SYSTEMATIC REVIEW

Pulmonary physical therapy techniques for the management of COVID-19 patients: A systematic review

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Abstract

Objective: To review studies reporting pulmonary physical therapy techniques for the management of coronavirus disease-2019 patients.

Method: The systematic review was conducted according to Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines Comprised search of MEDLINE via PubMed, Physiotherapy Evidence Database (PEDro), Excerpta Medica Database (EMBASE), Allied and Complementary Medicine Database (AMED) and Cumulated Index to Nursing and Allied Health Literature (CINHAL) for Observational and interventional studies published in English language between December 2019 and January 2022 describing pulmonary physical therapy techniques for the management of coronavirus disease-2019 patients. Google Scholar and reference lists of relevant studies were also searched to identify additional articles. Methodological quality of the included studies was assessed using either the Physiotherapy Evidence Database (PEDro) scale for interventional studies or the National Institutes of Health quality assessment tool for observational studies.

Results: Of the 3767 studies found, 17(0.45%) were analysed; 13(76.5%) observational and 4(23.5%) interventional. The most common pulmonary physical therapy techniques used were active cycle of breathing techniques, positive expiratory pressure device, breathing exercises, percussions, and chest abdomen muscle exercises. However, majority of the studies applied prone positioning and suctioning as priority treatment. During mechanical ventilation, mucus clearance and alveolar recruitment manoeuvres were commonly applied.

Conclusion: There was scarcity of high-quality studies regarding the use of different pulmonary physical therapy techniques in coronavirus disease-2019 patients. Based on available literature, different techniques can be used, depending on stage and severity of the disease.

Keywords: COVID-19, Physical therapy, Pulmonary, Rehabilitation, Techniques. (JPMA 72: 1824; 2022)

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Introduction

The very first case of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), also known as coronavirus disease-2019 (COVID-19) emerged in Wuhan, Hubei province, China, in late 2019. Later, the number increased to 11.3 million confirmed cases globally.[1] In February 2020, the World Health Organisation (WHO) declared the outbreak a pandemic.[2] Its symptoms vary, with most (80%) people presenting with mild to moderate illness characterised by fever, dry cough, sore throat, malaise and difficulty in breathing.[3] About 20% people experienced much severe symptoms, in particular adults over 65 years having co-morbidities, including cardiovascular disease, diabetes and other respiratory diseases. As estimated, about 30% people required hospitalisation, and, of those, around 20% needed intensive care unit (ICU) treatment.[4]

COVID-19 is a highly transmissible disease that causes further physical and respiratory disorders. It transmits via the respiratory route mainly and by human-to-human contact.[5] Life-threatening respiratory characteristics of COVID-19 are hypoxaemia and acute respiratory failure. Its plan of control and management still remains a challenge for many countries.[6] Therefore, different ventilator-based strategies may be essential for different patients. Previously, pulmonary physical therapy (PPT) services have proven to be effective in the recovery of chronic respiratory diseases. PPT is safe and suitable for patients with acute exacerbations of different lung diseases.[7] Providing early rehabilitation enhanced physical performance and quality of life (QOL). It plays an important role in non-invasive support management.[8] PPT is a wide-range intervention based on comprehensive patient assessment followed by therapy which is modified according to the patient's need. This is designed to promote the physical and psychological wellbeing of people with respiratory disorders.[9]

Considering the increasing number of COVID-19 patients, particularly those hospitalised and needing ICU management, the majority requires rehabilitation to aid recovery post-infection.[10] PPT has a role in improvements observed in survivors of acute respiratory distress syndrome (ARDS) and respiratory impairments associated

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with spinal cord injury (SCI).[11] PPT appears to be effective in improving long-term physical and respiratory function in critically ill patients. However, literature regarding the use of different respiratory techniques for COVID-19 patients is still lacking. Therefore, the current systematic review was planned to analyse studies reporting PPT techniques for the management of COVID-19 patients.

Materials and Methods

The systematic review was registered with International Prospective Register of Systematic Reviews (PROSPERO) database in January 2021, and was conducted by following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) checklist.[12] For retrieval of studies, MEDLINE via PubMed, Physiotherapy Evidence Database (PEDro), Excerpta Medica Database (EMBASE), Allied and Complementary Medicine Database (AMED) and Cumulated Index to Nursing and Allied Health Literature (CINHAL) were searched for observational and interventional studies published in English language between December 2019 and January 2022 describing PPT techniques for the management of COVID-19 patients. Google Scholar and reference lists of the relevant studies were also searched to identify additional articles. The search terms included: "pulmonary rehabilitation" OR "respiratory rehabilitation" OR "pulmonary physical therapy" OR "chest physical therapy" OR "respiratory muscle training techniques" OR "respiratory therapy" OR "pulmonary recovery" OR "physiotherapy" OR "physical rehabilitation" OR "physical intervention" OR "respiratory muscle train" OR "respiratory muscle strength" AND "COVID-19 patients" OR "SARS-CoV-2" OR "coronavirus" OR "2019 novel coronavirus" OR "new coronavirus" OR "2019 nCoV".

Reviews, editorials and conference papers were excluded.

The titles and abstracts of articles were screened against the criteria by three reviewers. Studies with relevant titles were cited to the reference manager software End Note X7. Two reviewers assessed full text articles independently. After removing duplicate articles, the remaining studies were thoroughly reviewed to ensure accuracy, and any disagreements were settled through consensus in consultation with the third reviewer, if required.

Variables extracted from the selected studies included article details, like the first author, year of publication, country, study design, as well as participant characteristics, and the intervention given and its detail, like type, frequency, duration and intensity.

Methodological quality of the included articles was assessed using either the Physiotherapy Evidence Database (PEDro) scale for interventional studies, or the National Institutes of Health (NIH) quality assessment tool for observational studies.

Results

Of the 3767 studies located, 347(9.2%) remained after duplicate removal and title screening. Of them, 330(95%) studies were excluded based on eligibility criteria, and the remaining 17(5%) studies were reviewed in detail; 13(76%) observational and 4(24%) interventional. Majority of the studies had poor methodological quality (Tables 1-2).[2,3,7-10,13-23]

PPT was given to participants at different levels post-infection, that is, acute, sub-acute and post-acute. Majority

Table-1: Risk of bias assessment of observational studies.

Study Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Bertolucci et al.[3]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Nr	Yes	No	Yes	No	NR	No	9
Curci et al.[7]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Nr	Yes	No	Yes	No	NR	No	9
Hermann et al.[9]	Yes	Yes	Yes	CD	Yes	Yes	Yes	Nr	Yes	No	Yes	No	NR	No	8
Li et al.[13]	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	NR	No	8
Mcwilliams et al.[15]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Nr	Yes	No	Yes	No	NR	No	9
Shelhamer et al.[2]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Nr	Yes	No	Yes	No	NR	Yes	10
Mooney et al.[16]	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	CD	CD	CD	CD	CD	6
Eggman et al.[8]	Yes	Yes	No	Yes	Yes	No	No	No	Yes	CD	CD	CD	CD	CD	5
Pancera et al.[17]	Yes	Yes	Yes	No	Yes	Yes	No	No	No	CD	CD	CD	CD	CD	5
Zhu et al[20]	Yes	Yes	Yes	Yes	No	Yes	Yes	CD	Yes	Yes	Yes	Nr	Yes	No	10
Spielmanns et al.[22]	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	No	CD	NO	8
Ceruti et al.[21]	Yes	Yes	Yes	Yes	No	CD	Yes	No	Yes	No	Yes	No	Yes	Yes	9
Gloeckl et al.[19]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	No	10

Table-2: Risk of bias assessment of observational studies.

Study Name	1	2	3	4	5	6	7	8	9	10	Total
Liu k et al.[14]	Yes	No	No	Yes	No	No	No	Yes	No	Yes	4
Kandhi et al.[10]	Yes	Yes	No	Yes	No	No	No	No	Yes	Yes	5
Srinivasan et al.[18]	Yes	No	Yes	No	No	Yes	No	No	Yes	Yes	5
Alahmri et al.[23]	No	No	No	No	No	No	No	No	Yes	Yes	2

Table 3: Summary of the studies reviewed.

		Pulmonary Physical Therapy techniques								
Study/ country/ study design	**Study setting/ Population**	**ACBT/ Controlled Coughing/ Inspiratory Resistive Training**	**General Breathing Exercises**	**Chest-Abdomen Muscle Exercises**	**PEP**	**Percussion/ Vibration**	**Positioning**	**Suctioning/ Secretion Clearance**	**Other**	**Intervention Frequency**
Bertolucci et al.[3] 2021/ Italy/ Observational study	ICU, ward/ Sub-acute COVID-19 patients	-	+	+	+	-	+	+		NR
Curci et al.[7] 2021/Italy/ Observational study	In-patient rehabilitation unit/ Post-acute COVID-19 patients	+	+	+	-	+	+	-	Postural drainage, Pumping, Passive Muscle Stretchi ng and Incentive Spiromerty	30 mins/set, 2 times/day
Eggmann et al.[8] 2020/Switzerland/ Observational study	ICU, ward/ Acute COVID-19 patients	+	+	-	-	-	+	-	Maximal Inspiration and Stretching in Side Position	8 sessions, 25-60 mins once daily (except for sundays)
Hermann et al.[9] 2020/ Switzerland/ Observational study	ICU, ward/ Post-acute COVID-19 patients	+	+	+	-	+	-	-		25-30 sessions, 5-6 days per week
Kandhi et al.[10] 2020/ India/ Interventional study	ICU, ward/ COVID-19 patients	+	+	-	-	+	-	+	Postural drainage	Once per hour for 30 mins when awake
Kandhi et al.[10] 2020/ India/ Interventional study	ICU, ward/ COVID-19 patients	+	+	-	-	+	-	+	Postural drainage	Once per hour for 30 mins when awake
Li et al.[13] 2021/ China/ Observational study	ICU/ Mechanically ventilated and non-ventilated COVID- 19 patients	+	+	-	+	+	+	+	Mechanical Hyperinflation	2 sessions, 30-40 mins per day
Liu et al.[14] 2020/ China/ Interventional study	In-patient rehabilitation unit/ COVID-19 patients	+	-	+	+	-	-	-		2 sessions per week for 6 weeks, 10 mins per day
Mcwilliams et al.[15] 2021/ United Kingdom/ Observational study	Ward/ Acute COVID-19 patients	-	-	-	-	-	+	+		NR
Mooney et al.[16] 2020/ USA/ Observational study	ICU, ward/ Acute COVID-19 patients	+	+	-	-	-	+	+	-	60 mins per day, 4-5 times weekly

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Table 3: *Continued from previous page.*

		Pulmonary Physical Therapy techniques								
Study/ country/ study design	**Study setting/ Population**	**ACBT/ Controlled Coughing/ Inspiratory Resistive Training**	**General Breathing Exercises**	**Chest-Abdomen Muscle Exercises**	**PEP**	**Percussion/ Vibration**	**Positioning**	**Suctioning/ Secretion Clearance**	**Other**	**Intervention Frequency**
Pancera et al.[17] 2021/ Italy/ Observational study	In-patient rehabilitation unit/ Sub-acute COVID-19 patients	-	-	-	-	+	-	-	Spontaneous Breathing Trials	11-24 sessions, 45 mins per day, 5 days a week.
Shelhamer et al.[2] 2020/ USA/ Observational study	ICU/ Acute COVID-19 patients	-	-	-	+	-	-	-		NR
Srinivasan et al.[18] 2021/ India/ RCT	Post COVID-19 patients	+	+	-	-	-	+	-		5-10 times thrice a day for 6 weeks
Gloeckl et al.[19] 2021/ Germany/ Cohort	Post-acute COVID-19 patients	+	+	-	-	-	-	+	Strength Training, Connective Tissue Massage, Energy Conservation / Relaxation Techniques	30 mints per session for 3 weeks
Zhu et al.[20] 2021/ China/ Cohort	COVID-19 patients	+	+	+	-	-	-	-	Ambulation,	10-15 mints each 4 times a day
Ceruti et al.[21] 2021/ Switzerland/ Cohort	Critically ill COVID-19 patients	-	-	-	-	-	+	-		3.52 cycles /patient
Spielmanns et al.[22] 2021/ Switzerland/ Cohort	Post COVID-19 patients	+	+	-	-	-	-	+	Endurance training, Gymnastics, Indoor and Outdoor Walk, Relaxation	3-4 times/week for 30 mints maximum for strength 3 times/week for 30 mints max for Respiratory Therapy
Alahmri et al.23 2020/ Saudi Arabia/ Interventional Study	COVID-19 patients	-	+	-	-	-	-	-		5 times/day

+ indicates that intervention was applied; - indicates that intervention was not applied; COVID-19: Coronavirus disease-2019, ACBT: Active cycle of breathing techniques, ICU: Intensive care unit, NR: Not reported, PEP: Positive expiratory pressure device.

of the studies with acute infection were given prone positioning and suctioning as their priority treatment. The most common techniques used were active cycle of breathing techniques (ACBT), positive expiratory pressure (PEP) device, breathing exercises, percussions, and chest abdomen muscle exercises (CAE). During mechanical ventilation, mucus clearance and alveolar recruitment manoeuvres (RMs) were commonly applied (Table 3).

Discussion

The COVID-19 pandemic has been spreading expeditiously. As seen in majority of the cases, pulmonary function is significantly compromised.[24] Presently, there is no obvious cure for COVID-19. However, medical treatment appears to be effective. Following the preventive guidelines and recommendations is crucial to limit the spread. Along with medicinal interventions, PPT should be started early and continued at outpatient service.[25,26] The goal of PPT is to alleviate dyspnoea, preserve the patient's function, improve QOL, and to facilitate return to routine life.[27] PPT has proven effective in improving long-term physical performance in ICU survivors.[28,29] PPT following COVID-19 is feasible and leads towards improvement in physical performance, health-related QOL and exercise capacity generally.[30,31]

The current review was planned to find the commonly applied PPT techniques in COVID-19 patients. Results revealed that ACBT, PEP, breathing exercises, percussions, chest abdomen muscle exercises, prone positioning, mucus clearance and alveolar recruitment manoeuvres were the commonly applied PPT techniques in the management of COVID-19 patients.

Positioning is an effective technique and is used to improve ventilation, perfusion, oxygenation, and mobilisation of secretions in different lung segments. Prone positioning increased oxygen saturation from 88% to 96% in COVID-19 patients with haemodynamic instability, but care had to be taken to prevent de-saturation or discomfort.[3] Repeated positioning helps prevent complications, such as contractures and pressure ulcers. A study reported approximately 40% reduction in mortality in COVID-19 patients with moderate to severe ARDS that underwent prone positioning. For intubated patients, even a slight change in body position causes disturbance in the ventilation/perfusion ratio, which can adversely affect alveolar gas exchange. However, patients weaning from ICU may benefit from postural change and prone positioning by improving gas exchange and excretion of pulmonary secretions.[8,32]

One of the most important components of PPT is deep breathing exercises. When comparing two groups, statistical analysis proved that the group given breathing exercises and inspiratory muscle training had forced expiratory volume at 1 sec (FEV-1) and forced vital capacity (FVc) values increased, and recorded significant improvement in pulmonary function compared to the other group in COVID-19 patients with Gullian Barre syndrome (GBS).[10] However, successful rehabilitation depends on coordination between muscles strength and trunk-limb posture. As observed, implementing spontaneous deep breathing and early mobilisation strengthens respiratory and diaphragmatic muscles and speeds respiratory function recovery.[31]

Airway clearance techniques may considerably reduce the required ventilation support, duration of mechanical ventilation and hospitalisation. It helps mobilise and eliminate mucus by cough or forced expectoration. No specific technique has shown to be superior over the other, and it should be recommended based on training and expertise.[11] Physical exercise is the cornerstone of PPT and seems to facilitate airway clearance. It may start with bed mobility in weak patients to walking in ambulatory patients. During the acute phase, early mobilisation and physical training are preferred over mucus clearance techniques used alone.[33]

COVID-19 patients may develop lung and cardiac problems simultaneously. Besides, patients with co-morbid cardiac problems or COVID-19-associated myocarditis are at a higher risk of morbidity and mortality. As a consequence, PPT strategies may not be alike for all survivors, and may differ depending on the extent of lung impairment and cardiac status.[34] Literature suggests that cardiac rehabilitation programmes should be administered to COVID-19 survivors. However, cardiovascular co-morbidities might affect the outcomes achieved by PPT. Hence, cardiac rehabilitation strategies should be implemented keeping in mind the current cardiac and pulmonary status.[35]

Conclusion

Different PPT techniques, such as breathing exercises, positioning, muscle training exercises and airway clearance techniques, can be used in COVID-19 patients, depending on stage and severity of the disease. Nevertheless, the effectiveness of PPT techniques in managing respiratory complications associated with COVID-19 disease could not be established through the studies reviewed. There is a need to conduct large-scale, multicentre clinical trials to truly determine PPt effectiveness in COVID-19 patients.

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