Analysis and Solutions of Rehabilitation Challenges for Patients with Long COVID in the Context of Normalization of COVID-19 Pandemic

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Abstract: Early intervention is necessary to enhance patient outcomes for long-term COVID, which is defined by symptoms that linger after an acute COVID-19 infection. Research highlights the importance of early monitoring and rehabilitation to mitigate long-term effects and enhance functional recovery (McGroder *et al*., 2021). Patient-centered approaches, such as the development of a monitoring app in collaboration with advocacy groups (Fischer *et al*., 2024), demonstrate the value of early symptom tracking. Structured physical and respiratory rehabilitation, including personalized aerobic exercises, has been shown to improve cardiopulmonary function and reduce fatigue (Cerfoglio *et al.,* 2024). Additionally, tele-rehabilitation and technological aids support muscle recovery and accessibility for patients with mobility limitations. Immune profiling (e.g., TCR/BCR repertoire analysis) offers insights into Long COVID's mechanisms, potentially guiding targeted therapies (Feng *et al.*, 2023). While full recovery remains challenging, early multidisciplinary care-combining physical therapy, psychological support, and technological innovations-can significantly enhance patients' quality of life. Future research should focus on optimizing rehabilitation protocols and exploring precision medicine approaches for symptom management.

1. Introduction

With the continuous growth of the number of people infected with COVID-19, the multiple impacts brought by the sequelae of COVID have become the focus of social concern, which has had a certain impact on the living standards of the public. At the initial stage of these sequelae, due to the lack of understanding of the mechanism of the sequelae of Long COVID, many people suffered from different kinds of diseases in the later rehabilitation process, resulting in serious psychological resistance and poor physical conditions. The public desires to alleviate these impacts through various means. According to research, the incidence of long-term COVID varies between 10 and 30 percent for non-hospitalized individuals and between 50 and 70 percent for severe cases. A prevalence of 50.9% of patients with prolonged COVID who still had acute phase symptoms was documented in the research conducted by Moreno-Pérez et al.(2021)[2]. Over 17 million individuals in Europe are said to have suffered from this illness.In August 2021, a worldwide

assessment found that 203 long-COVID symptoms were present in 10 organ systems. After analyzing survey data from over 4,000 individuals, researchers found that weariness, post-exercise malaise, and cognitive impairment were the top three symptoms six months later. But symptoms might appear elsewhere and in different combinations.(Esposito, 2022)[1]. Hassanien *et al.* (2022)[3] demonstrated the use of machine learning to better understand and forecast how patients would respond to their illness and their chances of recovering. According to the survey, after six months, 21% of patients were still having severe symptoms. Two-thirds needed to work fewer hours or stopped working because they were sick(Wise, 2021)[4]. According to meta-analytic studies, the incidence of long-term COVID is between 10% and 30% among those who get the virus, and between 50 and 70% among those who are hospitalised, even though the majority of COVID-19 instances are linked to an asymptomatic presentation or a short illness. Long COVID, which was initially discovered by patients, has a wide range of symptoms, from headaches, exhaustion, mental fog, muscular soreness, and cognitive impairments to heart problems and mental health disorders. Women, members of racialised minorities, those with a more severe COVID-19 infection, smokers, those in poverty, and those with obesity or other physical or mental health comorbidities are among the populations most at risk of having long-term COVID (Nguyen *et al.*, 2025)[5]. For COVID-19 patients who report with respiratory failure, rehabilitation is advised to maximise health outcomes during the acute phase of therapy. There are a number of clinical symptoms, nevertheless, that can call for rehabilitation in addition to acute treatment. People who have the disorder prefer the name "long COVID," which refers to the long-lasting impacts of coronavirus disease(DeMars, 2022)[7]. According to Celayne *et al*. (2024)[6], the phrase "long COVID," often referred to as "post-COVID syndrome," refers to a variety of symptoms that continue to exist weeks or months after contracting SARS-CoV-2. The impact of long COVID on patients' health is substantial. This article will focus on the solutions in the rehabilitation of long COVID patients and provide some assessment of possible rehabilitation strategies and auxiliary methods. Firstly, it will discuss the early monitoring and physical treatment which has been used. Secondly, it examines the function of the relevant rehabilitation exercises. Last but not least, the impact of technological rehabilitation devices is highlighted.

2. Methods

Early monitoring and physical treatment are conducive to the rehabilitation of the Long COVID. According to McGroder, early rehabilitation should begin as soon as feasible since it has been shown in several studies to be crucial for reducing the likelihood of long-term symptoms and boosting patients' functional restoration. The partnership with Apresj20 COVID association patient partners Since Long France 35 had already been developed in earlier studies, they could participate right away. They initiated the creation of the app by expressing their need for a monitoring tool. Therefore, this software was created by and for those with Long COVID.(Fischer *et al*., 2024)[9]. Thus, early monitoring and treatment are the best way to alleviate symptoms. Since a number of variables may contribute to chronic symptoms following a COVID infection, diagnoses such as direct organ damage, post-ICU syndrome, and metabolic or endocrine abnormalities should be recognised and treated appropriately. (Chuang, Lin, Hsiao *et al*., 2024)[10]. If detected and treated promptly and early, there will be a good prognosis. Rehabilitation professionals should screen for physical, cognitive, social, and emotional triggers. Beyond standardized tools, clinicians should conduct a thorough assessment through history taking and reporting of symptom experiences and patterns(DeMars, 2022)[11]. Through Omni-directional monitoring and real-time tracking of patients with the symptoms of long and new crowns, most of the various sequelae will be found and treated in a timely manner, thus improving the prognosis and the quality of life of patients. Early

timely monitoring and physical treatment delayed the process of physical dysfunction in a timely manner, and greatly alleviated the long-term adverse physiological impact of the patients' social life caused by the symptoms of growing new crowns[14-15].

Relevant exercise makes contribution to Long COVID rehabilitation. According to Cerfoglio, for respiratory rehabilitation, patients engaged in individualised breathing exercises up to five times per week. On the other hand, motor therapy mostly involved three to five times a week of basic free body movements that targeted the trunk, upper, and lower limbs.It can be seen that it can help patients exercise related respiratory muscles, improve cardiopulmonary vitality, so that patients who are suffering from Long COVID can greatly recover to the respiratory level and cardiopulmonary vitality before COVID-19 infection. A research by Silvia (2022)[17] found that all LCS patients had significant symptoms at baseline and had significant deficits in psychological, QoL, and physical performance. During the exercise training sessions, no negative effects or dropouts were noted. According to the research, people who do not exercise frequently are more likely to develop long-term COVID. For instance, in addition to reducing anxiety and sadness, aerobic exercise can increase aerobic capacity, which improves short-term immunity by raising immunoglobulin levels, immune cell activity, and respiratory function in COVID-19 patients (Diabetes, 2021)[8]. Zheng et al. (2024)[12] conducted a comprehensive review and meta-analysis to evaluate the evidence of PASC symptoms associated to physical activity in COVID-19 survivors at least three months after infection. According to our findings, PASC symptoms are underreported. Using exercise testing, it was shown that many physical activity-related metrics of aerobic and anaerobic capacity, including 6MWT, VO2max, and AT, were impaired in COVID-19 survivors; however, these were equivalent between COVID-19 survivors and non-COVID-19 controls at rest.

That is to say, compared with anaerobic exercise, which has more strict requirements on human condition, aerobic exercise has more relaxed requirements on human function and less load on human body during exercise, which can better help COVID-19 patients recover human function, alleviate residual symptoms, promote the recovery process and shorten the recovery time. Three sessions per day of a rehabilitation program included a 30-minute group breathing exercise session led by a professional physiotherapist (controlled breathing technique, chest mobility-enhancing and muscle strengthening exercises with own body weights and dumbbells as well). Additionally, two sessions per day of 30-minute individualised low-intensity continuous individual exercise training (arm ergometer, stationary bicycle, treadmill, or rowing machine) were conducted, taking into account the severity of symptoms, age, comorbidities, and current conditions. Although it is a million to one that patients with only Long COVID symptoms can fully recover to the original through daily exercise and rehabilitation, this method has greatly improved the physiological and psychological status of patients.

The technological devices accelerates the rehabilitation process of patients with Long COVID.

Following release, patients received a customised three-week motor and respiratory telerehabilitation program based on their specific evaluations and hospital rehabilitation course, as well as appropriate, user-friendly technology for remote rehabilitation (Cerfoglio 2024)[13]. The telerehabilitation program helped patients to relieve the symptoms. The muscle power of patients can be relieved buy the telerehabilitation. According to Cerfoglio(2024)[16], furthermore, since patients with long COVID are often characterized by compromised muscle strength, also affecting upper limbs and grip abilities, upper limb strength and function were evaluated by measuring the maximum isometric force exerted during handgrip for both the dominant (D) and non-dominant (ND) upper limb using a hand-held dynamometer. The technological devices play an important role in relieving the loss of the muscle power. The application of TCR/BCR immune helps to find out how Long COVID came into being more detailedly. The growth and evolution of SARS-CoV-2 infection on the adaptive immune system is described by Feng (2023)[18]. The first time

seven-chain immune repertoire profiling was used in a longitudinal holistic for COVID-19 infection, it showed dynamic alterations over the first month of infection. TCR/BCR immune makes contributions to the demonstration of principles of Long COVID and provide these patients with more targeted rehabilitation treatment. In general, the production and application of various types and aspects of scientific and technological devices have enabled relevant researchers to have a further understanding of the mechanism and principle of the symptoms of Long COVID. In the future, it may be possible to provide the accessible rehabilitation therapy for alleviate the symptoms of Long COVID through targeted treatment to reduce side effects on the human body.

3. Conclusion

Providing amounts of rehabilitation strategies and auxiliary methods for patients who have not recovered from Long COVID is confronted by many challenges. Therefore, the essay has demonstrated some accessible solutions. Firstly, with the consent of the patients, the relevant medical rehabilitation workers can monitor and track the COVID-19 rehabilitation patients discharged from the hospital for a long time, and detect their physical conditions in real time, so as to facilitate the timely treatment and relief of COVID-19's sequelae. Secondly, the relevant rehabilitation exercises also play an important role in the rehabilitation process, such as respiratory exercises and aerobic exercises, which will help the untreated patients of Long COVID obtain a better prognosis, improve the endurance and vitality of the heart and lungs, and greatly recover to the state before the onset of symptoms. Specifically, aerobic exercise showed large effect sizes on long COVID anxiety and depression. According to Cheng et al.(2024)[19], this change has traditionally been ascribed to endorphins (Heijnen et al., 2015)[20]. Taichi, a form of qigong, had a similar ES on long COVID fatigue, the most common long COVID symptom (O'Mahoney et al., 2023)[21], to multimodal exercise. Thirdly, the rational and extensive use of scientific and technological tools (such as TCR/BCR immune technology) also promotes rehabilitation related Researchers can even predict the development trend of the symptoms of the new crown. In this way, we can develop targeted rehabilitation strategies for COVID-19 patients. The essay outlined a progression from early monitoring of drug administration to cardiopulmonary rehabilitation therapy to exploring the Cause of Formation of New Long Crown by TCR/BCR Immune science Method. However, such experiments still have shortcomings and deficiencies. It is still necessary to expand the number of experimental samples, explore more symptoms of the Long COVID and give them particular rehabilitation strategies. Future research should focus more on the exploration and monitoring of many patients with Long COVID, and provide more practical, efficient and economical rehabilitation therapy for various patients with Long COVID through comparative experiments and scientific judgments. Future research should focus more on the research and exploration of specific rehabilitation methods for various Long COVID symptoms, not only limited to the current treatments, but also should greatly innovate and simplify them to make them more suitable for public life. Such research would not only realize the organic combination of new scientific and technological methods with traditional sports therapy, but also combine rehabilitation with multiple disciplines, so as to achieve multidisciplinary consultation and complementary advantages.

References

[1] DeMars, J., Brown, D.A., Angelidis, I., Jones, F., McGuire, F., O'Brien, K.K., Oller, D., Pemberton, S., Tarrant, R., Verduzco-Gutierrez, M. and Gross, D.P. (2022) 'What is Safe Long COVID Rehabilitation?', Journal of Occupational Rehabilitation, 33. Available at: https://doi.org/10.1007/s10926-022-10075-2

[2] Moreno-P´erez, E. Merino, J.-M. Leon-Ramirez, M. Andres, J.M. Ramos, J. Arenas-Jim´enez, S. Asensio, R. Sanchez, P. Ruiz-Torregrosa, I. Galan, A. Scholz, A. Amo, P. Gonz´alez-delaAleja, V. Boix, J. Gil, Post-acute COVID-19

syndrome. Incidence and risk factors: a Mediterranean cohort study, J. Infect. 82 (2021) 378–383, https://doi.org/10.1016/j.jinf.2021.01.004.

[3] Hassanien AE, Salam A, Darwish A. Artificial intelligence approach to predict the COVID-19 patient's recovery. [cited 20 April 2022]. (Available from: https://easychair.org/publications/preprint/4bf1)

[4] Wise, J. (2021) 'Long covid: WHO calls on countries to offer patients more rehabilitation', BMJ, p. n405. Available at: https://doi.org/10.1136/bmj.n405.

[5] Nguyen P T A ,Ski F C ,Thompson R D , et al.Health and social service provider perspectives on challenges, approaches, and recommendations for treating long COVID: a qualitative study of Canadian provider experiences[J]. BMC Health Services Research,2025,25(1):509.

[6] Sugiyama, A.; Takafuta, T.; Sato, T.; Kitahara, Y.; Yoshinaga, Y.; Abe, K.; Chanroth, C.; Ataa, A.G.; Phyo, Z.; Kurisu, A.; et al. Natural course of post-COVID symptoms in adults and children. Sci. Rep. 2024, 14, 3884.

[7] DeMars, J., Brown, D.A., Angelidis, I., Jones, F., McGuire, F., O'Brien, K.K., Oller, D., Pemberton, S., Tarrant, R., Verduzco-Gutierrez, M. and Gross, D.P. (2022) 'What is Safe Long COVID Rehabilitation?', Journal of Occupational Rehabilitation, 33. Available at: https://doi.org/10.1007/s10926-022-10075-2

[8] McGroder C. et al.(2021)Pulmonary fibrosis 4 months after COVID-19 is associated with severity of illness and blood leucocyte telomere length. Thorax. 2021;76:1242-1245

[9] Fischer A ,Aguayo G ,Pinker I , et al.Co-design of a voice-based app to monitor long COVID symptoms with its end-users: A mixed-method study.[J].Digital health,2024,1020552076241272671.

[10] Cerfoglio, S.; Verme, F.; Capodaglio, P.; Rossi, P.; Cvetkova, V.; Boldini, G.; Galli, M.; Cimolin, V. (2024)Motor and Respiratory Tele Rehabilitation in Patients with Long COVID-19 after Hospital Discharge: An Interventional Study. Life 2024, 14, 864. https://doi.org/ 10.3390/life14070864.

[11] DeMars, J., Brown, D.A., Angelidis, I., Jones, F., McGuire, F., O'Brien, K.K., Oller, D., Pemberton, S., Tarrant, R., Verduzco-Gutierrez, M. and Gross, D.P. (2022) 'What is Safe Long COVID Rehabilitation?', Journal of Occupational Rehabilitation, 33. https://doi.org/10.1007/s10926-022-10075-2.

[12] Zheng C ,Chen J J ,Dai H Z , et al.Physical exercise-related manifestations of long COVID: A systematic review and meta-analysis[J].Journal of Exercise Science & Fitness,2024,22(4):341-349.

[13] Szarvas Z ,Fekete M ,Szollosi J G , et al.Optimizing cardiopulmonary rehabilitation duration for long COVID patients: an exercise physiology monitoring approach.[J].GeroScience,2024,46(5):4163-4183.

[14] REH-COVER - Interactive living evidence | Cochrane Rehabilitation (2022) Cochrane.org. Available at: https://rehabilitation.cochrane.org/covid-19/reh-cover-interactive-living-evidence (Accessed: 7 March 2025).

[15] Esposito, L. (2022) 'Long COVID Treatments and Recovery', U.S. News & World Report, 22 June. Available at: https://health.usnews.com/conditions/coronavirus-and-your-health/articles/long-covid-treatments.

[16] Cerfoglio, S.; Verme, F.; Capodaglio, P.; Rossi, P.; Cvetkova, V.; Boldini, G.; Galli, M.; Cimolin, V. (2024)Motor and Respiratory Tele Rehabilitation in Patients with Long COVID-19 after Hospital Discharge: An Interventional Study. Life 2024, 14, 864. https://doi.org/ 10.3390/life14070864

[17] Compagno, S., Palermi, S., Pescatore, V., Brugin, E., Sarto, M., Marin, R., Calzavara, V., Nizzetto, M., Scevola, M., Aloi, A., Biffi, A., Zanella, C., Carretta, G., Gallo, S. and Giada, F. (2022) 'Physical and Psychological Reconditioning in Long COVID syndrome: Results of an out-of-hospital Exercise and Psychological - Based Rehabilitation Program', IJC Heart & Vasculature, 41, p. 101080. Available at: https://doi.org/10.1016/j.ijcha.2022.101080.

[18] Feng, B., Zheng, D., Yang, L., Su, Z., Tang, L., Zhu, Y., Xu, X., Wang, Q., Lin, Q., Hu, J., Lin, M., Huang, L., Zhou, X., Liu, H., Li, S., Pan, W., Shi, R., Lu, Y., Wu, B. and Ding, B. (2023) 'Post-hospitalization rehabilitation alleviates long-term immune repertoire alteration in COVID-19 convalescent patients', Cell Proliferation, 56(10). Available at: https://doi.org/10.1111/cpr.13450.

[19] Xueyan Cheng,Mengyao Cao,Wing Fai Yeung & Denise Shuk Ting Cheung.(2024).The effectiveness of exercise in alleviating long COVID symptoms: A systematic review and meta-analysis. Worldviews on evidence-based nursing,21(5),561-574.

[20] Heijnen, S., Hommel, B., Kibele, A., & Colzato, L. S. (2015). Neuromodulation of aerobic exercise-a review. Frontiers in Psychology, 6, 1890. https://doi.org/10.3389/fpsyg.2015.01890.

[21] J. P. T. Higgins, J. Thomas, J. Chandler, M. Cumpston, T. Li, M. J. Page, & V. A. Welch (Eds.). (2023). Cochrane handbook for systematic reviews of interventions version 6.4 (updated August 2023). Cochrane. www.training. cochrane.org/handbook