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Remote Rehabilitation System for Patients after COVID-19 in Tyumen Region: a Prospective Comparative Randomized Study of 100 Patients

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ABSTRACT

AIM. To evaluate the system of remote rehabilitation for patients after coronavirus infection (COVID-19) in Tyumen region and its first results.

MATERIAL AND METHODS. A randomized trial, including 100 cases in patients who had had a moderately severe coronavirus infection. The following were analyzed: dyspnea progression (according to mMRS), the Borg test progression, Stange and Henci functional tests, and quality of life results according to the EQ-5D questionnaire. Telemedicine interaction was carried out using the Telemed72 application. The rehabilitation program included physical exercises and video classes.

RESULTS AND DISCUSSION. There were no major problems with remote communication between the patient and the therapist in the course of the telerehabilitation. At the end of the rehabilitation period, two groups showed some positive changes. Group 1 reduced the severity of dyspnea by 2 points, Group 2 – by 1.5 points, the data of functional breathing tests improved, muscle strength increased and self-evaluation of the quality of life also improved. Contact with a medical professional during telerehabilitation sessions and exercising under the remote supervision of a specialist are of great importance for the patient. This preserves the principle of continuity and consistency in rehabilitation care.

CONCLUSION. A system of telerehabilitation has been launched in Tyumen region. The patients, participating in remote tele-rehabilitation sessions, demonstrate improvements in functional breathing tests and quality of life scores. Expanding the boundaries of distant rehabilitation beyond large scientific and clinical centres will require training in the use of videoconferencing and operating special equipment.

KEYWORDS: telerehabilitation, coronavirus infection, COVID-19, remote technologies, telemedicine technologies, telemedicine-72, technological advances

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Система дистанционной реабилитации пациентов после COVID-19 в Тюменской области: проспективное сравнительное рандомизированное исследование 100 пациентов

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РЕЗЮМЕ

ЦЕЛЬ. Оценить систему оказания и первые результаты реабилитационной помощи с применением дистанционных технологии пациентам после перенесенной коронавирусной инфекции в Тюменской области.
МАТЕРИАЛЫ И МЕТОДЫ. Проведено рандомизированное исследование, в которое включены 100 историй болезни пациентов, перенесших коронавирусную инфекцию тяжелой и средней степени тяжести. Сформированы 2 группы пациентов: 1 группа – реабилитация на базе ГАУЗ ТО «Лечебно-реабилитационный центр «Градостроитель» и 2 группа – реабилитация в ГАУЗ ТО «Городская поликлиника № 17». Обе группы продолжили занятия в системе телереабилитации. Анализировались: динамика показателей одышки (по mMRS), динамика теста Борга, функциональные пробы Штанге и Генчи, результаты опроса качества жизни по опроснику EQ-5D. Телемедицинское взаимодействие осуществлялось с помощью приложения «Телемед72». Программа медицинской реабилитации включала комплекс физических упражнений и видеозанятия.
РЕЗУЛЬТАТЫ И ОБСУЖДЕНИЕ. В процессе телереабилитации крупных проблем с дистанционной связью между пациентом и врачом не было. По окончании реабилитации получена положительная динамика в обеих группах. Уменьшилась выраженность одышки в 1 группе на 2 балла, во второй на 1,5 балла, улучшились данные по функциональным пробам Штанге и Генчи, увеличилась сила мышц, существенно улучшилась самооценка качества жизни. Контакт с медицинским работником на сеансах телереабилитации, выполнение упражнений под дистанционным контролем специалиста имеет огромное значение для пациента. Это сохраняет принцип непрерывности и преемственности в реабилитационной помощи.
ЗАКЛЮЧЕНИЕ. В Тюменской области организована система телереабилитации. У пациентов, участников дистанционных телереабилитационных занятий отмечается улучшение функциональных дыхательных проб и показателей оценки качества жизни. Расширение границ дистанционной реабилитации за пределы крупных научно-клинических центров потребует подготовки специалистов, владеющих методами проведения занятий в режиме видеоконференцсвязи и работы со специальным оборудованием.

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INTRODUCTION

The new coronavirus pandemic has had an impact on the health of people around the world [1]. Scientists and the medical community continue to study the manifestations and possibilities of rehabilitation of Post-COVID-19 syndrome. The organization and evaluation of the effectiveness of rehabilitation measures for the patients who have undergone Covid-19 is another relevant issue for the health care system. Telemedicine methods – an affordable solution to the problems of continuity and consistency of medical care in large cities and regions [2, 3]. From 2020, for the first time in the domestic practice, rehabilitation programmes can be carried out over a long period of time and without face-to-face contact with the patient, based only on the analysis of medical records and testing through videoconferencing [4].

AIM

To evaluate the first results and the system of remote rehabilitation care for patients after coronavirus infection (COVID-19) in Tyumen region.

MATERIAL AND METHODS

For telemedicine consultations in Tyumen region there is a Telemed72 application, which is integrated with the information system for resource management of medical organization in Tyumen region (hereinafter IS URMO TO). The app is available for Android and IOS operating systems. The Telemed72 system is organized on a "doctor-patient", "doctor-doctor" basis, and registration in medical institutions is also organized.

The doctor schedules a teleconsultation via the app and the patient receives a push notification with a reminder 10 minutes before the session. At the appointed time, the

doctor gets in touch: an incoming call from Telemed-72 is displayed on the mobile phone screen. When the call is answered, a video image of the doctor and the patient appears on the screen of the mobile device. The doctor initiates the call and completes the teleconsultation in his or her personal account. Telemedicine consultation recordings can be accessed in the "Recordings Archive" section.

Also, the IS URMO TO supports the "doctor-to-doctor" type of telemedicine consultations. During such consultations, doctors from medical institutions in the districts can swiftly exchange medical information about the patient (discharges, results of diagnostic studies, X-ray data, expert opinions, test results, etc.). Rehabilitation referrals are made in accordance with: Order of the Health Department of Tyumen region (hereinafter DZTO) of March 17, 2021. No. 115 "On the organization medical rehabilitation for the adult population of Tyumen region", Orders of the DZTO of December 31, 2013, No. 15/33 "On the organization of medical rehabilitation of the population of Tyumen region", Decree of the Government of Tyumen region of September 29, 2009 No. 279-p "On the rehabilitation of certain categories of citizens in specialized rehabilitation centres in Tyumen region".

The Treatment and Rehabilitation Centre "Gradostroitel" is the coordinating centre for medical rehabilitation in Tyumen region, carrying out II stage rehabilitation, to which, according to the referrals, patients are sent after the inpatient treatment (by transfer from a mono-infectious hospital) or by referral from a general practitioner and with a severity of condition corresponding to the rehabilitation routing grade according to a 4-3 point scale.

Evaluated legal acts and studied the technological issues regarding the organisation of support for rehabilitation assistance using remote technologies for the patients after COVID-19 in Tyumen region.

Department of Medical Prevention and Rehabilitation of Tyumen State Medical University of the Ministry of Health of the Russian Federation has developed a program of the medical rehabilitation of patients with a new coronavirus infection using telecommunication technologies for medical organizations in Tyumen region. The program is based on the recommendations of the Russian Union of Rehabilitation Specialists and includes printed manuals and video lessons with a set of exercises (from sparing to trainers). The lessons are conducted by an instructor, who is an expert in exercise therapy methodology, under the supervision of an exercise therapy doctor through the Telemed72 application. The main objective is to improve the mobility chest, restore respiratory muscles and increase lung capacity, improving gas exchange [4, 5]. Prior to the introduction of a tele-rehabilitation programme after a coronavirus infection in Tyumen region, a pilot study in Municipal Polyclinic No. 17 showed a positive result [3]. The rehabilitation programme was subsequently joined by Treatment and Rehabilitation Centre "Gradostroitel". Indeed, throughout the year, about 350 patients received telerehabilitation at the premises of the polyclinic, and more than 600 people were rehabilitated in the rehabilitation centre.

In February 2021, 20 exercise therapy instructors, 20 physiotherapists, and all specialists from state and municipal medical organizations of Tyumen region were trained to carry out the rehabilitation of patients after coronavirus infection. The training was conducted by the teachers of the Department of Medical Prevention and Rehabilitation of Tyumen State Medical University of the Ministry of Health of the Russian Federation in advanced training cycles of 36 hours, on a face-to-face basis, which minimizes the distraction of specialists from their main work. The lessons included an analysis of the "Temporary Guidelines for the Rehabilitation of Patients after a new Coronavirus Infection", the selection of rehabilitation methods and technologies, issues of conducting physical therapy lessons via the telerehabilitation system, practical exercises in respiratory gymnastics, mastering methods for monitoring the condition of patients during the lessons, including remote sessions. The issues of rehabilitation and telerehabilitation after COVID-19 are included in the professional training program at Tyumen State Medical University for doctors in the specialty "Physical and Medical Rehabilitation".

The inclusion criteria for the study were: no decompensation of chronic noncommunicable disease, refusal to undergo in-person rehabilitation, consent of the patient to continue rehabilitation using remote technologies, availability of a smartphone and mobile internet connection.

100 case histories of patients with severe and moderate coronavirus infection were analysed, subject to the III stage of rehabilitation. 50 of those patients received the II stage of rehabilitation in the Treatment and Rehabilitation Centre "Gradostroitel", a state autonomous health care institution in Tyumen region and another 50 patients were registered in Municipal Polyclinic No. 17, a state autonomous health care institution in Tyumen region and also discharged after the II stage of rehabilitation. The patients were matched by sex and age. Evaluated: dynamics of dyspnea indicators (according to mMRS), dynamics of the Borg test, functional tests of Stange and Genci, the results of a survey of the quality of life according to the EQ-5D questionnaire.

The patients were divided into 2 groups: group 1 – the Treatment and Rehabilitation Centre "Gradostroitel" and group 2 – discharged after the II stage of rehabilitation and were registered in Municipal Polyclinic No. 17. The patients of the 1st group were residents of Tyumen region (towns, villages). As can be seen from Table 1, the patients in both groups were comparable in terms of gender, age, and severity of the coronavirus infection.

Table 1. *Characteristics of patients at the time of inclusion in the rehabilitation program using telemedicine technologies*

Characteristics	Group 1	Group 2
Gender: women/men, n(%)	30 (60%) / 20 (40%)	26 (53%)/ 24 (37%)*
Mean age, years	61,3±11,7	66,5±29,2*
Mean pulmonary involvement	74,8 ± 11,9	69,7 ± 37,4 *
Number of days before telerehabilitation from the moment of illness (days)	59,5 ± 31,2	62,5 ± 37,3*
Comorbidity		
Arterial hypertension	41 (83%)	45 (90%)*
Ischemic heart disease	38 (77%)	33 (67%)*
Chronic Obstructive Pulmonary Disease	15 (30%)	20 (40%)*
Diabetes mellitus	25 (50%)	30 (60%)*
Obesity	43 (87%)	40 (80%)*
Complaints		
Dyspnea	50 (100%)	50 (100%)
Weakness	50 (100%)	50 (100%)

Note: **p<0,05 – significant difference between groups*

There were deviations in physical health in patients of both groups, which was confirmed by complaints of shortness of breath during habitual physical activities, and in 19 (37%) patients from group 1 and 10 (20%) patients from group 2, the shortness of breath was reported during a minimal physical activity. Severe weakness and fatigue were reported by all the patients. The patients in both groups had a burdened comorbid background, which had an impact on the severity of the coronavirus infection.

The patients of the 1st group were initially slightly more severe than the patients of the 2nd group in terms of the severity of the condition. Figure 1 shows that the severity of dyspnea according to mMRS was 0.6 points lower in the patients of group 1 (<0.05), muscle strength by 0.2 points (<0.05), Stange's test by 5 sec (<0.05), quality of life evaluation by 13.3 points (<0.05, 05). A significant difference in the perceived quality of life between the groups, in our opinion, is associated with the remote location from home, from relatives, for the patients in group 1.

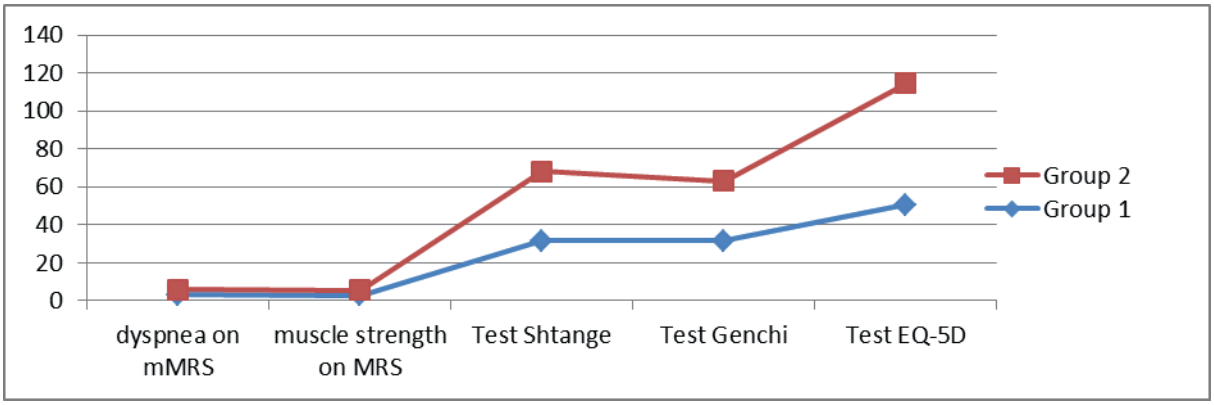

Fig. 1. *Clinical indicator of the patients who had a coronavirus infection at the beginning of treatment using remote technologies*

Statistical processing of the results of the study was carried out using tables "Microsoft Excel" and packages of applied statistical programs "Statistica-6.0". Differences were considered statistically significant at error levels <0.05.

All patients received informed consent for medical intervention, consent for processing of personal data, processing of medical data for medical care and scientific purposes when contacting a medical organization. Due to the introduction of remote support technologies for patients with coronavirus infection in the region, we additionally received informed consent for remote support of an outpatient (including the closure of temporary disability certificates, prescriptions, consultation with a medical professional, rehabilitation, etc.). The identification of medical personnel and the patient during tele-rehabilitation was done through the ESIA system.

RESULTS AND DISCUSSION

During the rehabilitation process, there were no major problems with remote communication between the patient and the doctor. According to the appointed schedule, 37 (73%) the patients from the 1st group and 45 (90%) from the 2nd group regularly got in touch with their doctors. One of the reasons for the non-attendance was a problem with communication, which

was manifested periodically by a "freeze" of the system. But the transmission of controlled indicators (BP, heart rate, saturation, respiratory rate) after the session was transmitted regularly.

At the end of telerehabilitation, positive dynamics was obtained in both groups. The severity of shortness of breath decreased by 2 points in group 1 and by 1.5 points in group 2, the Stange's functional test showed an improvement of 5.6/10 seconds, and Genchi 6.2/9.9 seconds, muscle strength increased by 1.6/1, 5 points, self-evaluation of the quality of life improved significantly – 21.1/16.6 (Table 2).

Table 2. *Comparative characteristics of clinical indicators of patients at the beginning and at the end of rehabilitation using telecommunication technologies*

Characteristics	Group 1		Group 2	
	At the start of rehabilitation	Upon completion of rehabilitation	At the start of rehabilitation	Upon completion of rehabilitation
Dyspnea on mMRS	3,33± 1,15	1,33±0,63	2,68 ±0,76*	1,17 ± 0,63*
Muscle strength on MRS	2,66± 0,97	4,22 ± 1,39	2,89 ± 0,57*	4,39 ± 0,96*
Shtange's test	31,56±0,26	37,22±12,9	36,57± 6,92*	46,58± 9,37*
Test Genchi	31,57±5,84	37,78 ±7,19	35,9±5,84*	45,8± 7,19*
Test EQ-5D	50,56±16,9	71,67±37,3	63,89±14,6*	80,49±14,81*

Note: **p<0,05 – significant difference between groups*

As can be seen from Figure 2, the severity of dyspnea, according to mMRS, comparing the two groups was 0.1 points lower in patients of group 1 (<0.05), and muscle strength was 0.2 points (<0.05) lower, which is not statistically meaningful.

Fig. 2. *Clinical indicators of patients who underwent coronavirus infection after rehabilitation using remote technologies*

After 3 weeks of the rehabilitation using telemedicine technologies, the main clinical indicators (data of fig. 2) are aligned in terms of the severity of dyspnea, with confirmation of its decrease in functional tests, an increase in muscle strength and a feeling of improvement in the quality of life. It does not matter where the patient lives in rural or urban areas, what is important is the contact between the doctor and the patient, his commitment to the implementation of medical recommendations, continuity in the rehabilitation process. The ability to be in touch, the availability of the available application "Telemedicine 72" and the schedule of classes has an additional stimulating value in the rehabilitation of the patient.

Analysing the initiation of telerehabilitation systems in world practice, common problems have been identified. Thus, the pandemic situation also provided Swiss physical therapists with the opportunity to gain experience in using digital technologies for remote therapy. Practical rehabilitators are facing a number of difficulties, including: technological limitations and a preference for a "practical" approach [6]. Interestingly, at first, physical therapists have a low opinion of telemedicine rehabilitation, precisely because of the preference for "manual technologies". In rehabilitation techniques, "clinical contact" is important, when a physical therapist or physical therapy instructor directly works out a movement technique with a patient, controls the patient's exercise and his condition during the lessons. This point is noted by rehabilitation practitioners in other countries that the lack of direct contact with the patient affects the quality of medical rehabilitation, and the adherence to telemedicine technologies of both the medical worker and the patient [7]. From our point of view, this issue can be overcome in the process of professional training in the cycles of advanced training of specialists in physical therapy and doctors of physical and rehabilitation medicine. Technologies and approaches are discussed at many conferences and in scientific publications. For example, the Italian Society for Physical and Rehabilitation Medicine (SIMFER) has issued recommendations for the rehabilitation of patients in the context of COVID-19, which states that for chronic disabling conditions, with or without exacerbations, in people who have not experienced a recent acute event, it is necessary to organize remote consultations and telerehabilitation as alternative treatment options [8].

Patients with other disorders not associated with coronavirus also get to the intervention of rehabilitation practitioners, while working with the patient is not possible due to infection [9]. On the other hand, if a patient with Post-COVID-19 syndrome does not receive rehabilitation assistance at all, then, in the future, he is predicted to have a decrease in clinical and social functioning, which may affect the quality of life. In this case, the principle of continuity and succession in rehabilitation assistance is violated. Another aspect must be considered when organizing telerehabilitation for patients after coronavirus and infection. Patients after this infection may have impaired cognitive function, or they may be elderly patients with difficulty in the perception of remote technologies. We found two diametrical aspects in patients' attitudes towards tele-rehabilitation. For example, the general situation with COVID-19 has forced older people to become housebound and use television or other digital activities as their main activities, which increased the risk of social isolation and physical and emotional inactivity. This trend can be reinforced by adding an additional telemedicine tool. Representatives of the patients considered direct human meetings necessary for life and the inner strength of a person [10]. On the other hand, the continuity of exercise and social activity during isolation or quarantine, especially for the elderly, is ultimately critical. Contacts with a medical worker during telerehabilitation sessions, performing exercises under the remote control of a specialist is of great importance for the patient. Therefore, many countries have introduced telemedicine exercise or rehabilitation programs, developed guidelines, or are currently testing telemedicine in clinical trials [11, 12]. Expanding the boundaries of distant rehabilitation beyond large scientific and clinical centres will require training in the use of videoconferencing and operating special equipment [13].

Thus, the organization of telerehabilitation as a means of improving the quality of life of patients after a coronavirus infection is expedient and has both a clinical and legal basis.

CONCLUSION

A system of telerehabilitation has been launched in Tyumen region, allowing both individual and group exercise therapy sessions with monitoring of the patients' condition. Establishing health monitoring, including exercise tolerance evaluation, is a prerequisite for effective telerehabilitation. The schedule of classes and the availability of the Telemed72 application for telerehabilitation also play a role. The patients who survived the coronavirus infection and participated in the telerehabilitation sessions showed improvements in functional breathing tests, increased muscle strength, and improved self-rated quality of life scores. The developed system can be used in the future, which will require additional training of specialists from other medical organizations. In this case, we see an effective collaboration between the university team, practitioners and representatives of the digital medicine.

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Authors' contribution:
All authors confirm their authorship according to the ICMJE criteria (all authors contributed significantly to the conception, study design and preparation of the article, read and approved the final version before publication).
Special contribution:
Turovinina E.F., Nemkov A.G. – study design development, critical content review, scientific editing of the text, approval of the manuscript for publication;
Kutergina T. I., Elfimova I.V. – review of publications on the topic of the article, screening, examination of the patients, processing, analysis and interpretation of data, writing the text of the manuscript;
Barsukova L.L., Andreeva O.V. – screening and monitoring of the patients' testing, data processing.

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