

EDITORIAL COMMENTARY

In the era of long COVID, can we seek new techniques for better rehabilitation?

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1 | INTRODUCTION

Since the coronavirus disease 2019 (COVID-19) outbreak has become a pandemic, medical staff and researchers have devotedly managed the disease in terms of pathogens, prevention, and treatment. Even so, the virus continues to wreak havoc in people's lives. Recent evidence shows that patients with severe acute respiratory syndrome coronavirus 2 show distinct symptoms ranging from asymptomatic or mild infection to fatal disease. Moreover, this virus not only provokes an acute inflammatory response but could also cause a range of persistent symptoms after the phase of acute infection. The National Institute for Health and Care Excellence defines this phenomenon as long COVID.¹ Currently, there is no definite definition of long COVID. However, the basic argument, that patients who have recovered from acute infection present with persistent symptoms that cannot be explained by another diagnosis beyond 3–4 weeks postinfection, remains the same. Academic publications have estimated that 10%–20% of patients with COVID-19 have some complaints after COVID-19.²

Most patients with COVID-19 present with respiratory dysfunction, fatigue, and psychological disorders during and after acute infection, and their lives are greatly affected. Under this circumstance, pulmonary rehabilitation (PR) has become a powerful weapon to deal with those symptoms in the context of quantities of evidence of its efficiency.³ However, restricting quarantine to minimize viral spread may limit the utility of conventional PR programs. Thus, new techniques and innovative programs or approaches must be discussed and estimated. In this case, we could obtain a more comprehensive and critical perspective on the frontiers of medicine.

2 | TELEREHABILITATION AND REMOTE ASSESSMENT

The pandemic necessitated a transformation of traditional PR. More physiotherapists have begun to move their attention from face-to-face to remote rehabilitation and evaluate its accessibility and safety. Remote rehabilitation, also named telerehabilitation, involves

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various techniques and could eliminate the limitations of distance. The techniques range from cell phone messages to videoconferencing and Internet platforms. It may not only provide more access to PR but also help maintain the original outcomes of traditional PR.

Accordingly, it facilitates many new techniques to conduct home-based assessments to guarantee the safety of PR and improve the prescription of PR programs. During the pandemic, artificial intelligence (AI) technology has been used to support diagnosis, treatment and vaccine discovery, epidemiological modeling, patient outcome-related tasks, and infodemiology.^{4,5} Currently, an increasing number of AI or robotic technologies are used to provide training to students and healthcare professionals, find appropriate remote rehabilitation approaches, and implement a standard PR program.

Initially, the environment and assessment are essential to support engagement and motivation. Thus, Vourganas et al.⁶ demonstrated a patient-centric individualized home-based rehabilitation support system with the help of accountability, responsibility, and transparency (ART) AI. They used the timed up and go (TUG) and five-time sit to stand (FTSTS) tests to evaluate patients' daily living activity performance in the presence or development of comorbidities. To satisfy the requirements of individualization, interpretability, and ART design, they used a hybrid learning approach. As a result, the model reaches up to 100% accuracy for both FTSTS and TUG in predicting medical conditions, 100% for FTSTS and 83.13% for TUG in predicting the area of difficulty, and is much more accurate and individualized than the state-of-the-art approaches in TUG and FTSTS AI. Moreover, the author advocates that if the condition can be more finely classified, such as by severity, the model can be improved. Lemhöfer et al.⁷ developed an integrative survey questionnaire, The COVID-19 Rehabilitation Needs Survey (C19-RehabNeS) for COVID-19 patients assesses functional limitations during and after infection due to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The questionnaire included the established 36-item Short Form Survey (SF-36), together with the newly developed COVID-19-Rehabilitation Needs Questionnaire (C19-RehabNeQ; 11 further dimensions, 57 items each). It not only assesses rehabilitation needs and satisfaction with health services but also treatment and therapy during the pandemic.

Further, if possible, monitoring during exercise sessions should be accessible through wireless devices and wearable technology, such as pulse oximeters that measure oxygen saturation (SpO₂). Some studies have used video-call or phone apps, such as WeChat,⁸ to verify patient adherence and the quality of program sessions.

Raising awareness on COVID-19-related knowledge and information is also essential to a telerehabilitation program. A descriptive review analyzed health apps related to COVID-19.⁹ These apps allow people to self-track their health and provide technology to self-assess and implement home-based PR programs. They use chatbots to offer AI-enabled health education agents.^{10,11} However, the study also stressed that the number of studies on apps aiming to address psychological problems remains small and the effectiveness and acceptability of apps remain unknown. Thus, more research is required to estimate and improve these apps.

Generally, home-based PR training lasts for 8–12 weeks.¹² If you quit face-to-face rehabilitation absolutely, how do you ensure adherence? Claudio provides an innovative proposal to promote PR.¹³ He recommended a multiprofessional hybrid mode of rehabilitation. Experienced and well-trained exercise professionals visited the patients' homes 1–3 times per week and collected and transmitted the basic signs and symptoms to physicians before the exercise sessions. Thus, exercise prescriptions can be adjusted with the help of exercise professionals through video calls. After the session had begun, the physiological and perceptual data were monitored throughout the session. This could make the system safer. Although the risk of infection increases, it is a more effective approach if thorough sanitization can be performed. As the situation stabilizes, professionals can reduce the frequency of home visits.

Occupational therapy (OT) is another crucial component of the PR program. Ganesan et al. used a questionnaire, including 21 questions involving demographic characteristics of occupational therapists, the impact of lockdown on OT practice, and the use of telerehabilitation practice to explore the impact of COVID-19 lockdown.¹⁴ Although face-to-face therapy services were detrimentally affected by the pandemic, telehealth was greatly promoted. One study reported that the practice of telemedicine during the pandemic increased by 8729% over the previous year.¹⁵ Most occupational therapists use smartphones to provide telerehabilitation services. Unsurprisingly, approximately a third of therapists have already used telemedicine methods to provide services. As for the types of telemedicine used in a telerehabilitation setting, some used real-time interactions and others used transferring tech. However, simply using smartphone messages may protect patients' privacy, and the outcome of PR may be abated compared with videoconferencing or virtual reality technology. As for the mental health or personal income of therapists, nearly 76% of respondents' income has been affected, more than 50% have been stressed, and 10% have lost their jobs.¹⁴ Thus, therapists' enthusiasm for their jobs may be lower, and the quality of services may decrease.

3 | NEW TECHNIQUES AND APPROACHES FACILITATING TELEREHABILITATION

3.1 | Neuromuscular electrical stimulation

COVID-19 can cause multiorgan impairments, and a proportion of patients need to stay in the intensive care unit (ICU) for additional days, which can increase the risk of dysfunction of both respiratory and skeletal muscles, commonly referred to as ICU-acquired weakness (ICUAW).¹⁶ Neuromuscular electrical stimulation (NMES) applies an electrical current, using electrodes applied to the skin, to modify the neuromuscular activity for rehabilitation and functional purposes, and has long been used as a treatment for muscle weakness. This type of current is small, but sufficient and safe to cause contractions when muscle contraction is difficult or impossible.

Overall, NMES can prevent muscle wasting and improve muscle function, especially in patients with ICUAW.¹⁷ Some patients with severe conditions should be discharged after treatment in the ICU; however, some physical functions remain affected. Many studies recommend a fifth weekly, 6-week duration NMES program.^{18,19}

Moreover, guidelines recommend the use of home-based NMES for chronic respiratory diseases.²⁰ Thus, after discharge, it is necessary to use NMES to enhance its capability. Many tech companies from home and abroad have invented portable and wearable instruments to promote the rehabilitation of home-based NMES; however, an accurate method requires professional technicians to guarantee the safety and efficacy of such techniques.

3.2 | Robot-assisted rehabilitation

In the context of COVID-19, it is impossible to provide a PR program as before because some caregivers' inappropriate sterilization may spread the virus. Thus, robot-assisted rehabilitation (RAR) has increased awareness.²¹ Moreover, it reduces the risk of falls in elderly people, making it possible for the elderly who live independently and people with disabilities to obtain safer and more effective rehabilitation aid.

It can help patients perform physical training and monitor the primary disease, as well as soothe their mood and help with daily activities and cognitive support. In the meantime, it can adjust the present training plan to make it more suitable for patients through feedback for better adherence.²² In addition, RAR devices will be stable enough to provide the service unless they break down and they will not be interrupted or interfered with by the status or level of therapists.

Moreover, the in-built virtual games within the RAR systems could provide more entertainment to patients and improve adherence to PR programs, which may improve the effectiveness of rehabilitation.

In the near future, robots might occupy a large part of the field of rehabilitation. However, the high costs of utility and maintenance are the main barriers to the use of this innovative technology in most developing and developed countries.

3.3 | New PR style: Music therapy

As in a previous study, 20–30-min music therapy (MT) could reduce patients' pain and soothe their mood, especially in ICUs. This can lower the cardiac workload and oxygen consumption to improve physical performance or respiratory muscle strength during PR sessions. It may also have a positive effect on cognitive and psychological functions.²³ The primary goal of MT is to help patients achieve higher levels of well-being. A music therapist creates an MT plan that includes singing songs, playing instruments, listening to, or even creating songs according to the patient's needs. The type of music used varies significantly and can be chosen based on patient preferences.

There is an advent in the use of technology to conduct therapy sessions, which can be used at home for discharged COVID-19 patients for better outcomes. Previous research also suggests that web-based services are promising avenues for increasing mental health awareness and treatment options.^{24,25} For example, certain traditional instruments are difficult to learn and handle. Thus, an innovative format with the help of technology, such as adaptive-use musical instruments or brain-computing music interface systems, has been proposed. Such technology helps people with physical impairments create music using their bodies or minds during MT. Serious games could also be created to promote movements in response to music stimuli.^{26,27} For those with cognitive impairment, technology also makes it possible to practice output vocal commands. This can also enhance social-emotional competence. Some facilities and companies have innovated a series of applications to aid in adaptive growth and well-being. Engaging in games allows patients to reduce their stress.²⁸

However, there are also barriers to implementing MT in PR programs. Copyright is one of the most significant and challenging barriers. Several types of music are subject to copyright protection. What is worse, having little awareness or lacking clarity about related laws in cyberspace has further decreased the use of music in PR medication. As our nation gradually develops and laws improve, this issue must emerge, which may, in the future, become a barrier to implementing MT in our country.²⁹

4 | CRITICAL THINKING AND FUTURISTIC VIEW

Telerehabilitation has reported definite outcomes in several types of chronic diseases. A promising result is that average adherence to a 30-day program could improve exercise tolerance, dyspnea, and muscle fatigue. Although a much higher profile of rehabilitation has become available, the utility proportion of telerehabilitation in the clinical setting remains low. Thus, figuring out the barriers to telerehabilitation and using some interventions to enhance the implementation of PR is essential. Cox et al.³⁰ used the theoretical domains framework (TDF) alongside capability, opportunity, and motivation (COM-B), to search for an appropriate intervention to remove the barriers to telehealth. They used a questionnaire involving four domains: knowledge, environmental context and resources, social influence, and beliefs about consequences. In a previous study, the barriers included changes to workload, access to equipment and technology support, time constraints, and above all, clinician training.^{31,32} Accordingly, Cox put forward a brief intervention, which contained group education delivered through videoconferencing led by a clinician researcher's expert in telerehabilitation and implementation science once a week for 6 weeks to support community-based therapists to implement telerehabilitation. Consequently, the rate of implementing telerehabilitation among the investigated subjects increased. Although the subjects engaged well in the group session and the intervention achieved clinical practice change, no change occurred in the questionnaire responses by the TDF domain at the end of the intervention. This may contribute to some stony barriers, such as limited time and a lack of staff due to the pandemic.

Besides, many patients who attend PR programs are older adults who may not use or are unable to use a smartphone or other required technology for a telerehabilitation program, especially for some older adults living alone. Previous studies have shown that more than one-third of individuals have never accessed the Internet, and 30%–40% have no interest in accessing rehabilitation services via telehealth.³³ These factors may influence the outcomes of the PR programs. Patient empowerment and digital health literacy are essential to successful e-health deployment. However, detailed instructions through a video or real-time narrator for the use of technology may compensate to some degree for the defect.³⁴ Some patients can manage the smartphone or related application properly, but the user interface and function of the applications are unattractive. Thus, many patients quit the PR program within 90 days due to a lack of motivation. Motivation is related to goal setting and program outcomes. Thus, remote rehabilitation technology must be co-created with patients through user motivational feedback to

determine achievable goals and individualized treatment.

Some physiotherapists believe that remote rehabilitation is not usable in all cases, and the method of performing home-based rehabilitation after a proper and accurate assessment is essential. Applicable populations and norms must be developed. We can incorporate strategies for assessing patient and environmental suitability and safety for telerehabilitation, especially in developing countries such as ours. Life-threatening events can crush the confidence of chronically ill patients who intend to participate in telerehabilitation.

Though we rank telerehabilitation highly and have some preliminary observations, there is no concrete evidence to show that its efficacy could be equal to traditional PR programs. The ideal post-COVID candidate, duration of intervention, and cost-effectiveness are still unknown. Moreover, transitioning to a new therapy method requires multi-faceted adjustments. Some patients may be concerned about the privacy of this method. Consequent to the lack of knowledge of the new PR program and the lack of options to implement PR programs at home, patients may find it difficult to adapt to the new modality. It seems that it is still not ready for full-scale implementation of telerehabilitation; however, greater-scale adoption of telerehabilitation is urgent as the pandemic continues. This is still a promising means, waiting to be explored and improved. Moreover, a larger cohort study including a larger population of telerehabilitation needs to be conducted.

AUTHOR CONTRIBUTIONS

He Jiaye: Writing original draft. **Yang Ting:** Conception and revising.

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CONFLICT OF INTEREST

Professor Ting Yang is a member of the Chronic Diseases and Translational Medicine editorial board and is not involved in the peer review process of this article. The remaining author declares no conflict of interest.

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None.

ETHICS STATEMENT

None.

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