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RESEARCH PAPER

Effects of Pulmonary Rehabilitation on the Patients with COVID-19 infection

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Abstract

Background: The coronavirus disease 2019 (COVID-19) is a threat to human health. The World Health Organization (WHO) stated it as a Public Health Emergency. It affects the respiratory system and may cause pneumonia.

Objective: The aim of this study was to find out the effects of pulmonary rehabilitation (PR) on patients with COVID-19.

Methods: A total of 155 patients with COVID-19 were included and divided into two groups in this randomized clinical trial. The intervention group was treated with standard treatment along with PR and the control group was treated with standard treatment only. Evidence of improvement was assessed weekly for four weeks. The student's 't' test and Chi-square test were done to observe the level of significance as required.

Results: There was an improvement of symptoms in both groups after treatment. But in comparison between groups, there was more improvement found in PR receiving group than the control group. Finally, O_2 requirement was same in both groups. Peripheral oxygen saturation was increased in the PR group than the control group after treatment. More improvement of dyspnea was found after treatment in PR group. Significant improvement in breathing was found after treatment in PR receiving patients than in the control group. ***Conclusions:*** PR receiving patients showed more improvement in this study. So, PR may be advocated to improve the symptoms of COVID-19.

Keywords: Pulmonary Rehabilitation (PR), Dyspnea, COVID-19.

Introduction

The coronavirus disease 2019 (COVID-19) emerged as a threat to human health in the World. It affects public health and the health systems of a country. COVID-19 was found at Wuhan, China first. Severe acute respiratory syndrome coronavirus (SARS-CoV-2) / COVID-19 has been observed in more than 195 countries and more than 8.5 million cases are confirmed, with a mortality risk of ~3.4%.[1] It caused global alarm and became a pandemic. The World Health Organization (WHO) declared it a Public Health Emergency on 30 January 2020 and issued advice in the form of recommendations under the International Health Regulations (IHR). The clinical features of COVID-19 include respiratory symptoms, fever, cough, dyspnea, fatigue, and pneumonia.[2-6] Most of the affected patients die due to breathing difficulty specially respiratory failure. COVID-19 may cause physical, psychological, respiratory, and generalized systemic dysfunction. The disease severity may be mild illness to severe pneumonia with respiratory failure and/or death and it affects the respiratory system dramatically.[7] COVID-19 is a highly infectious disease, resulting in the disruption of physical, psychological and breathing failure. Individuals affected and surviving from the disease may require pulmonary rehabilitation

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(PR) for improving of pulmonary capacity.[7] PR is based on an assessment of the patients, and it includes breathing exercises training, behavioral changes, physiotherapy, and education to improve patient's physical & psychological status having chronic respiratory disease and focusing on the interventions for long-term health-related behaviors.[8]

In a systematic review, it was found that increasing the aerobic capacity of people, decreases risk factors of COVID-19 and improves respiratory functions. A routine of mild to moderate aerobic exercises for 10 to 30 minutes is recommended for the patients with mild pulmonary symptoms and increasing aerobic capacity may also give a curable and preventive role against respiratory difficulties and infections.[9] Aerobic exercises, as well as breathing exercises, can be used to treat and prevent pneumonia.[10-12] PR is helpful in acute respiratory distress syndrome (ARDS) which is a common disorder that may develop in COVID-19 patients and it may lead to respiratory failure. Mechanism of improvement includes increased aerobic capacity, improvement of lung tissue elasticity, and respiratory muscle strength which ultimately help in increasing the ventilation, and thus lung tissue damage is decreased.[13-16] Gloeckl R et al. found that pulmonary rehabilitation is safe, effective, and feasible to improve lung function, exercise performance and to enhance the quality of life in patients having persistent impairments due to a mild to critically affected with COVID-19.[17] But their sample size was small and so they recommend a large-scale randomized controlled trial. It is also helpful to improve aerobic capacity and airway clearance by increasing lung immunity and by producing autonomic modulation.[18-20] Appropriate measurements should be taken for the COVID-19 affected patients to improve breathing capacity along with pulmonary function. It is also time demanding in this era and hence this study is conducted to find out the effectiveness of pulmonary rehabilitation for improvement of the respiratory capacity and functions of the patient affected with COVID-19.

Materials and Methods

This randomized, parallel controlled trial was conducted in Bangabandhu Sheikh Mujib Medical University (BSMMU) Hospital and Kurmitola General Hospital, Dhaka Bangladesh from 1st July 2020 to 15th November 2021. The report is written according to the guideline of CONSORT statement for randomized trials of nonpharmacologic treatments.[21] The study population was the patients having Coronavirus infection who were selected from the Fever clinic of BSMMU and Kurmitola General Hospital. The patients were selected with the following inclusion and exclusion criteria. Subjects were included whose nasopharyngeal swab samples (tested by RT-PCR) positive for the novel coronavirus, subjects, aged ≥15 years of all genders, oxygen saturation as measured by pulse oximetry (SpO2) > 90 % in room air, patients having symptoms of mild to moderate in nature, a resting respiratory rate 30/m or less and able to understand the content of questionnaires and who gave informed consent. Subjects aged less than 15 years and more than 70 years of all genders, subjects having oxygen saturation < 90 % in a pulse oximeter, a severe form of COVID-19, severe COPD, bronchial asthma, severe ischemic heart disease, and pregnant woman were excluded from the study. A total of 176 patients were included but finally 79 patients in intervention group and 76 patients in control group were analyzed after dropping out. The patients were divided randomly into two groups by the way of lottery. The intervention group was treated with standard treatment along with PR (Group-A) and control (Group-B) groups were treated with standard treatment only. PR group was provided intervention along with standard treatment, and it was given by the same physiotherapist under the direct supervision of a physiatrist. PR was given daily for 4 weeks, each session was taken 15 minutes to complete. A Bangla written PR procedure document was provided to the patients who were treated at home and they were supervised every alternate day. PR was given by the way of prone positioning, chest physical therapy, breathing exercises: breathing control, deep breathing exercise, pursed lip breathing, expansion breathing exercise, exercise through three-ball spirometry machines and postural drainage. Standard treatment was given according to WHO guideline.

Objective evidence of improvement was assessed by using the respiratory rate, temperature chart, requirement of O2 inhalation and Ventilation support. Modified Borg Scale (MBS), and Modified Medical Research Council (MRC) scales. [22-23] Follow up was done weekly for four weeks. This research was done according to the National guidelines of Bangladesh and ethical standard was maintained following the Declaration of Helsinki and CIOMS guidelines. Both scientific and ethical approval was given by Bangladesh Medical Research Council

[registration no. 2019-2020/753 (1-31). Informed consent was taken from all participants before inclusion in the trial. It was registered on Australian New Zealand Clinical Trials Registry: ACTRN12621001108808. All data were analyzed statistically by using the statistical package for social science (SPSS). The results were expressed as frequency, percentage, and mean (SD). Both student's 't' test and Chi-square test (as required) were used to compare differences between different variables. p-value < 0.05 was considered as significant.

Results

A total of 199 patients with COVID-19 were assessed for enrolment, 176 patients were meeting the inclusion criteria and were included in the study, flow diagram is given herewith. Out of them, 110 (71 %) were male and 45 (29 %) were female and male: female ratio was 1: 0.41. The mean age was 48.08 (13.74) years.

Baseline clinical criteria: Before admission into the clinical trial, the baseline characteristics of the patients were recorded, and it was found to be identical (Table I).

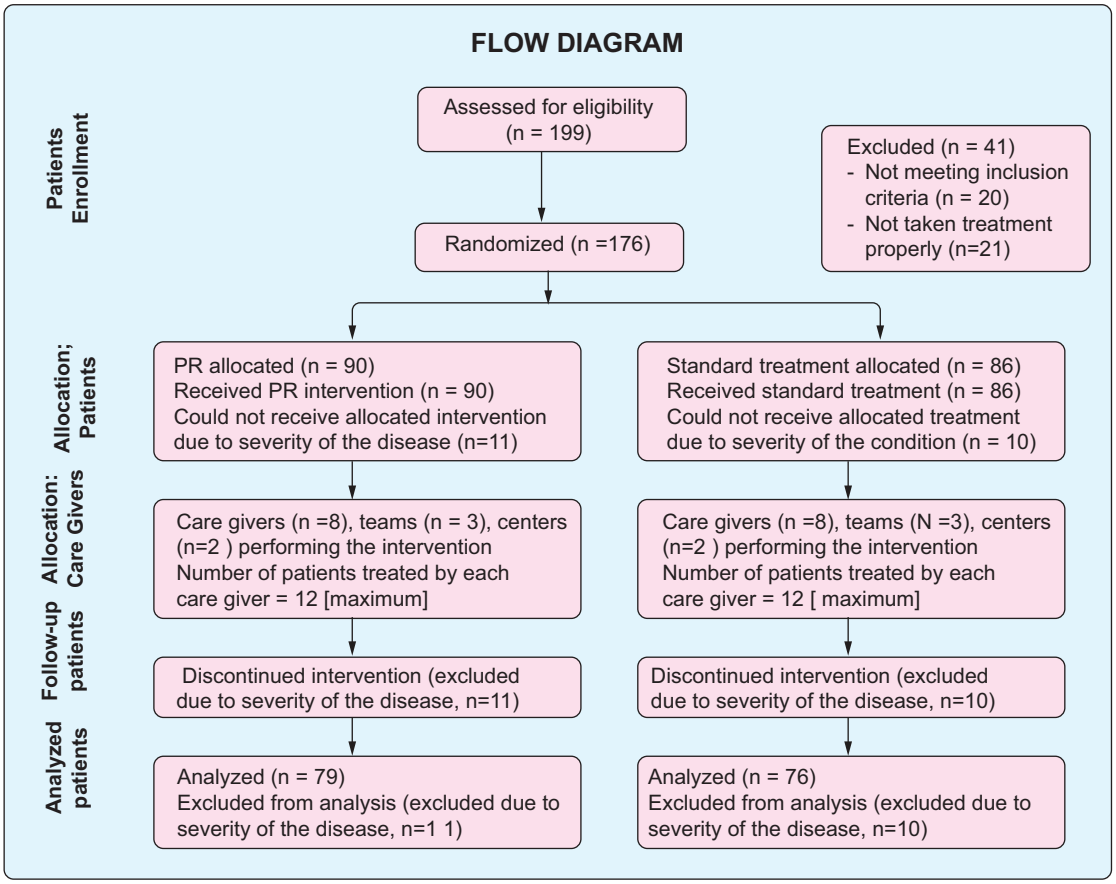
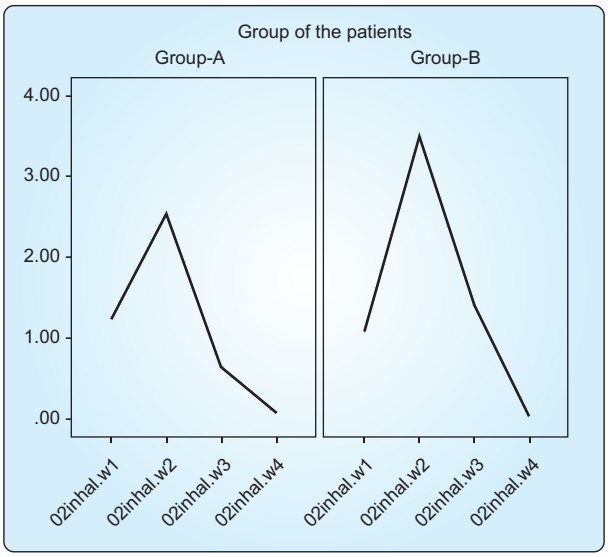


Table I: Baseline clinical criteria of the patients (N=155).

Group	Age in years	Temp in ^{0}F	Rate of resp.	O_2 saturation (%)	O_2 inhalation (L/min)
A	48.16	99.87	19.44	95.81	1.23
(n = 79)	(13.25)	(2.12)	(1.35)	(1.68)	(2.39)
B	48.08	99.45	19.51 (1.73)	95.76	1.08
(n =76)	(13.74)	(11.50)		(1.52)	(2.04)
p-value	0.96	0.76	0.78	0.86	0.68
95% CI	-4.2 to 4.37	-2.26 to 3.11	-0.56 to 0.43	-0.46 to 0.57	-0.56 to 0.85

The results are expressed in mean (SD)
N= Total number of patients, n = Number of patients in groups.

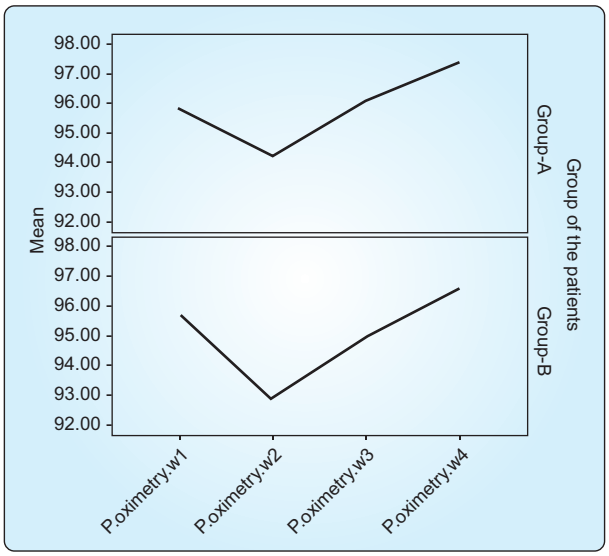
There was significant improvement after treatment in both the group. In respect to time point improvement, marked improvement started to occur after two weeks compared with an initial assessment and after the end of treatment. In comparison between groups, it was found that there was no significant difference in pre-treatment in all parameters. But after starting treatment, more improvement was found in PR receiving patients in maximum parameters. Regarding temperature, it was found that the temperature in each group was more or less same but a little bit more in group -B initially (p=0.75), and after treatment it became normal in both the group (p=0.72). Respiratory rate was found a little bit more in Group-B initially (p= 0.78), it may be due to more temperature found in Group=B. And after treatment, it became normal in both the group (p= 0.56). Initially, oxygen requirement was apparently same in both the group (p= 0.67) but there was increased requirement of oxygen in Group-B than in Group-A in second week [3.5 (2.2) L/m in Group-B Vs 2.53 (2.43) L/m in Group-A, p= 0.01] and in third week [1.42 (1.46) L/m in Group-B Vs 0.65(1.4) L/m in Group-A, p= 0.001]. And finally. it became normal in both group, p=0.32 (Figure 1).



Group-A = PR group, Group-B= Control group, Results are expressed as mean (SD), W= week

Figure 1: Comparison of O_2 requirement (L/min) in different time points between group.

In comparison of peripheral oxygen saturation, measured by pulse oximetry (SpO_2) in different time points, there was no significant difference in SpO_2 between groups initially (p= 0.67). But SpO_2 increased in Group-A than Group-B in second week [SpO2 in Group-A was 94.22 (2.47) % Vs 92.38 (2.73) % in Group-B, p=0.01] and third week [SpO2 in Group-A was 96.11(1.6) % Vs 94.64 (2.3) % in Group-B, p=0.001]. And finally. it was found that SpO_2 was not significantly more in Group-A than in Group-B, p=0.32, Figure 2).

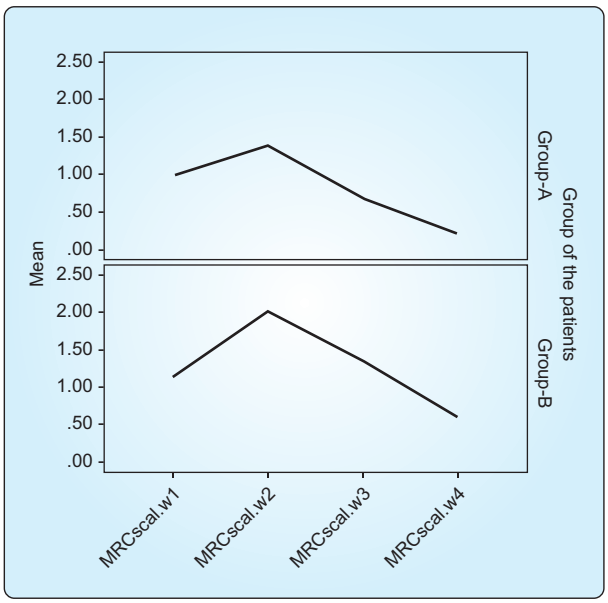


Group-A = PR group, Group-B= Control group, Results are expressed as mean (SD), W= week

Figure 2: Comparison of pulse oximetry (SpO2) in different time points between groups.

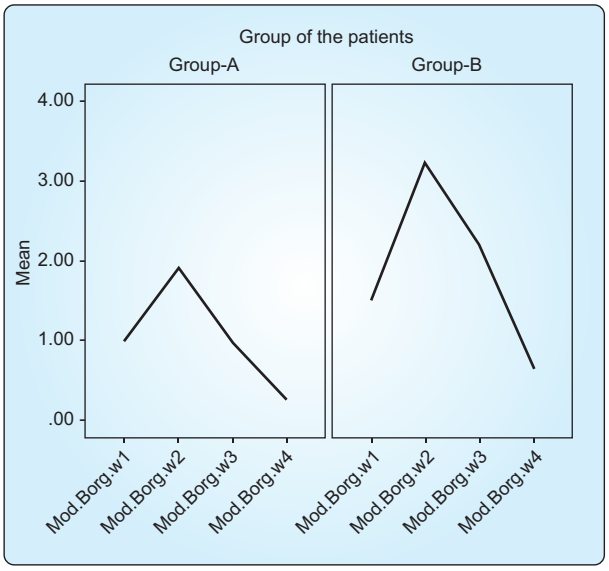
Regarding breathlessness, MRC Scale was used as the tool and found that there was no significant difference in breathlessness between groups initially, (p=0.28). But there was less breathlessness found in Group-A than Group-B in second week (p=0.001) and in third week (p=0.001). Finally, more improvement of breathing was found after 4th week in Group-A than in Group-B [MRC scale in Group-A was 0.20 (0.40) Vs 0.61 (0.61) in Group-B, p=0.001, Figure 3).

Regarding dyspnea, Modified Borg Scale (MBS) was used as the tool and found that found some difference in dyspnea between groups initially, p=0.001. But there was less dyspnea found in Group-A than in Group-B in second week (p=0.0001) and third week (p=0.0001). And finally, more improvement of dyspnea was found after 4th week in Group-A than in Group-B [MBS in Group-A was 0.25 (0.41) Vs 0.63 (0.69) in Group-B, p=0.0001, Figure 4).



Group-A = PR group, Group-B= Control group, Results are expressed as mean (SD), W= week

Figure 3: Comparison of MRC scale in different time points between groups.



Group-A = PR group, Group-B= Control group, Results are expressed as mean (SD), W= week

Figure 4: Comparison of Modified Borg Scale in different time points between groups.

Discussion

Among the study subjects 110 (71 %) were male and 45 (29 %) were female. The mean age of the patients in the study was 48.08 (13.74) years and most of the patients were in the age group of 50 to 59 years. Forty-nine (31.6%) patients were in this group. And 36 (23.3 % patients were in the age group of 60 years plus. Grasselli G et.al. found 82 % male and 18 % female and the maximum number of patients were in the age group of 56 to 70 years which is in favor of our study.[24] In another study, Mao L et.al. found in their study that the mean (SD) age was 52.7 (15.5) years, and 87 were men (40.7%).[25] The mean age here is also more or less the same found in our study. But they found more female patients in their study. This may be due to more active female persons found in China than found in Bangladesh and in Italy they found more male like us in their study. In the present study, marked improvement started to occur after two weeks compared with the initial assessment and after the end of treatment i.e., after four weeks there was significant improvement found in both the group. This indicates that pulmonary rehabilitation treatment and standard treatment both showed improvement of the patients with mild to moderate COVID-19 infection. Wang TJ et.al. recommend, after their analysis, to add mobility, breathing exercises, and physical activity to improve the COVID -19 patients.[26] After starting treatment, more improvement was found in PR receiving patients than in the standard treatment receiving group in maximum parameters. Peripheral oxygen saturation, breathlessness after activity (MRC scale), and dyspnea (Measured by Modified Borg Scale) was significantly improved in the patients who were taking pulmonary rehabilitation after treatment for four weeks. Yang L L, Yang T et.al. stated in a review that pulmonary rehabilitation is important to improve symptoms for both admitted and discharged patients of COVID-19.[27] This is in the line of the experiment that we have applied in our study. Gloeckl R. et.al. found in their prospective observational cohort study that PR is safe and effective for the improvement of lung function in patients with mild to critical case of COVID-19. [28] Chen H et.al. found in a systematic review that PR could improve exercise capacity among patients with mild-to-moderate lung problems on post-COVID-19 patients.[29] In the present study, mild-to-moderate form of COVID-19 infected subjects were included and found more improvement PR receiving patients, So, it may be recommended that PR which was used in this study should be continued after recovery from the disease to improve lung functions as it was found in other studies also.

Conclusions

It may be concluded that PR has a great role in improving the symptoms effectively on the patient with mild to moderate COVID-19 affected patients.

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Conflict of Interest: There is no conflict of interest.

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