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Case Series

Functional Status of Acute Covid-19 Patients Receiving Physiotherapy, At Discharge: A Case Series

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ABSTRACT

COVID-19 affection is known to show multi-system involvement. As impairments are expected to be seen in various systems of the body, outcomes related to the function of different systems should be considered while evaluating a patient. This case series of 5 patients brings out the functional status of acute covid-19 patients admitted to the hospital. The evaluation involves outcomes related to Musculo-skeletal (30 second sit to stand test) pulmonary function (single breath hold & breath holding time) and functional capacity (6-minute walk test), which were practical in COVID-19 scenario, in view of maintaining restricted contact with the patient. The evaluation is also done at the time of discharge from the hospital to evaluate the need for post-acute-covid rehabilitation.

KEY WORDS: COVID-19, impairments, Musculo-skeletal, pulmonary function.

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INTRODUCTION

Declared as a global pandemic by WHO in early 2020, COVID-19, caused by Severe-Acute-Respiratory-Syndrome Coronavirus-2 (SARS-CoV-2) is a primary respiratory illness known to cause atypical pneumonia with respiratory distress, characterised by an inability to maintain oxygen saturation and dyspnoea, requiring intensive care management. The spectrum of severity ranges from a complete asymptomatic/very mild presentation requiring no hospitalisation, to a severe viral-pneumonia and high incidence of acute respiratory distress syndrome requiring intensive care, which in many cases, leads to respiratory failure and eventual mortality [1].

A person infected with COVID-19 typically shows symptoms within 2-14 days, with a plethora of presentations including fever, dry cough, dyspnoea and loss of sense of smell. Severe infection presents with multi-system involvement, metabolic & coagulation dysfunction [2-4].

Following an exposure to the virus, a person typically has an inflammatory response commonly termed as “cytokine storm”, which subsequently results in interstitial oedema affecting lower zones of the lung, manifesting as ground glass opacities on HRCT, which results in an eventual V/Q mismatch and arterial hypoxemia, commonly without much dyspnoea, termed as “Happy Hypoxia” [5]. Early rehabilitation is essential to prevent complications and aid recovery [6].

As an adjuvant, physiotherapy has been an integral component of respiratory rehabilitation, that prevents and mitigates the adverse effects of prolonged bed rest and mechanical ventilation during critical illness, promoting lung function through a dedicated approach focusing on improvement and maintenance of oxygen-saturation through positioning, breathing exercises, bronchial hygiene, inspiratory muscle training etc, thus facilitating early weaning [7,8].

The following case series explains history, clinical presentation and management of 5 patients infected with COVID-19 admitted to a tertiary care hospital in Mumbai, highlighting the course of physical rehabilitation parallel to medical management. All patients tested COVID-19 positive on RT-PCR at the time of admission.

All patients were briefed and counselled thoroughly regarding the program, and an informed consent was taken.

CASE SERIES

Case 1: A 28-year-old male with no existing co-morbidities was admitted in the COVID ward with chief complaints of fever, dyspnoea & dry cough for 3 days with 97% oxygen saturation at rest. Chest x-ray showed no significant lung involvement, however; ABG revealed mild hypoxemia. supplemental oxygenation of 2 L O_2 (via nasal prongs), Inj. Ceftriaxone 1gm IV OD, Inj. Methyl Prednisolone 0.5 mg, Tab. Favipiravir 800 mgs, vitamin c, d and zinc supplementation was administered. Physiotherapy management started on the same day. Counselling the patient, to alleviate the fear and anxiety associated with the condition, as well as educate the patient regarding the significance of adhering to physiotherapy regime to aid recovery helped to build rapport with the patient. Prone & side lying body positioning, deep segmental breathing & thoracic expansion exercises, PNF manoeuvres and limb mobility exercises in sitting & standing were initiated and progressed accordingly with close monitoring and supervision. Patient's response to the combined therapy was good, and his supplemental oxygen requirement reduced gradually, with an eventual maintenance of oxygen saturation on room air. Following good improvements on various grounds, he was discharged on the 8th day post admission.

Case 2: A 43-year-old male with a history of chronic pancreatitis for 3 years was admitted to the COVID ward following an onset of acute febrile illness, dyspnoea and generalized weakness for 6 days. His resting oxygen saturation was 93%. Chest x-ray showed mild patchy infiltrates bilaterally with lower zone predominance. Along with supplemental oxygenation (3 L O2 via nasal prongs), drug regimen included Inj. Ceftriaxone 1gm IV OD, Inj. Dexamethasone 6 mg OD, antibiotic piperacillin tazobactam, Inj. Remdesivir 200 mgs IV OD, and multi-vitamin & mineral supplementation. The patient was counselled thoroughly. Physiotherapy sessions began on the 2nd day of admission with a goal of improving ventilation. Patient's vital parameters and saturation was closely monitored with every manoeuvre and technique. The patient responded to the regime very well; improvements were noted in functional as well as medical parameters, and he was discharged on the 14th day post admission.

Case 3: A 49-year-old-male with a history of type II diabetes mellitus for 4 years was admitted in the COVID ward following dyspnoea, fever, dry cough, vomiting and loss of sense of smell for 4 days. Chest x-ray showed no significant abnormality but HRCT-Chest showed reticular ground glass opacities in bilateral lower zones. ABG revealed mild hypoxemia. Resting oxygen saturation was 94%, with a respiratory rate of 30. The patient was feeling very weak and was unable to stand or walk. His HbA1c was 8.79%. Management was started with supplemental oxygenation (4L O_2 via Nasal Prongs) and drug regime included Inj. Methyl Prednisolone 0.5mg, Tab. Tamiflu, Metformin along with multi-vitamin & mineral supplementation. Physiotherapy began on the 3rd Day, with initial counselling and motivation. The frequency, intensity & duration of the maneuverers and exercises was progressed according to the vital parameters and patient's response on close supervision. Following good clinical and functional

recovery, the patient was discharged on the 11th day post admission.

Case 4: A 70-year-old-male with a history of chronic kidney disease, type II diabetes mellitus and hypertension was admitted following an onset of fever, dry cough & dyspnoea for 3 days. With a resting saturation of 95%, patient was put on supplemental oxygenation (5L O2 via nasal prongs) along with basic drug regimen similar to previous cases. Physiotherapy management began on day 2, with an initial focus on positioning, deep segmental breathing exercises and chest PNF with a view of facilitating ventilation. Mobilization exercises were started gradually. Patient showed good clinical recovery, and was thereafter discharged on the 13th day post admission.

Case 5: A 73-year-old-female with a history of type II diabetes mellitus, hypertension & Ischemic Heart Disease (IHD) was hospitalized 5 days after onset of severe dyspnoea, fever, dry cough and diarrhoea. HRCT chest revealed ground glass densities with inter-lobular septal thickening in both lung fields with 60% lung involvement (CORADS 6). ABG revealed respiratory acidosis with moderate hypoxemia. D-Dimer levels were raised (>0.5) suggestive of thrombosis. As her resting oxygen saturation was 90%, she was put on supplemental oxygenation (6L O_2 via face mask), along with Inj. Ceftriaxone, Inj. Methylprednisolone, Inj. low molecular weight heparin 40mgs, Inj. Remdesivir 100 mgs OD, Inj. Lobet, Tab. Nicardia and vitamin-mineral supplements. Physiotherapy was initiated on 3rd day due to risk of thrombus and initially dealt with facilitating ventilation and breathing control, with deep segmental breathing exercises and chest PNF techniques. Mobilization was started gradually. The patient required an extensive rehabilitation, but showed gradual improvements in clinical and functional outcomes. She was discharged on the 19th day post admission.

Physiotherapy Management: The guidelines about physiotherapy management in acute care released by Maharashtra state council was followed to plan the physiotherapy for each of the above 5 patients. These interventions have been extensively used during this COVID pandemic by many [8,9].

It consisted of similar components, but its frequency, intensity & duration planned subjective to every patient. Patients were supervised and closely monitored for their response using a pulse oximeter during their performance. Techniques used and exercises performed were documented each day along with patient's response in terms of heart rate, oxygen saturation and titration, if required.

Table 1: Components of Physiotherapy Program.

Breathing Exercises **Thoracic Expansion Exercises**	Controlled breathing exercises focusing on diaphragmatic breathing with pursed lip expiration were started initially [7] Care was taken that the patient doesn't hyperventilate, while minimizing accessory muscle work. Crocodile Breathing, which focuses on posterior basal breathing was also used to improve oxygen saturation, along with bilateral lateral costal expansion in supine & sitting [6,7]
Chest PNF	8-10 Repetitions each of PNF for diaphragm and inter-costal muscles were applied with adequate rest between stretch. Repeated Contraction Technique of PNF was used [9,10]. Scoop technique was used for diaphragm, with the patient in semi-fowler's position. For the inter-costal muscles, patient was in supine, and inter-costal stretch was applied to parasternal muscles, applied to 2nd Rib bilaterally with the thumb.
Mobility Exercises	In-Bed exercises included ankle-toe movements, heel slides, straight leg raises and bilateral front & side shoulder raises along with controlled deep breathing. Bed-Side mobility exercises included dynamic knee extensions, bilateral hip raises and sit to stand. Exercises in standing and spot marching was started gradually [6,7,8].
Ambulation	Initially, ambulation was started as short bed-side walking. The walking distance was increased in short increments with due respect to patient's oxygen saturation and response. Pacing & titration was done wherever necessary [10, 11].
Positioning	Prone and side positioning was given in accordance with the CARP protocol [12].

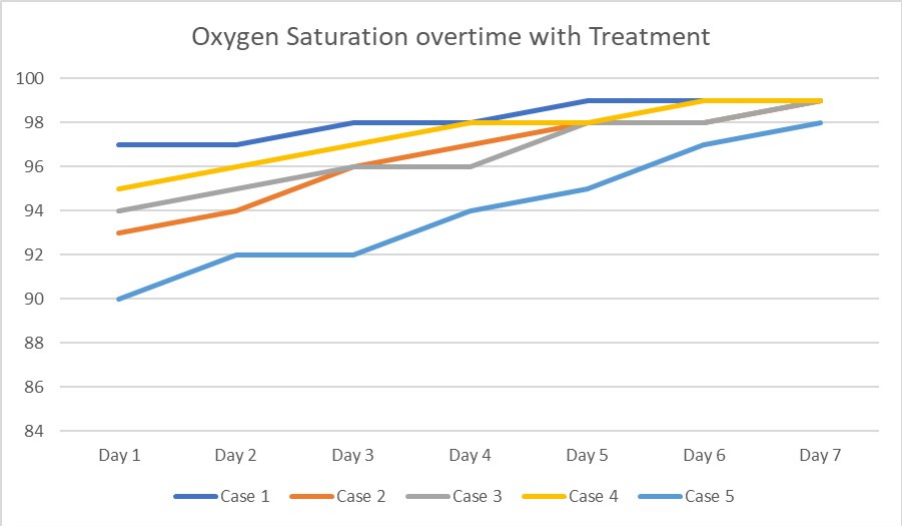
Patients' response to treatment:

Table 2: Response to Physiotherapy in 7 days from admission.

Case	Oxygen Saturation %			Breath Hold Time (Seconds)			Single Breath Count			30 Second Sit to Stand Test (Seconds)		
	Day 1	Day 7	% Difference	Day 1	Day 7	% Difference	Day 1	Day 7	% Difference	Day 1	Day 7	% Difference
1	97	99	2%	32.4	59.21	83%	24	36	50%	11	24	118%
2	93	99	6%	33.4	51.21	53%	20	40	100%	14	21	50%
3	94	99	5%	29.27	54.09	85%	17	39	129%	15	29	93%
4	95	99	4%	11.53	27.31	136%	9	16	77%	6	11	83%
5	90	99	10%	28	32	14%	24	26	8%	12	17	41%

Table 3: Association between Existing Co-Morbidities, Total Hospital Stay (Days) and 6 Minute Walk Distance at Discharge Arranged in an Ascending Order of 6MWD).

Case No.	Age in years	Existing Co-Morbidities	Total Hospital Stay (Days)	6 Minute Walk Distance (At Discharge)
5	**73**	Diabetes, Hypertension, IHD	18	280 m
4	**70**	Chronic Kidney Disease, Diabetes, Hypertension	12	310 m
2	**43**	Chronic Pancreatitis	13	370 m
3	**49**	Diabetes Mellitus	10	400 m
1	**28**	None	7	420 m



DISCUSSION

The course following an infection with COVID-19 is highly variable, and it is fairly severe and inconsistent in patients with associated co-morbidities. Prompt administration of a supervised physiotherapeutic rehabilitation program and parallel medical management can aid in recovery [8].

Table 1 describes the components of supervised physiotherapeutic rehabilitation program which was implemented. Although the components were fairly common to all the patients, individual components were tailored to meet individual demands of the patient with respect to their severity and clinical status. With close monitoring and supervision, patient's performance and pre-post status was documented on regular basis.

Table 2 describes patient's response to the treatment, in terms of percentage change of various outcome measures, namely Breath Hold Time, Single Breath Count and 30 Second Sit to Stand Test. Graph 1 highlights the improvement in oxygen saturation over-time with treatment.

The Maximum Voluntary Breath Holding Time (BHT) Test requires the subject to make a maximum expiration followed by maximum inspiration, and to hold the breath for as long as possible at the maximal inspiration [13]. It has been widely used to serve as a screening test in cardio-respiratory conditions [13, 14].

Single Breath Count (SBC) Test is a simple functional test which is a measure of how far an individual can count in a normal voice after an effort inhalation. Both SBC and BHT are found to correlate well with FEV_1 and FVC [15]. 30 Second Sit to Stand Test (30SSTS) is an exercise tolerance performance measure test which assesses functional mobility and lower limb strength in adults [16] and is a valuable method to evaluate exercise tolerance in patients with respiratory pathologies exhibiting desaturation with exercise [17].

Patient's improvement with regular physiotherapy was admirable. As the patients are in isolation, anxiety and depression is common. As the first step of interaction, all the patients were thoroughly counselled and motivated before the therapy began. Effective counselling focusing on the problem rather than the individual helped them better understand the condition and its probable outcome and the role of therapy in the same. This led to better adherence. Slow deep breathing exercises and chest PNF were crucial components of respiratory physiotherapy [9,10,19] diaphragmatic breathing as well as crocodile breathing exercise, which is posterior basal breathing was emphasised. Research shows that the grade of diaphragm movement has a positive correlation with pulmonary mechanics such that, greater the difference in diaphragm movement between inspiration and expiration, the greater is the tidal volume. Emphasis on pursed lip breathing resulted in reduction in respiratory rate and hence the work of breathing [6] Neural respiratory facilitation in the form of chest PNF helped in proper recruitment and contraction of primary respiratory muscles, using the principle of stretch reflex, thereby

reducing the work of breathing. Positioning techniques were incorporated, in accordance with CARP protocol, which helped in improving saturation status, by improving ventilation-perfusion ratio [12].

In-Bed and Out-Of-Bed mobility exercises were also integrated into the program, which helped in preventing hospital-acquired muscle atrophy and associated complications. Physical activity in the form of mobility exercises also had an effect on the mental status and might also have played a role in alleviating anxiety and depression [6].

Case No 1 showed an improvement of 83% in BHT, 50% in SBC compared to the baseline levels as on day 1, following medical care and parallel physiotherapy rehabilitation, indicative of improved lung function. Patient's oxygen saturation on admission was 97%, with mild hypoxemia on the ABG without any significant lung involvement on the chest x-ray. Consequently, Patient's supplemental oxygen requirement was also low (2L O_2 via nasal prongs). Patient's response to physiotherapy intervention was excellent, and intervention was progressed exponentially. Patient was able to maintain an oxygen saturation of 99% on room air by the 3rd day of intervention. There was also an 118% increment in 30SSTS score when compared to day 1, which shows improvement in muscle endurance and exercise tolerance [16,17] following regular physiotherapy; Endurance training has shown to be a useful modality to alleviate symptoms in patients with COPD by showing improvements in dyspnoea and pulmonary function tests [18].

This 28-year-old, physically active individual admitted in the isolation facility showed excellent response to the intervention, as evident by the outcome measures (Table 2) which can be explained due to virtue of his young age & physically active lifestyle, good age-appropriate chest wall mobility & lung function, absence of pre-exiting co-morbidities as well as high motivation and compliance with therapy.

In contrast to this, **Case 5** was a 73-year-old female admitted with an oxygen saturation of 90% on admission. Consequently, her oxygen requirement was high (6L O_2). Following PT interventions, patient showed an improvement of 14% in BHT, 8% in SBC and 41% in 30SSTS when compared to the baseline levels as on day 1. She had pre-existing co-morbidities of diabetes, hypertension and IHD. Less improvement can be seen with treatment in this case as compared to the first one. Advanced age could be the probable contributing factor.

Advancing age affects the lung & pulmonary biomechanics in many ways [20] Stiffening of the thorax owing to calcification of the ribs as well as associated kyphosis from osteoporosis reduces the ability of the thoracic cage to expand during inspiration and places the diaphragm at a mechanical disadvantage to generate effective contraction. Also, associated reduction in diaphragmatic strength due to age associated muscle atrophy and reduction in fast twitch fibres affects overall respiratory biomechanics, with an eventual reduction in lung compliance, Maximal Inspiratory Pressure (MIP), Maximum Voluntary Ventilation (MVV) FEV1, FVC, and a resultant reduction in Vital Capacity. There is also an evidence of impaired pulmonary function associated with co-morbidities, including diabetes mellitus and hypertension [21].

Even though patient in case 5 responded well to the PT treatment, the percentage change in the outcome measures was the least. Patient also had the maximum hospital stay (18 Days). This slow uncomprehending increments in outcome measures can be explained by patient's advanced age (73), existing co-morbidities and significant lung affection. Also, occasionally, the patient refused to follow the program on the given day, which can also be a factor in delayed recovery. Nevertheless, patient did show improvements in pulmonary function & functional capacity in terms of SBC and BHT, as well as improvement in endurance and exercise tolerance in terms on 30SSTS, as evident by table 2, highlighting the significance of timely physiotherapeutic rehabilitation.

According to the recent literatures, patients with COVID-19 along with pre-existing comorbidities are more likely to develop a

more severe course and progression of the disease. Moreover, those 65 years old and above who have comorbidities have an increased admission rate in ICU and an associated high mortality with Covid-19 [22].

Case No 2, 3 & 4 showed improvements which were almost similar as seen from Table 2.

All these patients responded to the treatment well, and were able to maintain oxygen saturation of 99% by the end of day 7 of intervention.

Case No 4 had pre-existing kidney disease, which required dialysis. This required him to be referred for dialysis regularly, which was taxing for the patient. Hence intermittently, the patient refused to perform out-of-bed mobility exercises and walking.

Case 2 and 3 also describe patients with some or the other pre-existing co-morbidity, which could have possibly contributed in aggravating the symptoms or delaying recovery, along with an underlying restrictive lung condition in the form of COVID-19.

Table No 3 attempts to establish a link between existing comorbidities, 6-Minute Walk Distance (6MWD) of the patients at discharge as well as total days of hospital stay, arranged in an ascending order of their 6MWD. The 6-Minute Walk Test (6MWT) is an established sub-maximal exercise test which has been a valid and a reliable tool for assessing functional capacity among cardiac and pulmonary populations.

Case No 1 had the least hospital stay (7 days) with relatively faster improvements in pulmonary function, which can be attributed to low oxygen requirement on admission, no significant lung involvement on CXR, young age and absence of pre-existing comorbidities. A high motivation factor can also be a reason for faster recovery.

Case No 5 had the maximum hospital stay (18 days). Incidentally, this case shows relatively slower but positive improvements in pulmonary function too. This can be due to a significantly higher oxygen requirement on admission, hinting towards a more striking involvement of the lungs as well as age associated pulmonary changes in presence of a restricted lung disease and an effect of pre-existing comorbidities on the same. Cases 2, 3 and 4 had marginally longer hospital stay (13, 10 and 12 days respectively)

Inferring from Table 3, case no 1 had the highest 6MWD at 420m, while case no 5 had the lowest at 280 m. Case 2, 3 and 4 had covered distances of 370 m, 400 m and 310 m respectively.

COVID-19 affects pulmonary function in a restrictive fashion, with typical reductions in Maximal Inspiratory Pressure, Forced Vital Capacity, Diffusing Capacity for Carbon Monoxide and Total Lung Capacity [23] which manifests as a reduction in exercise capacity, highlighted by the distance covered in the 6MWT. To add to this are pre-existing co-morbidities such as diabetes, hypertension, patient lifestyle and age.

Strikingly, among these patients, a relatively higher 6MWD at discharge corresponds with lesser to no co-morbidities as well as less hospital stay. (Table 3)

A Literary review on 6MWT conducted by Arun Maiya et.al in COPD population [24] observed that healthy individuals will have a predicted 6MWD of 631 ±93meter. They also highlighted that patients with a 6MWD of less than 360m have low-exercise capacity.

Even though all 5 cases showed good improvements with rehabilitation, their 6MWD at discharge warrants the need of further post-discharge post-covid pulmonary rehabilitation to improve the functional capacity as well as the quality of life of the patient [25].

CONCLUSION

Physiotherapy intervention as an adjunct to medical management proved safe, tolerable, practical and effective in alleviating the symptoms of acute COVID affection and assisting good recovery, in terms of improved pulmonary function, muscle endurance and functional capacity. The reduced functional status and exercise capacity when compared to normative values at the time of discharge warrants the need for Post-COVID rehabilitation after discharge.

Conflicts of interest: **None**

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