Original Article

Study of the effectiveness of telemedicine-based pulmonary rehabilitation in recovered patients of COVID-19 pneumonitis

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Abstract

Objective: To determine the effectiveness of the telemedicine-based pulmonary rehabilitation programme in COVID-19 pneumonitis. **Design:** Prospective intervention study. **Setting:** Rehabilitation outpatient department, Tertiary-Care institute. **Participants:** Consecutive sample of patients ($N = 50$) in recovered COVID-19 infection. **Intervention:** Six weeks of telemedicine-based pulmonary rehabilitation in recovered patients of COVID-19 infection. **Outcome Measures:** All patients were clinically assessed by six minutes walk test (6MWT), Modified Medical Research Council Scale (mMRC), 30s-STS and SF 36 at zero week and six weeks post-intervention. **Statistical Analysis:** Difference in means of pre- and post-intervention was compared using paired *t*-test. A *P* value <0.05 was considered statistically significant. **Results:** The 6MWT, mMRC Scale, 30 seconds sit-to-stand test, and WHO QoL scale-SF 36 were assessed and post-rehabilitation sessions, all the patients' showed improvement in the prescribed parameters. After six weeks of respiratory rehabilitation, the distance covered in the 6MWT was significantly longer than that of before the intervention. There was a significant difference between zero and six weeks during the PR intervention. mMRC and 30s-STS results showed a significant difference between zero and six weeks (2.36 ± 0.598, 4.54 ± 1.94. Quality of life improved significantly after six weeks of pulmonary rehabilitation in eight domains of the SF-36. **Conclusion:** Six-week pulmonary rehabilitation programme delivered through telemedicine platform improves respiratory function, QoL and anxiety in patients with post-COVID-19 pneumonia during a recovery phase.

Keywords: COVID-19 Coronavirus disease 2019, PR: Pulmonary rehabilitation, telerehabilitation

Coronavirus disease 2019 (COVID-19) is a contagious infection that causes respiratory, physical and mental difficulties in persons who are affected. The respiratory system is the primary target of the COVID-19 pandemic. Survivors who have been weaned off mechanical ventilation are more likely to develop post-intensive care syndrome.[1]

The involvement of the lungs and respiratory system in COVID-19 is of primary concern, since it causes dyspnoea, decreased blood oxygen saturation, and ultimately respiratory failure, necessitating mechanical ventilation.[2] Pneumonia is the most common complication observed in COVID-19 patients, but many other complications and even

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Received: 19-07-2023 **Revised:** 14-09-2023
Accepted: 03-10-2023 **Published:** 14-06-2024

Access this article online

Quick Response Code:

Website: http://journals.lww.com/JFMPC

DOI: 10.4103/jfmpc.jfmpc_1177_23

How to cite this article: Prageeth NP, Wadhwa RK, Gupta NK, Popalwar H, Badhal S, Kumar BK. Study of the effectiveness of telemedicine-based pulmonary rehabilitation in recovered patients of COVID-19 pneumonitis. J Family Med Prim Care 2024;13:2237-41.

multiple organ failure, which are more commonly seen in high-risk groups.[3]

In severe COVID-19, pulmonary fibrosis was also a problem. Fibrosis is more common in the elderly and in people who have severe and chronic illnesses.[4] Many COVID patients received high-dose steroids on a regular basis, which helped to reduce the occurrence of fibrosis. However, pulmonary rehabilitation (PR), in addition to pharmacologic treatment, may ameliorate the treatment of post-COVID fibrotic lung disorders.[5]

PR alludes to the individualized rehabilitation management of persons with persistent lung problems following a thorough assessment. Pulmonary rehabilitation not only means exercise training but also pay attention to a number of interventions such as education, behavioural changes and psychological and nutritional support.[6]

The aim of PR was to help patients recover their physical and emotional health while also allowing them to return to their work, families and community sooner. People with COVID-19 tend to be prone to various issues like fatigue which is associated with the movement, even if they do not develop a critical disease.[7] As a result, both hospitalised and discharged COVID-19 patients require pulmonary rehabilitation.[3]

Telerehabilitation can take several forms, including phone assessment and management services. Telerehabilitation is useful for individuals with musculoskeletal problems, some neurological conditions, degenerative diseases of the knee (OA) and motor function recovery, according to several systematic evaluations.[8] Telerehabilitation can also save healthcare costs, cut time enhance compliance with therapy, improve physical and mental function and improve holistic QoL, all while being given in a patient-friendly manner.[9]

The aim of the study was individuals with COVID pneumonia, after recovery were required to undergo pulmonary rehabilitation programmes, as soon as possible. The COVID-19 recovered patients can access pulmonary rehabilitation from remote locations via teleplatform. There is a paucity of literature regarding telemedicine-based pulmonary rehabilitation programme in recovered patients of COVID-19 pneumonitis.

The present study aspires to evaluate the effectiveness of the pulmonary rehabilitation programme in COVID-19 pneumonitis via telerehabilitation mode.

Materials and Methods

The present study was undertaken as a prospective intervention study in a tertiary care teaching institute. fifty clinically diagnosed recovered patients of COVID-19 pneumonitis were enrolled and study was conducted in the Department of Physical Medicine and Rehabilitation (PMR) in the hospital. COVID-19-recovered patients (age 18–80 years) with clinical and/or radiological evidence of pneumonitis with follow-up within 15 days post-discharge from the hospital and those patients with basic smartphone and internet availability comprised the study population.

The minimum required sample size was calculated using the software Epi Info 7.0 considering pre- and post-6MWT improvement in the study by Liu *et al.*,[10] for an alpha error of 5% and attrition rate of 10%. First 50 eligible patients from the study population, consenting to participate comprised the study sample.

The study was undertaken during the period starting from February 2021 to June 2022 after CTRI approvals. Patients with pneumonitis due to other causes and clinical evidence of existing lung diseases like COPD, interstitial lung disease; uncontrolled diabetes and hypertension; any major symptomatic illnesses like ischemic heart disease and chronic kidney diseases were excluded from the study; further, few clinical conditions like dementia/cognitive impairment or symptomatic psychiatric illness and vision disability/hearing impairment were excluded from the study in view of the instructions are not understood.

All patients coming to PMR-OPD, diagnosed with recovered COVID-19 pneumonitis with fulfilling inclusion and exclusion criteria were enrolled for PR programme after written informed consent. The relevant history, duration of ICU stay, lung complications, radiological investigations, COVID test report, assessment of psychiatric co-morbidities, if any, and previous treatment history were mentioned and recorded. All the study patients underwent clinical examination which included body mass index and respiratory system.

The initial assessment was done in the physical presence of the patient, and the remaining six-week pulmonary rehab programme was advised and monitored through telemedicine (Video consultation/40-minute session) thrice in a week.

The 6-minute walk test (6MWT), mMRC Scale and 30s-STS were the study tools used. The 6MWT was used to assess endurance and walking capacity. The distance covered over a time of 6 minutes indoors in a flat and straight corridor of 30 m in length is used as the outcome by which to compare changes in performance capacity. mMRC Scale quantifies disability attributable to breathlessness and is useful for characterizing baseline dyspnoea in patients with respiratory diseases. It consists of five statements that describe the entire range of dyspnoea from Grade 0 to Grade 4. QoL was evaluated using WHO QoL-SF 36 scale.[3]

Depending upon assessment individualized PR programme was prescribed

The patient was counselled about the effect of COVID-19 on the lungs and the importance of PR programme. The video call-based PR monitoring and supervised programme were conducted

three times in a week for six weeks. The PR in each session lasted for 45 to 60 minutes. Each session includes breathing exercises, incentive spirometry, cough removal techniques, stretching exercises, home-based aerobic conditioning exercise and strengthening exercises of upper and lower limbs.

PR was terminated when the patient experienced a rise in temperature (>38.2°C) during any stage of TR session, if there was any exacerbation of respiratory symptoms and fatigue that was not improved after rest or if any of the following symptoms occurred during the pulmonary rehab programme: chest tightness, chest pain, dyspnoea, severe cough, dizziness, headache, blurred vision, heart palpitations, profuse sweating and unstable gait. However, none of the study patients was terminated from the telemedicine programme due to the above-mentioned complaints.

Ethics

For this study, appropriate clearance was taken from Institutional Review Board and Institutional Ethics Committee.

Statistical analysis

Data analysis was carried out using IBM Statistical Package for Social Sciences (SPSS) Version 22.0, Chicago, USA. Difference in means between paired samples was tested using paired sample *t*-test and Wilcoxon signed-rank test for parametric and non-parametric variables, respectively. A P value <0.05 was considered statistically significant.

Results

In this study age of the patients ranged from 30 to 80 years. Out of the 50 enrolled patients, most of them fall in the age group of 51–60 years. The mean age of the patients was 52.48 ± 12.7 years. The majority of the patients were males (72%) [Table 1].

After six weeks of pulmonary rehabilitation, the distance covered in the 6MWT was significantly longer than that of before the PR intervention. The MMRC at zero week was (Mean ± SD) 3.1 ± 0.58, and after six weeks, it was reduced to 0.74 ± 0.66.

Table 1: Distribution of study participants based on baseline demographic characteristics

Characteristic	Frequency	Percentage
Age (in years)		
≤30	5	10.0
31-40	4	8.0
41-50	7	14.0
51-60	23	46.0
61-70	7	14.0
71-80	4	8.0
Sex		
Female	14	28.0
Male	36	72.0
Total	50	100.00

The 30 seconds sit-to-stand at zero week was 4.28 ± 2.07 which is increased to 8.82 ± 1.81 after six weeks of telemedicine-based pulmonary rehabilitation. SF-36 scores in 8 dimensions [physical functioning (27.5 ± 23.67 to 85.2 ± 10.45), role limitations due to physical health (98 ± 9.9 to 2.3 ± 5.07), role limitations due to emotional problems (100 ± 0 to 2.67 ± 7.22), energy (33.2 ± 20.52 to 79.2 ± 10.27), emotional well-being (33.48 ± 19.38 to 75.48 ± 12.44), social functioning (24.35 ± 18.83 to 79.25 ± 14.42), pain (84.05 ± 12.52 to 28.4 ± 24.07) and general health (29.43 ± 12.72 to 77.64 ± 12.46)] which were statistically significant between pre- and post-sessions suggesting an improvement in QoL [Table 2].

Discussion

The present study was aimed to study the effectiveness of the pulmonary rehabilitation programme in COVID-19 pneumonitis in terms of reduction of dyspnoea according to Modified Medical Research Council Scale,[11] reduced morbidity (physical and mental function) according to 6MWT[12] and 30 seconds sit-to-stand test,[13] improvement in the QoL in recovered patients of COVID-19 pneumonitis according to WHO Quality of life scale-SF 36.[14] The 6MWT, mMRC Scale, 30 seconds sit-to-stand test, WHO QoL scale-SF 36 were assessed pre- and post-rehabilitation sessions, all the patients' showed improvement in the prescribed parameters.

There was a significant improvement in the distance covered in the 6MWT after six weeks of respiratory rehabilitation than the baseline. There was a significant difference between zero and six weeks, meaning that the participants improved their walking distance (4.78 ± 1.95 (4.23 to 5.33); $P < 0.01$) during the PR intervention. Our study is in concordance with Liu *et al.* [10] who observed that 6MWD within the intervention group was significantly longer than baseline, after six weeks of respiratory rehabilitation within the intervention group. Giansanti *et al.*[15] who reported a significant improvement in 6MWD after six–nine weeks of respiratory rehabilitation, suggesting an improvement in exercise capacity. Priya *et al.*[16] observed that post-PR a mean improvement of 20 meters in the intervention group after six weeks compared to the controls who had a mean increase of 7 meters. However, there was no statistically significant difference between the groups in the aforementioned study.

Other studies have concluded that the baseline 6MWD recorded was 25 and at the end of rehabilitation, i.e., after six weeks is 30 m which shows there is a 5 m increase in distance covered by the patients.[12] Maltais *et al.*[17] demonstrated that a home-based PR programme is as effective as conventional PR in patients with moderate-to-severe COPD. Concluding six weeks of training, subjects had reduction in shortness of breath and better performance with their 6MWD increased by an average of 42.8 m after rehabilitation.

Gloeckl *et al.*[18] have also observed a significant 6MWD in both mild/moderate and severe COVID patients. At discharge after

Table 2: Comparison of various parameters at baseline and six weeks after intervention

	At zero week Mean±SD Median (IQR)	At 6 weeks Mean±SD Median (IQR)	Mean difference (95% CI)	*P*
6-minute walk test (Laps)	3.28±1.94 3 (1.25-5)	8.06±1.96 8 (7-9)	4.78±1.95 (4.23 to 5.33)	<0.01*
MMRC Grade	3.1±0.58 3 (3-3)	0.74±0.66 1 (0-1)	2.36±0.598 (2.19 to 2.53)	<0.01*
30 seconds sit-to-stand	4.28±2.07 4 (3-5.75)	8.82±1.81 9 (8-10)	4.54±1.94 (3.99 to 5.09)	<0.01*
SF 36-Physical Functioning	27.5±23.67 20 (10-35)	85.2±10.45 85 (75-95)	57.7±23.11 (51.13 to 64.27)	<0.01*
SF 36-Role limitations due to physical health	98±9.9 100 (100-100)	2.3±5.07 0 (0-0)	95.7±10.69 (92.66 to 98.74)	<0.01*
SF 36-Role limitations due to emotional problems	100±0 100 (100)	2.67±7.22 0 (0-0)	97.33±7.22 (95.28 to 99.39)	<0.01*
SF 36-Energy/fatigue	33.2±20.52 40 (10-45)	79.2±10.27 80 (75-80)	46±26.26 (38.54 to 53.46)	<0.01*
SF 36-Emotional well-being	33.48±19.38 37 (12-44)	75.48±12.44 72 (68-80)	42±23.57 (35.3 to 48.7)	<0.01*
SF 36-Social functioning	24.35±18.83 25 (2.5-37.5)	79.25±14.42 87.5 (75-87.5)	54.9±28.45 (46.81 to 62.99)	<0.01*
SF 36-Pain	84.05±12.52 77.5 (77.5-100)	28.4±24.07 22.5 (10-45)	55.65±20.35 (49.87 to 61.43)	<0.01*
SF 36-General health	29.43±12.72 30 (21.25-40)	77.64±12.46 75 (65-90)	48.21±21.82 (42.01 to 54.41)	<0.01*

6MWT=6-min walk test, SF-36=Short form survey-36, mMRC=Modified Medical Research Council, 30s-STS=30 sec sit-to-stand test

pulmonary rehabilitation, patients in both subgroups were able to improve exercise performance significantly by 48 m (mild/moderate COVID-19: 88% of patients exceeded the MID, $P = 0.001$) and 124 m (severe/critical COVID-19: 92% of patients exceeded the MID, $P < 0.001$), respectively. Patients who were having worse walking distances of 6WMD ≤ 200 meters showed an improvement post-rehabilitation.[19]

Modified Medical Research Council Scale and 30 seconds sit-to-stand test results showed a significant difference between zero and six weeks (2.36 ± 0.598 (2.19 to 2.53) 4.54 ± 1.94 (3.99 to 5.09): $P < 0.001$ which is statistically significant. This study results are similar to those conducted by Santus *et al.*[20] in which the findings were 30% of patients achieved a clinically significant improvement in the mMRC dyspnoea scale when compared pre- and post-session of PR. Patient had a significant distribution of pre- to post-change in 6MWD and mMRC according to the baseline categories. Patients who perceived dyspnoea (mMRC 3-4 points) had greater improvement post-rehabilitation.[19]

QoL also improved significantly after six weeks of pulmonary rehabilitation where *P* value is <.0001 in eight domains of the SF-36. QoL SF-36 scores in eight dimensions were statistically significant within the intervention group and between the two groups, suggesting an improvement in QoL. However, exercise training is the main essence of respiratory rehabilitation and its effect is affected by the way exercise is done, the intensity, time period and place of exercise training. If practiced reasonably exercise training has a positive impact on the physical and mental health and QoL of COVID-19 patients.[21] Maki N. *et al.*[22] evaluated in a RCT while investigating the effects of respiratory rehabilitation on respiratory function and swallowing in older patients with musculoskeletal disorders that, the respiratory rehabilitation is not only improve respiratory and swallowing function but also QoL, in frail older patients. The mechanism of action of exercise training on COPD rehabilitation is mostly related to the improvement of ventilation and gas exchange function, cardiovascular function and limb muscle function in patients.[23] In the light of the above-said research, this study also suggests that exercise training has a significant improvement on exercise capacity in COVID-19 patients. QoL improved significantly only in patients with severe/critical COVID-19 in the mental component sum score of the SF-36 (from 38.5 to 52.9 points; $P < 0.001$).

This study results were similar to Gloeckl *et al.*[18] who reported a statistically significant change post-PR in both mild/moderate (from 48.6 to 54.2) and severe COVID patients (from 38.5 to 52.9 with a change of 14.4 (*P* - 0.036). Pulmonary rehabilitation may play a promising and important a role in restoring function and limiting disability in post-COVID-19 infection. PM&R interventions and pulmonary rehabilitation give us additional tools in the fight against COVID-19 and telemedicine is an effective tool to deliver PR.

Limitation of study

Larger sample size and control group is warranted for further consolidation of our findings.

Conclusion

Telemedicine-based pulmonary rehabilitation in patients with recovered COVID-19 pneumonitis is effective in terms of reduction of dyspnoea, reduced morbidity, increased endurance and improvement in the QoL.

List of abbreviations

- COVID-19 = Coronavirus disease 2019
- QoL = Quality of life
- 6MWT = 6-minute walk test
- SF-36 = Short form survey-36
- CET = Cycle endurance test
- mMRC = Modified Medical Research Council
- 30s-STS = 30 seconds sit-to-stand test.

Acknowledgement

I would like to acknowledge the efforts and help from my patients without which the study was not possible to complete during the pandemic period.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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