistencies) and their evaluation;

– Analyzing the causes of deviations;

– Use of analytical information to support management decisions to improve the quality of rehabilitation.

It is possible to achieve the maximum degree of objectivity of the control if it is carried out on the basis of the information base of criteria and quality indicators developed and approved by the head of the health care institution, corresponding to its components [29], primarily related to the compliance of the applied rehabilitation methods with the standards of providing rehabilitation assistance.

In our opinion, an important component of RPM is the performance of rehabilitation telemedical examination (RTME), which should determine monitoring indicators that can be used as criteria for evaluating the impact of physical therapy in the patient's TR process and the effectiveness of TR as a whole.

RTME begins with a detailed history that can be explored in sufficient detail during a telemedicine communication session. If necessary, various forms of questionnaires can be used, which can be processed automatically during the session or later. Indications and contraindications for the use of TR can be determined at this stage. Among the anamnestic data that are contraindications for performing physical exercises during the TR procedure are unstable course of cardiovascular diseases (complicated course of myocardial infarction in the acute and subacute period, unstable angina pectoris, arrhythmic forms of coronary heart disease, uncontrolled arterial hypertension, frequent hypertensive or hypotensive crises, complicated course of cerebral circulation disorders, presence of deep vein thrombosis of the lower limbs), clinically significant renal pathology (for example, bilateral renal artery stenosis, stenosis of the artery of a single kidney, patients with renal transplantation), mental disorders, presence of foreign bodies near the main vessels or nerve trunks [2].

During the RTME, great importance should be attached to the patient's complaints and appearance. Conducting a physical examination during RTME is more complex, but certain elements of it can be used, especially if there is an assistant (relative, social worker, etc.) at the patient's side. In general, the examination technique during a telemedicine session (telerehabilitation) is not standardized and is constantly being improved with the emergence of new technical possibilities of remote control [30]. There are also a number of problematic issues related to the technical support of the Internet connection, the quality of the video image, the patient's ability and willingness to perform one or another type of self-monitoring for further data transfer, etc. [25].

During a TR-physical examination in a state of rest (in a sitting position), a PhRM doctor can examine and evaluate [10]:

- the presence of accelerated breathing (tachypnea);
- difficulty breathing at rest, during communication, presence of cough, loud wheezing;
- skin color (especially cyanosis, redness, probably pallor);
- the presence of tumors, lesions and ulcers on the skin (as well as differences in the color of these areas);
- vision, vigilance and attentiveness of the patient;
- mood and presence of affects in the patient;
- level of vigilance, communication orientation, ability to identify objects, perform tasks;
- during a conversation – pace of speech, choice of words, volume of speech;
- symmetry of eyes, eyelids, pupils (their size);
- symmetry of facial folds, jaw movements at rest and during conversation;
- normality or deterioration of hearing, as well as features of the voice (presence of hoarseness) suggest damage to the auditory (VIII pair), glossopharyngeal (IX pair) and vagus (X pair) afferent nerves of the CN;
- the possibility and performance of upper limb movements (abnormal movements, tremors, dystonia, clonus).

During the TR-physical examination when performing simple tasks (in a sitting position), the PhRM can examine and evaluate [10]:

- in the presence of an assistant – a sense of smell (smell) from known sources (the study is performed with closed eyes);
- upon request to close the eyes and direct the movement of the eyes – nystagmus, ptosis, evaluate the function and its symmetry for the III, IV and VI pairs of cranial nerves (CN);
- at the request to close tightly, release the jaws – the function of the V pair of CN;
- at the request to smile, raise the eyebrows – the function of the VII pair of CN;
- at the request to lower the shoulders, turn the neck – the function of the XI pair of CN;
- at the request to stick out the tongue – the function of the XII pair of CN;
- at the request to perform a quick tapping with the fingers – the function of the flexors of the palm and fingers of the hand and the nerves of the upper limb;

During the TR-physical examination, when performing simple tasks (in various positions), the PhRM doctor can examine and evaluate [10]:

- execution of arbitrary movements without changing the posture;
- performing movements against gravity;
- ranges of motion in symmetrical joints;
- the patient's gait;
- walking on heels and toes;

- coordination, on request to perform rapid alternating movements, finger-nose test with open and closed eyes, purposeful touching of certain objects, heel to shin, etc.;
- performance of Romberg tests and tandem walking (in the presence of an assistant);
- sensitivity, at the request of the PhRM doctor to the patient or an assistant to touch the relevant dermatome areas (at the same time, tactile and pain sensations can be investigated);
- if necessary, remote palpation can be carried out (under the guidance of the PhRM doctor, performed by the assistant present, or by the patient);
- devices for remote listening (phonendoscopes), local thermometry, etc. have been developed and tested for use today.

During the telerehabilitation examination, it is necessary to carry out measurements using measuring devices for home or personal use, the results of which the patient transmits to the PhRM doctor [10]:

- Thermometer – body temperature;
- Scales with a height meter – height, body weight;
- Pulse oximeter – heart rate (HR), oxygen saturation;
- Automatic tonometer – blood pressure (BP);
- Glucometer – blood glucose level;
- With a portable ECG monitor – as a rule, a recording is made in one of the leads (most often I) and transmitted as a signal to the PhRM doctor.

Nowadays, there is an intensive development of devices for control of movement amplitude and central nervous system activity, which are based on biological feedback and can simultaneously play a diagnostic and rehabilitative role due to a dosed feedback effect on the damaged links of the motor apparatus [4; 31].

During RTME it is also possible to use portable devices – trackers, pedometers, accelerometers, heart rate monitors, the information from which must be transmitted to the PhRM doctor (i.e. asynchronously). Information from these devices collected at the end of the procedure can also be useful for retrospective analysis of the effects of the TR procedure.

Barriers may arise during RTME that can be overcome with the help of caregivers or family members who are with the patient during the visit. The clinician should be aware that assisted examinations may require more time, especially when examining the elderly [32].

It should be added that a number of studies have compared the results of telemedicine examinations with the direct examinations in the diagnosis and treatment of diseases of the nervous system and locomotor system. Studies have shown that in many cases the results of telemedicine examinations are similar to the results of personal examinations [4, 10].

RTME should be carried out before the appointment of TR as a form of physical therapy, also to determine the dosage criteria, which are determined taking into account not only the main injury or disease, but also the physical development of the patient, the functional state of the damaged link of the body and the body as a whole (according to ICF), as well as tolerance to physical exertion, which is a prerequisite for the prevention of possible negative consequences.

Solving these problems during RTME is somewhat complicated. If the possibility of studying the physical development with the participation of the patient and especially the assistant is absolutely feasible, then the study of the functional state of the cardiorespiratory system and its tolerance to physical exertion is problematic. An acceptable way to determine this in remote conditions is to perform a 6-minute walking test with subsequent conversion to absolute VO_{2max} values.

In a certain way, it is possible to study the functional state (in the presence of an ECG data transmission channel) by performing an orthostatic test, or by studying the heart rate variability [33], a combined analysis of the activity of the cardiovascular and respiratory systems [34, 35, 36], which is partially implemented today in some telemetry systems and devices [37]. Regarding the possibility of determining the tolerance to physical exertion, it is difficult to comply with the guidelines of the European Society of Cardiology [38] and the European Respiratory Society [39], which regulate the maximum (before failure) test, in remote mode from the point of view of compliance with safety conditions. However, recent studies have shown a sufficiently high degree of correlation between VO_{2max} and the results of the 6-minute test [40].

With regard to the performance of TR procedures in the synchronous version, it is necessary to point out the need for remote medical monitoring during the procedure.

At present, there are no clear guidelines, which would provide for admission to the TR procedure, which should be determined not only by the existing disease, injury, results of functional examinations, but also by the current condition of the patient, which can be characterized by a number of unfavorable external signs and indicators of cardiorespiratory system activity.

Among the external signs that can be detected during RTME and require withdrawal from the TR procedure are severe pallor or redness of the skin of the face, redness of the eyes, «swollen» eyes, bags under the eyes, red veins on the sclera and yellowing of the sclera, shortness of breath at rest. These signs predict the development of unpleasant and acute conditions during the procedure and can be detected by careful external examination.

Among the objective criteria that can be determined during RTME and are an indication for non-admission to the TR procedure are sinus tachycardia over 100 min-1, sinus bradycardia under 50 min^{-1}, blood pressure over 220/120 mmHg or under 90/50 mmHg, acute inflammatory diseases, intoxication, severe pain syndrome, body temperature over 37.5 °C and any condition that makes the physician concerned about the safety of the TR procedure [9]. According to Japanese researchers, the criteria for temporary withdrawal from TR procedures [41] are: resting heart rate less than 40 or more than 120 min^{-1}; blood pressure higher than 200/120 mmHg or systolic blood pressure less than 70 mmHg, complaints of chest pain at rest or during exertion, dizziness, cold sweat, nausea, headache, severe fatigue while sitting, tachypnea for more than 30 min-1 or shortness of breath, resting oxygen saturation <90 %.

From the point of view of organization of TR procedures performed at home in psychologically favorable conditions for the patient, it is also necessary to follow a number of recommendations that determine the safety of physical exercises. Such conditions include regulated requirements for sanitary and hygienic condition of the premises, which should be checked before the start of the TR procedure – proper condition of the premises, ventilation, air temperature, humidity, light, dimensions of the room, equipment for the procedure, including proper Internet connection, necessary additional devices and programs, as well as the ability to use them [26]. At the stage of preliminary teleconsultation, which can be carried out by a multidisciplinary team, part of the problems can be solved in video mode. However, if necessary, a separate video consultation of the RS can be performed with the determination of the conditions in the likely place of the TR procedure and the patient's skills.

An important component of the organization of the procedure is the preparation of the program and plans for the procedures, which should include TR means that correspond to the deviations in the state of the organism according to the International Classification of Functioning (ICF) [42]. However, the use of means should obey the general physiological principles of exercise in the procedure. Their use should consider the stage and sequence of changes in the patient's body, which is possible only by maintaining the structure of the procedure and appropriate distribution of rehabilitation means in it. This should be confirmed by clear criteria of effects on the body (physiological parameters), which is possible either by using portable feedback devices or by operational measurement (performed by the patient or an assistant) of physiological indicators with simpler means (pulse oximeter, tonometer, etc.), the information of which should be provided to the PhRM doctor [43]. It is the responsibility of the PhRM physician to monitor the correctness of the organization of the TR procedure, keeping in mind the changes in physiological parameters. Simple but important evaluation methods include timing, calculation of the motor density of the exercise, construction of a physiological curve, etc. These issues can be effectively addressed using RPM tools.

After the evaluation, it is possible to make corrections to the TR procedure, which are related to the solution of the main task (correction of the patient's problems), as well as to the construction of the procedure and the distribution of rehabilitation means in it.

The main feature of application of rehabilitation means is their direct effect on the patient's body. In the process of assigning and carrying out rehabilitation tasks, problems of insufficient influence of certain physical exercises, as well as physiotherapeutic procedures may arise, which requires correction of their dosage or method of application. While waiting for the positive results of the TR procedure, which are overwhelming, it is necessary to remember that inadequate use of physical exercises can lead to a number of complications, primarily associated with damage to the neuroendocrine, cardiovascular and respiratory systems, which requires appropriate control of their use during RPM [43].

Equally important in the implementation of the TR program is the understanding of the presence of distant effects of physical exercise – immediate (immediately after the procedure), remote (during the first three days after the procedure) and cumulative (at the end of the training course). The direction of these effects determines the course of adaptive changes in the body, which can have a positive or negative effect on the planned result [44]. For their prevention and timely decision-making, heart rate monitors, ECG monitors and accelerometers are most commonly used today, but in asynchronous mode [43], which can delay the response of the PhRM doctor.

Today, biotelemetry devices offer the possibility of personalized care at all stages of the patient journey, from early diagnosis and personalized interventions to individually designed treatment and rehabilitation plans [25]. In addition, data obtained from such devices may better reflect certain parameters of health status because they are measured non-invasively at home and are independent of the potential stress and discomfort that patients face in a medical facility during rehabilitation assessments and monitoring.

Increasing the capabilities of RPM during TR is associated with the use of external devices or assistants present beside the patient. Today, the use of virtual reality tools is proposed, which can be used to assess both physical and cognitive functions [45]. Virtual reality can be combined with augmented reality and tactile technologies, which significantly improve assessment tools. The combination of virtual reality or augmented reality with devices such as robots, sensors, and wearables is called augmented reality and can be used in TR for remote monitoring, assessment, and diagnosis [46].

With the development of flexible electronic materials, as well as the widespread development and application of smartphones, cloud and wireless systems, the technology of flexible wearable sensors has a significant and promising impact on the implementation of personalized healthcare and TR. However, due to the high requirements of accuracy, reliability, low power consumption and fewer data errors, the development of these potential directions has some challenges [6].

At the same time, due to the successful combination of recordings from biotelemetry devices with the computational power of artificial intelligence tools, it is possible to achieve promising improvements in the performance of RPM during TR based on continuous monitoring of relevant physiological parameters [47]. These advanced methods pave the way for the transition from traditional to personalized rehabilitation, identifying the needs of each patient and adapting the rehabilitation process to their anatomical features, physiological conditions and pathological status [27].

It should be noted that many biotelemetry devices that can be used during RPM are still in the prototyping stage and require further in-depth testing for usability, functionality, safety, security and user acceptance before they can be implemented [30]. In addition, the wide variety of technologies, applications, and terminology prevents the creation of a single, unified system for collaboration. Thus, there is still a need for a basic system framework that facilitates the adoption of digital tools by physicians, patients, and organizers. Certain issues also arise from the training positions of RS, who need to be trained in the specifics of performing TR examinations and procedures, as well as working on relevant digital platforms.

Conclusion

The development of modern technologies and digital medicine has led to the emergence of remote services in the rehabilitation system, which, on the one hand, significantly increases access to the rehabilitation system, and, on the other hand, significantly increases the requirements for its implementation. First of all, this concerns the safety of telerehabilitation procedures. It is necessary to pay attention to basic safety requirements, which can be achieved first of all by using synchronous remote monitoring of the patient's condition, when the PhRM doctor can objectify changes in the patient's body under the direct influence of telerehabilitation means.

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ТЕЛЕРЕАБІЛІТАЦІЯ: СУЧАСНІ МОЖЛИВОСТІ ТА ПРОБЛЕМИ ВІДДАЛЕНОГО МОНІТОРИНГУ СТАНУ ПАЦІЄНТІВ

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Резюме.

В останні п'ять років на тлі появи COVID-19 у світі інтенсивно розвивається напрямок віддаленої телереабілітації, що вимагає удосконалення та впровадження нових підходів до синхронного моніторингу стану пацієнтів із залученням новітніх технічних розробок.

Мета дослідження. Дослідити останні публікації щодо можливостей віддаленого моніторингу пацієнтів від час проведення реабілітаційного обстеження та процедур синхронної телереабілітації.

Матеріал та методи дослідження. Публікації іноземних науковців у галузях клінічної, фізичної та реабілітаційної медицини, біометрії, цифрових технологій з питань впровадження синхронних технологій моніторингу за станом пацієнтів з різною патологією

Результати. Дослідження сучасних публікацій показало, що проведення синхронних сеансів віддаленого обстеження пацієнтів дозволяє з високим ступенем вірогідності провести загальний огляд пацієнта, провести антропометричне та деякі функціональні дослідження. Серед останніх дослідження змін ЧСС, артеріального тиску, частоти дихання, сатурації кисню, дані ЕКГ та ЕЕГ досліджень. Їх результати можуть передаватися для безпосередньої оцінки лікарем. Існують певні проблеми під час синхронного проведення тестів з фізичним навантаженням до відмови у зв'язку з неможливістю дотримання умов безпечності. Знайдено технічні рішення щодо передачі біметричних сигналів під час проведення процедури телереабілітації. Так, поєднання віртуальної реальності або доповненої реальності з такими пристроями, як роботи, датчики та носії може використовуватися для дистанційного моніторингу, оцінки та діагностики. Ці передові методи прокладають шлях для переходу від традиційної до персоналізованої реабілітації, визначаючи потреби кожного пацієнта та пристосовуючи процес реабілітації до його індивідуальних особливостей.

Висновки. Розвиток сучасних технологій та цифрової медицини призвів до появи в системі реабілітації напрямку віддаленого надання послуг, що з одного боку істотно збільшує можливості доступу до системи реабілітації, а з іншого, істотно підвищує вимоги для їх реалізації. Насамперед це стосується безпечності проведення процедур телереабілітації. Дотриманню основних вимог безпечності має надаватися належна увага, що можна досягти, в першу чергу, з використанням віддаленого синхронного моніторингу стану пацієнта, коли лікар ФРМ може об'єктивізувати зміни в організмі пацієнта за безпосереднього впливу засобів телереабілітації.

Ключові слова: телереабілітація; телереабілітаційне обстеження; віддалений синхронний моніторинг.

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