Acta Scientific MEDICAL SCIENCES (ISSN: 2582-0931)

Volume 6 Issue 9 September 2022

Review Article

Safety and Efficacy of Respiratory Physiotherapy and Breathing Techniques in Patients with COVID-19

Maheen Shad[1], Faran Khan[2]*, Abdullah Khalid Qureshi[1], Mahnoor Javed[1] and Umer Rafiq[1]

[1]Department of Physical Therapy, School of Health Sciences, University of Management and Technology, Pakistan

[2]Department of Nutritional Sciences, School of Health Sciences, University of Management and Technology, Pakistan

***Corresponding Author:** Faran Khan, Department of Nutritional Sciences, School of Health Sciences, University of Management and Technology, Pakistan.

DOI: 10.31080/ASMS.2022.06.1371

Received: July 06, 2022

Published: August 30, 2022

Abstract

Background: The global COVID-19 pandemic has brought the entire world to a halt, resulting in illness, disabilities, death, and changes in personal roles. Pneumonia and respiratory complications along with failure of respiratory system are the most common causes of morbidity and death in these individuals, necessitating mechanical ventilation and other methods to enhance respiratory function**.** Chest physiotherapy is one of these methods.

Objective: The goal of this review was to collate and critically review chest physiotherapy- related articles that were relevant to COVID-19 and its complications and summarize different techniques and their safety and efficacy in critically ill as well as in post extubation period.

Methods: Google Scholar, PubMed, PEDro, and The Cochrane Database of Systematic Reviews were utilized to conduct the literature search. "Respiratory Physiotherapy," "Breathing Techniques," "COVID-19," and "Coronavirus" were among the keywords. As needed, a Boolean search was used. Studies that utilized physiotherapy intervention as a technique for COVID-19 recovery were included in the selection criteria. Animal trials, non-COVID-19 investigations, and physiotherapy as an additional treatment were all ruled out. The study looked at evidence from all full-text English papers published between December 2019 and January 2022.

Results: Of the retrieved 130 articles, 33 articles were excluded at the title and abstract screening. 97 articles underwent full-text screening and further narrowed to 12 studies matching the expected criteria. 86 studies were excluded for various reasons.

Conclusion: Patients with COVID-19 may benefit from chest physiotherapy, especially after discharge, to improve their respiratory functioning and quality of life. Apart from some expert advice based on anecdotal data, there is still a dearth of proof on its efficacy during the acute period.

Keywords: Chest physiotherapy; COVID-19; SARS-CoV-2; ventilation; Extubation

Introduction

A respiratory illness epidemic caused by a new human coronavirus (SARS-CoV-2) was discovered in Wuhan, China, in late 2019. The illness, now known as coronavirus disease 2019 (COVID-19), spread quickly over the globe and was declared a pandemic by the World Health Organization on March 11, 2020. SARS-CoV-2 is

transmitted by respiratory droplets as well as human-to-human contact, which are the two most common ways of infection. A mild febrile sickness with dry cough as well as moderate to severe respiratory distress emerges within a few days after infection. [1] Furthermore, if the respiratory symptoms are severe, they may develop to respiratory failure (acute respiratory distress syndrome), which may result in mortality if not treated quickly with invasive ventilation. Noninvasive methods such as chest physiotherapy may be employed for patients with mild to severe symptoms.

Coronavirus 2019 (COVID-19), often known as SARS-COV-2, is a coronavirus that is distributed mostly by droplets and belongs to the -corona cluster. When a person develops the illness, the virus enters the lungs and is recognized by angiotensin-converting enzyme 2 (ACE2), which is found in normal human alveolar cells of types I and II. When the virus attaches to ACE2, the alveolar cells are damaged. Under normal conditions, alveolar cells manufacture and release surfactant, perform xenobiotic metabolism, aid in water transepithelial transport, and repair alveolar epithelium after lung damage. These functions aid in the correct functioning of the lungs. As a consequence, alveolar cell destruction may lead to respiratory issues, additional systemic symptoms, and finally death. As a result, COVID-19 illness symptoms include fever, cough, myalgia or tiredness, pneumonia, and complex dyspnea [2].

Myalgia, sputum production, sore throat, diarrhea, loss of smell, and stomach discomfort are all possible side effects. The virus is most often seen in the upper respiratory tract. However, lower respiratory tract inclusion is more prevalent than upper respiratory tract inclusion. [3] Individuals with COVID-19 may have an influenza-like sickness and a respiratory tract infection, with symptoms such as fever (89%), fatigue (38%), cough (68%), sputum production (34%), as well as shortness of breath (34%). (19 percent). The severity of the disease varies from asymptomatic infection or moderate upper respiratory tract sickness to extensive viral pneumonia, which may result in respiratory failure and/or death. According to current studies, 80 percent of cases are asymptomatic or moderate; 15% are severe (infection needing oxygen); and 5% are critical (requiring ventilator and life support).

Chest radiographs could have diagnostic limits in COVID-19, according to preliminary data. Numerous mottling and ground-glass opacity are common abnormalities on lung computed tomography (CT) scans, which clinicians should be aware of. With observations of multi-lobar distribution of B-lines and widespread lung consolidation, lung ultrasound is now being employed at the bedside.

In comparison to influenza, which has a fatality rate of roughly 0.1 percent, the present mortality rate is 3-5%, with fresh reports of up to 9%.

Intensive care unit (ICU) admissions account for around 5% of all hospital admissions. Approximately 42% of hospitalized patients will need oxygen treatment. Individuals who are older, male, have at least one co-existing comorbidity, greater severity of illness scores (measured via SOFA scores), elevated D-dimer levels, and/or lymphocytopenia are at the highest risk of developing severe COVID-19 disease needing hospitalization and/or ICU support, according to data obtained [4].

Respiratory physiotherapy in covid-19

The goal of chest physiotherapy for COVID-19 patients is to ease dyspnea, anxiety, and sadness in the near term. It is to enhance physical functions in the long run, which will increase quality of life and assist return to society. Airway clearance techniques (active cycle of breathing technique, forced expiratory technique, percussion and vibrations, positive expiratory pressure (PEP) therapy (including bubble PEP), positioning and gravity-assisted postural drainage, intra- or extrapulmonary high-frequency oscillation devices, autogenic drainage) are among the chest physiotherapy interventions recommended and/or used for patients with COVID-19 [5].

Cardio-respiratory physiotherapy, in particular, aids in the clearing of secretions in persons who are unable to do so on their own, whether or not they have comorbidities, resulting in a favorable recovery. COVID-19 patients in the ICU are treated with extended protective ventilation and sedation, which increases the risk of ICU-acquired weakness (ICU-AW), increasing morbidity and death. As a result, early rehabilitation was required for all COVID-19 cases in order to improve the rate of functional recovery [6].

Respiratory characteristics of covid-19

Hypoxemia and acute respiratory failure are two respiratory features of severe COVID-19. COVID- 19 is linked to unusual respiratory mechanics, such as a reasonably well-preserved respiratory system and high or low respiratory system compliance.

Additionally, chest CT scans of COVID-19 patients have revealed distinct patterns of pulmonary involvement: 1) a multifocal, over-perfused ground-glass phenotype, with centrilobular nodules, patchy consolidation, and intra-bronchial air bronchogram; 2) dilatation and congestion of septal capillaries, followed by exudation into the alveolar space with interstitial edema; 3) vascular exudation in the interstitium, with consolidations filled by air bronchogram; 4) fibrous exudation with multiple consolidations; and 5) thickening of bronchial walls, the interlobular septum, and patchy consolidations. This explains why COVID-19 patients present with an extremely variable clinical course, and why individualized ventilatory strategies are required [5].

- **Chest Physiotherapy during the Acute Period:** Because most patients do not have exudation at this time, chest physiotherapy may not be suggested. Additionally, diaphragmatic breathing, pursed-lip breathing, and bronchial hygiene/lung re-expansion techniques are not recommended at this time. The use of a mechanical ventilator is the first priority, especially in patients with severe symptoms. On a case- by-case basis, it has been suggested that chest physiotherapy can be utilised to treat dyspnoea, sadness, and anxiety in patients with exudation and mild to moderate symptoms. However, except from a recommendation based on anecdotal evidence, no studies have been published on the use of chest physiotherapy during the acute period [5].

- **Chest Physiotherapy during the Mechanical Ventilation of Patients With COVID:** Ventilatory support is essential for the patient of COVID-19 who develops condition like Acute Respiratory Distress Syndrome (ARDS).

For the management of COVID-19 patients initial guidelines corroborated this strategy, recommending that the value of low-VT ventilation (4-8 mL/kg PBW) with PEEP levels titrated according to peripheral oxygen saturation (SpO2). However, this should only be applied to patients with ARDS-like COVID-19. Continuous positive-pressure ventilation (CPAP) or non- invasive ventilation (NIV) with vigorous breathing effort may be detrimental in COVID-19, as it could increase the risk of patient self-inflicted lung injury (P-SILI). In fact, longer periods with non- invasive ventilatory supports should be avoided and intubation prioritized in order to prevent the development of P-SILI, which may worsen lung damage [1].

Patients who are on mechanical ventilation may lose their ability to breathe on their own. This increases the risk of lung collapse and ventilator-associated pneumonia in the patients. Chest physiotherapy can be performed in these situations to shorten the amount of time spent on a mechanical ventilator and in the ICU, as well as to avoid ventilator-associated pneumonia. Furthermore, intubated patients who received high-frequency chest wall oscillation had higher dry sputum weight and PaO2 on day 3, reduced lung collapse on days 2 and 3, and culture positive on day 3.

Over the course of a 48-hour stay in the ICU, a patient who received 11 sessions of physical therapy consisting of upright body positioning, mobilization, and exercise, as well as the active cycle of breathing exercise technique every 2 hours for 12 hours (six sessions on day one and five sessions on day two), arterial oxygen levels improved significantly, and radiographic infiltration was resolved. Because chest physiotherapy can reverse pathological development, prevent atelectasis, improve poor gas exchange, and reduce culture positive, all of which are pathological markers of COVID-19, it can be used in patients with this condition.

As a result, airway clearing procedures, lung maneuver recruitment, endotracheal suctioning, and a change in posture are all indicated in patients on a ventilator [2].

Procedure	Description
Positioning Therapy	Patients can be put in a prone position, 12-16h per day, preferably within 72h of endotracheal intubation. If this is effective, it should be repeated until PaO2/FiO2 ratio (P/F) ≥ 150 mmHg with PEEF ≤ 0.60 for at least 4h in a supine position.
Active cycle of breathing (airway clearance technique)	Nil
Manual and/ or ventilator hyperinflation (airway clearance technique)	Nil
Percussion and vibration (airway clearance technique)	Nil
Positive expiratory pressure (PEP) (airway clearance technique)	Nil
Mechanical insufflation- ensufflation (airway clearance technique)	Nil
Lung maneuver recruitment	Nil
Endotracheal suctioning	Nil

Conventional chest physiotherapy maneuvers for critically Ill patients

In general, airway clearing methods, lung re-expansion using RMs, patient-ventilator interactions, inhalational therapy, humidification, and tracheostomy and bronchial aspiration are some of the procedures that are used. Other, equally effective strategies that can replace these techniques have lately been found and implemented in clinical practice. We believe that early physiotherapy and movement may be critical for improving outcomes since the severe respiratory disease associated with COVID-19 can lead to long-term mechanical ventilation and a high ICU death rate. The chest physiotherapy maneuvers used in COVID-19 patients in our ICU and their rationale are described in the following paragraphs. The physiotherapy modalities used in our ICU for COVID-19 patients are summarized in figure 1 [1].

Figure 1: Genoa-COVID-19 algorithm for respiratory physiotherapy.

Alveolar recruitment

Although alveolar recruitment may be achieved in critically sick patients using a number of approaches during mechanical ventilation, whether alveolar RMs should be employed at all has been a point of contention. When compared to "rapid" RMs, "slow" RMs resulted in more homogenous lung inflation and functional impairment with less ventilator-induced lung damage (VILI) in experimental ARDS. A strategy based on lung RMs and PEEP titration according to the best respiratory system compliance resulted in higher 28-day all-cause mortality than a low-PEEP strategy in a large, multicenter, randomized controlled trial of ARDS patients, suggesting that this type of recruitment is best avoided. Figure 2 Stepwise recruitment maneuvers and lung ultrasound.

Figure 2

Results of chest physiotherapy evaluated by lung ultrasound. The figure represents a stepwise recruitment maneuver (RM) at different positive end-expiratory pressure (PEEP) levels that allowed to recruit atelectatic areas of a COVID-19 patient.

Drainage of Subglottic Secretions

Although the research on the true therapeutic advantages of SSD in COVID-19 is inconclusive, we feel that a strategy focused on early physiotherapy (including SSD) might lower the incidence of subsequent lung infections. Nonetheless, the single publication on CPT in COVID-19 does not recommend that this method be begun too soon, and cautions that SSD should only be conducted with a closed aspiration circuit to minimize droplet dispersion and PEEP loss. We offer a unique approach to analyze this maneuver and limit the danger of aerosol dispersion based on our actual experience with respiratory physiotherapy in our ICU. In a nutshell, we conduct SSD by lowering the endotracheal cuff pressure, allowing for subglottic aspiration via a closed-aspiration circuit while concurrently aspirating the oral cavity via a separate circuit. This strategy, in our experience, reduces airborne dispersion and assures perfect SSD. Figure 3 depicts this procedure figure 3.

Genoa-COVID-19 subglottic secretion drainage novel technique.

Figure 3

Genoa-COVID-19 subglottic secretion drainage technique using a mixture of closed aspiration circuit and open aspiration circuit to minimize airborne dispersion

Postural Drainage

While postural drainage has been abandoned because it requires a considerable time investment and provides only minor clinical benefit, patient positioning is still considered an optimal and quick technique to mobilize secretions and increase lung volumes, perfusion, and oxygenation. Different positioning maneuvers reduce the risk of secondary respiratory bacterial infections in mechanically ventilated COVID-19 patients, facilitating mucus clearance and mobilizing secretions, thereby improving lung volumes, perfusion, and oxygenation.

Ventilator hyperinflation

Physiotherapists routinely use ventilator hyperinflation to increase airway clearance in mechanically ventilated ICU patients. Ventilator hyperinflation requires the use of a ventilator generating an expiratory flow rate bias when the peak inspiratory flow rate is less than 90% of the peak expiratory flow rate, with a minimal difference of 17 L/min and an expiratory flow rate of 40 L/min. In both clinical and pre-clinical settings, the efficacy of manual vs. ventilator hyperinflation has been studied. Manual or ventilator hyperinflation had no effect on pulmonary indices in pigs in an experiment. Instead, both techniques reduced inspiratory flow while increasing peak expiratory flow by up to 44 L/min. In conclusion, the ventilator hyperinflation approach for severe COVID-19 patients may be considered to enhance airway clearance, albeit its real positive benefits have yet to be proved [1].

Pre-extubating chest physiotherapy

To limit exposure, health care providers should begin the treatment only after donning proper personal protective equipment and, if feasible, in a negative-pressure room with an antechamber. Health care professionals should begin the process only after donning appropriate personal protective equipment. Criteria for extubation are the same as for other critically ill patients. A daily awakening trial followed by a spontaneous breathing trial (SBT) is suggested to improve outcomes in critically ill mechanically ventilated patients.

Figure 4

Chest physiotherapy during the chronic period

Severe muscular atrophy and decreased muscle function are typical among severely sick ICU patients who survive. Muscle loss can contribute to a loss of independence and quality of life by impairing respiratory muscle strength, delaying weaning from mechanical ventilation, and prolonging ICU and hospital stays linked with diminished functional status. The acute impact of severe COVID-19 on muscle atrophy and functional impairment, on the other hand, is unclear. As a result, we set out to describe and evaluate the time course and amount of acute muscle loss in critical illness, as well as the impact that these changes play in functional ability [7].

Post-extubation and after discharge

Many individuals may experience respiratory failure again after being extubated. Chest vibration and pounding can be used to avoid this. There appear to be no reports of chest physiotherapy being used soon after extubation in COVID-19 patients. Rehabilitation comprising respiratory muscle training, cough exercise, diaphragmatic training, stretching exercise, and home exercise has been implemented following discharge. When these types of training and exercise were done twice a week for six weeks, they improved FEV1 (L), FVC (L), FEV1/FVC percent, diffusing lung capacity for carbon monoxide (DLCO percent), endurance, and quality of life, as well as lowering anxiety and depression symptoms. The indications and contraindications of chest physiotherapy, as well as explanations of the procedures utilized during this stage, may be found in table 2 and 3 respectively.

	Respiratory Function	Cardiovascular function	Nervous system function	Other
Indication	A blood oxygen saturation of ≤95%, mini-mental state examination (MMSE) score > 21, no COPD or any other respiratory disease, and forced expiratory volume in 1s (FEV1) 70%	A heart rate of > 100beat per minute and a blood pressure of < 90/60 mmHg or > 140/90 mmHg	Nil	Other diseases that are not suitable for exercise
Contraindication/ Discontinuation of Intervention	Exacerbation of respiratory symptoms and fatigue that are not alleviated with rest, dyspnea, severe cough, moderate or severe heart disease, and ischemic or hemorrhagic stroke or neurodegenerative diseases	Chest tightness, chest pain, and heart palpitations	Dizziness, headache, blurred vision	Temperature fluctuation (37.2 ◦ C), profuse sweating, and unstable gait

Table 2: Indications and contraindications of chest physiotherapy in patients in after discharge [adopted from [20,30].

Procedure	Description
Respiratory training	Patients should use a hand-held resistance device for three sets, with 10 breaths in each set. Parameters should be set at 60% of the individual's maximal expiratory mouth pressure with a rest of 1 min between the three sets
Cough exercise	Three sets of active coughs should be adopted for cough exercises
Diaphragmatic training	Patients should perform 30 maximal voluntary diaphragmatic contractions in the supine by placing a medium weight (1-3 kg) on the anterior abdominal wall to resist diaphragmatic descent
Stretching exercise	The respiratory muscles should be stretched under the guidance of a rehabilitation therapist. The patient should be placed in the supine or lateral decubitus position with the knees bent to correct the lumbar curve. Patients should be ordered to move their arms in flexion, horizontal extension, abduction and external rotation
Home exercise	Patients should be instructed in pursed- lip breathing and coughing training. They should carry out 30 sets per day

Table 3: Description of the chest physiotherapy used in patients with COVID-19 after discharge [adopted from [30].

Effects and safety of chest physiotherapy in patients with other respiratory conditions and covid-19

Several different respiratory disorders have been treated using chest physiotherapy. When given early, it is reported to promote gas exchange, revert pathological development, and minimize or eliminate the requirement for mechanical ventilation. Aside from few position papers or suggestions based on anecdotal findings, there is currently a lack of information on the effects of COVID-19 in patients, particularly during the acute period. This is due to the fact that the characteristics of respiratory difficulties in COVID-19 individuals vary greatly from complications in other respiratory disorders. Patients with COVID-19, for example, seldom develop exudation during the acute period. Dyspnea in COVID-19 patients may also quickly lead to acute respiratory failure. As a result, mechanical ventilation should be used as soon as possible in such cases.

COVID-19 is a highly contagious virus that spreads quickly, raising concerns regarding the use of chest physiotherapy in contagious disorders. Because it has been suggested that chest physiotherapy may produce aerosolization, this is the case. COVID-19 might spread faster as a result of this. Later discoveries under comparable situations, however, refuted this theory. An examination of droplet scattering in the Influenza pandemic as well as other airborne illnesses by Simonds and colleagues found that chest physiotherapy substantially and primarily generated droplets of > 10 µm. Only droplets within the inspirable range (approximately 5 µm) may play a major role in the transmission of diseases, therefore droplets this small are not respirable. Similarly, a study of influenza, a virus transmission by aerosol threw doubt on whether or not droplets from chest physiotherapy may transfer viruses. In addition, chest physiotherapy was subsequently advised in SARS, an illness with a pathophysiology similar to COVID-19. Furthermore, since scientists are still striving to comprehend COVID-19's pathophysiology and viral behavior, the virus's therapy is currently symptomatic. Because the illness may kill within days to months after beginning, particularly in the elderly and those with weakened immune systems, we can have our patients sneeze or cough into disposable plastic bags both during as well as after chest physiotherapy to limit or lessen the risk of aerosolization. Previously, a similar approach was suggested.

Similarly, we can clean the surrounding environment while therapists and other health personnel wear protective gear to keep themselves from being infected. We can save the lives of countless persons infected with COVID-19 in this manner. Patients may, however, wear surgical masks throughout the process to avoid the transmission of infection if they are available. In a simulation and cadaver model, surgical masks plus oxygen masks on the face of patients were observed to deflect aerosols while chest compression. Other options for helping patients govern themselves 24 hours a day include the use of self-management approaches such as the supply of self- management brochures and instructive movies, as well as online consultations, such as through Skype video conversations. Cross-infection will be less likely as a result of this.

The goal of chest physiotherapy for COVID-19 patients is to reduce dyspnea, anxiety, and depression in the near term, and to enhance physical functions in the long run, which will make life better and assist return to society. Airway clearance methods (active cycle of breathing technique, forced expiratory technique, percussion and vibrations, positive expiratory pressure (PEP) therapy (along with bubble PEP), positioning as well as gravity-assisted postural drainage, intra- or extra pulmonary high-frequency oscillation machines, autogenic drainage) are among the chest physiotherapy intervention strategies recommended and/or used for patients with COVID-19. But, since patients' clinical features varies, it has been suggested that rehabilitation be administered on a case-by-case approach [2].

Potential therapeutic effects during disease

One of the treatment choices for symptom relief in many respiratory viral infections is respiratory physiotherapy. Studies have shown that prone posture improves airway clearance and oxygenation in people with influenza. Breathing exercises, in combination with other therapies, may help patients with influenza-related acute respiratory distress syndrome improve their total lung capacity (ARDS). Chest physiotherapy approaches consisting of prolonged slow expiration have demonstrated to improve respiratory parameters transiently in infants having respiratory syncytial virus bronchitis, but no improvements in the length of admission have been recorded. The efficacy of respiratory treatment on children hospitalized with acute viral bronchiolitis was studied in many randomized control studies. In addition to the decrease in wheeze,

improvements in SpO2, respiratory rate, as well as chest retraction were seen [2].

Some patients develop severe respiratory problems such as pneumonia and multi-organ failure, necessitating ICU hospitalization. Patients who are hospitalized to the intensive care unit (ICU) are vulnerable to ICU acquired frailty. Early physiotherapy therapies, including as exercise and movement, often assist to reduce the degree of ICU-associated problems, and hence promote functional recovery following the acute period of ARDS. Exercise increases muscular performance as well as cardiorespiratory function in those who have recovered from SRAR-CoV-1. Both SARS-CoV-1 and SARS-CoV-2 are known to cause lower tract respiratory problems. Respiratory treatment for LTRI, which comprises mostly of breathing methods, exercise training, plus education, may improve SpO2 levels, lung capacity, as well as activity restriction caused by LRTI-related dyspnea [2].

Potential prophylactic effects after recovery

After recovery, the possibility of COVID-19 recurrence has been confirmed in certain individuals. According to recent investigations, after becoming afebrile and recovering from respiratory syndrome, a few individuals develop fever, a positive nucleic acid for SARS-CoV2, and the virus in an oropharyngeal swab. Even after two consecutive discharges, one patient was reported to have tested positive. Virus eradication is not accomplished in these situations, but the clinical symptoms vanish. Patients with co morbidities, such as cardiovascular disease as well as diabetes mellitus, and also the elderly, seem to be more susceptible to recurrence due to longer hospital stays. Chest physiotherapy approaches that concentrate on minimizing breathing effort and promoting alveolar recruitment may assist to reduce the frequency plus complication of pulmonary problems, lowering the chance of recurrence after COVID-19 [2].

Breathing techniques in reducing the disease burden

Yogic breathing and its impact on body

Yoga is a mental, physical, and spiritual discipline that focuses on varied breathing patterns. It started in ancient India. Pranayama, or yoga breathing done in a regulated way, is among the eight limbs of conventional yoga. Furthermore, there are eight different types of Pranayamas: (1) Surya Bhedana meaning Right Nostril Breathing, (2) Ujjayi or Victorious or Ocean Breath, (3) Sheetkari or Hissing Breath, (4) Sheetali or Cooling Breath, (5) Bhastrika or Bellows Breath, (6) Bhramari or Humming Bee Breath, (7) Moorchha or Swooning Breath, and These Pranayamas, as per the "Hatha Yoga Pradipika," provide a variety of advantages for the body and mind as a whole. Surya Bhedana Pranayama enhances body heat, improves physical vitality, and treats anxiety, depression, as well as exhaustion. The throat, cardio-respiratory, neurological, as well as digestive systems all benefit from Ujjayi Pranayama. Sheetkari Pranayama increases immunity, memory, cleanses blood, and replenishes the body by calming the mind and reducing negative emotions. Sheetali Pranayama is useful in the summer since it cools the body and mind. It also improves mood, lowers foul breath, and helps to regulate BP. In hypertensives, the Sheetkari and Sheetali Pranayamas lower blood pressure. By increasing lung capacity, Bhastrika Pranayama energizes the body and mind. It aids in the treatment of respiratory issues such as sinus as well as bronchitis, as well as improving sensory awareness and perceptive strength. Bhramari Pranayama helps to alleviate stress, anger, and anxiety while also lowering blood pressure, reducing headaches and migraines, and improving focus and memory. Moorchha Pranayama improves mental bliss, aids in mental introspection, eliminates body fat, and lowers muscular weakness. Plavini is a more advanced Pranayama that strengthens the body's ability to go without food and drink for many days, detoxifies the body, and reduces stress.

The effects of yogic breathing on stress and immunity

New research suggests that Pranayama may help regulate the hypothalamic-pituitary-adrenal axis and inflammatory processes. They might be used as a supplement to existing techniques, if not as a new non-pharmacological therapeutic option. Yoga practice helps mental health by lowering stress, promoting mental serenity, and enhancing physical health, breathing, as well as sleep. Meditation and mindfulness may also help with psychological well-being and anxiety reduction. These advantages are mentioned in ancient Indian writings; nevertheless, the necessity to prove these advantages with contemporary methods has prompted several scientific research on Yoga, meditation, as well as breathing exercises [8].

In breast cancer patients, yoga has been demonstrated to enhance quality of life, decrease tiredness, and improve sleep. In diabetic patients, a yoga program developed in India expressly to treat diabetes may minimize co-morbidity of dyslipidemia. Yoga practice has also been shown to reduce stress-related inflammation in fe-

ISHA KARIYA OR LONGER DURATION BREATHING TECHNIQUE (LDBT) https://youtu.be/K4hCvdDn7Zc		
Time Interval: ~12-18 min		
Preparation: Crossed leg posture with straight spine, hands on thighs with palms facing upward, face slightly upward, mid focus between the eyebrows		
3 stages		
Stage 1	Inhale/Exhale, 7-11 min	While inhaling mentally saying: I am not the body While exhaling mentally saying: I am not even the mind
Stage 2	Utter "aa" 7 times, ~ 1 min	Producing the sound from the navel region with mouth wide open. Not very loud but enough to feel the vibrations produced by the sound
Stage 3	Sit silent for ~ 5-6 min	Face slightly upward with mild focus between the eyebrows
SIMHA KARIYA OR SHORT DURATION BREATHING TECHNIQUE (SDBT) https://youtu.be/P1Y1bk1YgU		
Time Interval: ~3-5 min		
Preparation: eyes closed, sit with the cross legs		
3 stages		
Stage 1	Powerful inhalation/exhalation 21 times with tongue outside, ~ 1-2 min	Constrictions from the throat, No abdominal jerks
Stage 2	Tongue rolled inside by pushing it back, 21 powerful inhalation/ exhalation, ~1-2 min	
Stage 3	Sit relaxed with fullness of breath for ~30 s – 1min	Mouth closed; eyes closed

Table 4

males. In HIV patients, yoga intervention, which includes Pranayama and Asana, raises CD4, a marker of t Helper cells, suggesting enhanced immunity, which is impeded in HIV. In HIV-positive children and adolescents, immunity increased following Yoga intervention, as shown by an increase in CD4 and a change in the CD4/CD8 ratio to the normal range. The Yoga intervention (Pranava Pranayama) group had lower levels of pro- inflammatory cytokines IL-1, IL-8, and monocyte chemotactic protein-1 (MCP-1). It is well known that IL-1 increases the amounts of cyclooxygenase-2 in the brain, which plays an important role in stress and pain control. However, the role of IL-1 as an anti-inflammatory target for chronic obstructive pulmonary disease (COPD) is also crucial to examine. On the other side, IL-8, a neutrophil chemoattractant, is understood to be elevated in chronic pulmonary disorder patients, including COPD, cystic fibrosis, acute respiratory disorder syndrome, and asthma. MCP- 1 helps macrophages, monocytes, lymphocytes, and airway epithelial cells to activate. MCP-1 has a chemotactic effect on monocytes, increases T cell activity, and stimulates the manufacture of transforming growth factor-β as well as synthesis of collagen. Yoga modulates the psycho-neuro- immune axis in rheumatoid arthritis by lowering inflammatory cytokines and improving mind- body communicative indicators and quality of life; activity of disease was also lower in the yoga group.

In Axial Spondyloarthritis, breathing exercises and meditation have been demonstrated to reduce inflammation. In bronchial asthma patients, breathing methods, particularly expiratory techniques, increase lung function and immunological response. The most common Pranayama, Bhastrika Pranayama, enhances lung function in healthy people. Deep breathing and meditation arec included in Shambhavi Mahamudra kriya, a 21-minute Isha yoga meditation from the Isha foundation in India, which reduces stress as evaluated by the Perceived Stress Scale. Diaphragmatic and pursed-lip breathing are two further breathing strategies that help with pulmonary rehabilitation in COPD patients. In COPD patients, both procedures result in increased inspiratory capacity, slower breathing rates, longer exhalation times, enhanced oxygen saturation, lung emptying, and less dynamic hyperinflation.

Individuals who practice yoga or breathing exercises have been proven to have enhanced ventilatory function in studies. Reduced respiratory rate and increased tidal volume, forced vital capacity, forced expiratory volume at the end of the first second, maximal voluntary ventilation, peak expiratory flow rate, and breath hold-

ing duration were all observed to improve ventilatory function. Learning new breathing strategies that enhance lung capacity, volume, as well as function may aid in the recovery of diseases including the flu, the common cold, as well as COVID- 19.

Isha kriya: breathing technique

Yoga follows the ancient idea of utilizing breathing to control one's emotions. Sadhguru, a yogi, founded the Isha Foundation to create and spread the practice of basic yogic breathing techniques such as Isha kriya (long duration breathing method), Simha kriya (low duration breathing method), and Shambhavi Mahamudra Kriya (low duration breathing method). A kriya is a yogic activity or inner practice, such as breathing control. The most striking quality of these kriyas is that they are simple to learn and perform, with straightforward directions. They are both free and directed by an app. It is best to do Isha kriya on an empty stomach. Isha kriya is supposed to strengthen a person in dealing with unfavorable situations around them by calming the mind and body, reducing stress, anxiety, and despair, energizing the body, and improving health. Isha Kriya's effectiveness and biological/physiological/psychological processes have recently piqued people's curiosity. Although further study is needed, the present literature indicates that Isha kriya has no adverse effects and that performing it twice a day is more beneficial to one's health. Interestingly, pilot research assessing the mood alterations before and after practice in stressed HCW from surgical grand rounds and anesthesia conference found that single-time Isha kriya practice may lessen mood disturbances in HCW. Isha devotees often believe that those who practice Isha kriya are less prone to colds and flu. It must, however, be examined [8].

Another Sadhguru kriya, Simha kriya, is supposed to enhance the immune system, expand lung capacity, and purify the body and mind. It may also be used to detect those who have respiratory problems since they are unable to execute Simha kriya after 4-5 days of consistent practice. However, no direct investigations have yet been published in the literature.

The Shambhavi Mahamudra Kriya is the most researched of the three kriyas, although it still needs further research. It's a mix of Pranayama, yogic postures, and meditation that's not seen in Yogic literature. A few studies have linked Shambhavi Mahamudra Kriya to an increase in heart rate variability, sympathetic tone, as well as vagal afferents balance. Though further research is needed, one of the studies provided sufficient evidence of the relaxation's link to reduced stress and improved well-being. Because of the COVID-19 epidemic, interest in such approaches has resurfaced, particularly in regard to the effectiveness and comprehension of Isha Kriya's biological/physiological underpinnings.

In contrast to the other kriyas, Art of Living's Sudarshan kriya (SKY) has been carefully investigated and has been proved to relieve stress and increase autonomic nervous system, immunity, and well-being. SKY has been shown to help with depression as well as post-traumatic stress disorder. SKY helps practitioners maintain oxygen saturation in severe high-altitude environments, lowering the chance of acquiring high-altitude-related illnesses (unpublished data). Recent research found that following SKY intervention, HCWs had less stress, anxiety, and sadness during the COVID-19 epidemic.

For effective integration, such improvements based on yogic knowledge need long term randomized studies in contrast to current approaches. Different Yoga schools in India, such as Isha Foundation, Art of Living, and many others, teach these breathing practices. These foundations have a vast number of adherents who use or have received instruction in these breathing practices. As a result, compared to fundamental Yoga practices, it is much easier to recruit a suitable sample size and evaluate such procedures. These kriyas often confront obstacles when they are attempted to be used as a health-care practice by the general public.

Regularly doing Isha Kriya, twice a day, is said to be beneficial to one's health. According to the Isha Foundation, those who practise Isha kriya are less prone to colds and flu. As a result, the combination of Isha kriya and Simha kriya is often recommended as an essential non- pharmacological therapy for COVID-19 management. Breathing methods are recommended for COVID-19 treatment because they raise the immune response, strengthen the respiratory system, and improve the immune response. COVID-19 may be improved by lowering stress, enhancing immunity, enhancing lung capacity, decreasing inflammation, and promoting overall wellness with the combined practice. However, there has been no evidence of stress reduction or immune strengthening when using yogic breathing techniques like Isha kriya. Unlike SKY, no extensive controlled studies have been conducted despite purported advantages from Isha kriya practitioners.

It is documented that pre-diabetics are more agitated than diabetic patients, and that a yoga intervention, such as the Diabetes Yoga Protocol, which includes breathing exercises, may reduce, if not stop, the progression of pre-diabetic to diabetic status by modifying stress responses. As a result, good co-morbidity treatment may minimize the incidence of COVID-19. Sadhguru created the aforementioned basic kriyas to incorporate the efficiency of modulated breathing into daily life, lowering the likelihood of co-morbidities like diabetes, hypertension, and possibly COVID-19. A doctor from the United Kingdom recommended a simple breathing method for relieving COVID-19 symptoms by promoting gaseous exchange and oxygenation.

Psychological stress and immune response

It was around 50 years ago that the immunosuppressive influence of psychological stress was first reported. Immunity is impacted by acute and chronic stress factors, according to a meta- analysis of 293 studies which are independent spanning 30 years. Chronic stress impedes both cellular and humoral immunity. While acute stress suppresses some elements of adaptive immunity while enhancing some parameters of natural immunity, chronic stress impedes both cellular and humoral immunity. Stressors that are brief but significant, such as a student exam or the current COVID-19 pandemic, have the potential to suppress cellular immunity. Under acute stress conditions, loneliness has also been shown to increase stress and inflammation. Individuals who are isolated, COVID-19 positive, convalescent, or lonely (during lockdown) may exhibit such behaviors, increasing their risk of developing a severe COVID-19 infection.

Asthma, a common respiratory and allergic disease in the twenty-first century, is linked to psychological stress, anxiety, and sadness, as well as a bidirectional relationship with panic. Anger and hostile behavior have a negative impact on physiology, resulting in a decline in lung function. Yogic interventions can help you avoid them.

Psychological stress has been shown in studies to increase the risk of diabetes, upper respiratory infections, and cancer, as well as play a role in cancer progression. The existence of chronic diseases, particularly respiratory disorders, as well as stress, may increase the level of COVID-19, that may be exacerbated by obesity. Obesity reduces respiratory function by reducing lung capacity and accumulating cytokine-producing adipocytes. It's worth noting that stress and obesity are linked because stress can cause obesity (overeating) or vice versa. Stress as well as obesity, on the other hand, have a negative impact on respiratory function, which may raise the risk and magnitude of COVID-19. Yogic breathing is a useful tool for increasing oxygen saturation. Moreover, psychological stress is correlated with increased susceptibility for viral diseases. Natural killer cells tend to diminish under stress. It gives protection until seroconversion plus availability of IgG and IgM antibodies to neutralize SARS-CoV-2 in middle or later stages of COVID-19. Apparently, wound healing is also hampered under stress as demonstrated by increased expression of genes associated to cell cycle arrest, apoptosis, as well as inflammation in wound site neutrophils.

Age is another potential risk of COVID-19 since immunity lowers with age. Hence, it is obvious that existence of psychological stress in HCWs, confined persons and COVID-19 positive patients may greatly impede their capacity to endure COVID-19, both psychologically and physically. Thus, pranayama and other breathing methods may play a significant role in stress management and immune enhancement, which may be effective in controlling COVID-19 response, particularly in obese or elderly patients with chronic respiratory or other illnesses. Furthermore, for a large number of people who are unable to breathe, wearing a mask is an added challenge; thus, yogic breathing can help.

Simple as well as controlled breathing methods, like Isha kriya or Simha kriya, may have a role in facilitating COVID-19-related stress as well as immune response, which could be useful in prevention or treatment as an added and indirect strategy [8].

Breathing exercises

Chest physiotherapy, which mostly consists of clearing procedures and prone posture, aids oxygenation in patients in the critical care unit (ICU). Percussion as well as vibration, in particular, are effective in moving the accumulated airway secretions. Patients who do active cycle breathing methods (ACBT) on their own may aid in the clearing of pulmonary secretions, enhancement of lung function, and alleviation of effective cough in such patients. Breathing regulation, deep breathing or chest expansion exercises, plus forced expiratory procedures such as huffing and coughing are the three components of this therapy [3].

Controlled breathing techniques pursed lip breathing

Pursed lips breathing involves inhaling via the nose and exhaling through pursed lips to lower airway collapse, respiratory rate, and dynamic hyperinflation while exercise training with the goal of improving overall stamina. Oxygen supplementation has also been shown to aid unload respiratory muscles while exercise training.

Diaphragmatic breathing (abdominal breathing)

Diaphragmatic breathing entails instructing the patient to use the diaphragm primarily while reducing the use of accessory muscles. Nasal inspiration must be encouraged to aid diaphragm recruitment and increase humidification. To enhance abdominal pressure and drive the diaphragm upward to a more favorable length-tension ratio, strong abdominal muscular contraction should be used near the conclusion of expiration [9].

Slow and deep breathing

It's a type of breathing in which each cycle's inspiration and expiration are repeated at longer intervals. It causes a slow, lengthy, and deep breathing pattern. It aids in the better use of the critical capacity of the lungs as well as instils a sense of tranquilly in the individual. Deep breathing can be done in ratios, which lengthens the time it takes to inhale and exhale in relation to each other [10].

Alternate nostril breathing

It is a form of breathing cycle that involves alternating nostrils and begins with the vigorous expulsion of air from the nostril from which inspiration is to begin. When inhaling via the right nostril, for instance, the left nostril is remained closed. The right nostril is shut after complete intake, and the air is ejected via the left nostril. After a complete exhalation, inhale via the left nostril again, then exhale through the right nostril after shutting the left nostril. As a result, only one nostril is employed in any inhaling or exhalation activity. Air is inhaled via the nostril by which it was previously expelled. "Alternative Nostril Breathing" is called from the usage of the alternate nostril. It is thought to be of tremendous relevance for our general health. It is predicated on the assumption that only one of our two nostrils is functional at any one moment. This breathing technique aids in the full cleaning of our nasal passages and their extension into our lungs. It treats mild upper respiratory infections and adequately oxygenates the blood. Its pace and rhythm may be simply changed by the individual. It gives you a sense of well-being and freshness right away. For maximum effect, Anulom Vilom should be practiced for at least 10 minutes per day. Before practice, it should be well learned. The pace of inspiration and exhalation is comparable and may be changed at will by the individual. Anulom Vilom is a kind of breathing that promotes serenity, relaxation, and activity [10].

Frog breathing (Glossopharyngeal breathing)

Air stacking and glottis holding are two lung volume recruitment procedures. The supply of air by Ambu bag is used in air stacking. Glossopharyngeal breathing is a kind of positive pressure breathing that may help weakening respiratory muscles and enhance tidal volumes. It entails inhaling boluses of air and forcing them into the lungs in a series of steps. A way of venting occluded lung segments is the three second breath hold. A three-second delay allows for Pendelluft flow, in which air flows from the unobstructed to the obstructed areas of the lung [9]. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7315835/

Head-down (Trendelenburg) and bending forward postures

Research involved seven adult patients ranging in age from 38 to 70 years old. Within 48 hours of having severe ARDS, prone positioning was initiated, and the bed was adjusted in Trendelenburg's stance within 3-6 hours after achieving prone position. Based on their lung mechanics, all patients were mechanically ventilated in a pressure-controlled mode with varying PEEP. To reduce spontaneous exertion and patient-ventilator dyssynchrony, patients were paralysed with Cisatracurium infusions. Tidal volumes were measured 15 minutes before and 60 minutes post Trendelenburg posture. The formula VT/(Pplat-PEEP) was used to determine respiratory system compliance, and the patient's ventilator conditions were not changed between measurements. To compare the results, a T-test was used. In this research, patients in the Trendelenburg position during prone position ventilation had a notable increase in tidal volume without higher pressure support, which might imply improved lung compliance and hence improved alveolar ventilation. These effects might be due to changes in pleural and transpulmonary pressure as a result of body posture [11].

Bronchial hygiene-airway clearance techniques huffing

To propel secretions, forced expiration movements like the huff cough might be employed. With an open glottis, a huff cough is done in which equal pressure point dynamic constriction of the air-

ways increases the linear velocity of expiratory airflow and pushes secretions. When a forced expiration is started with a low lung capacity, the identical pressure point is shifted to the periphery and tiny airways. A forced expiration with a big lung capacity will shift the equal pressure point to the big central airway [9].

Postural drainage, percussion, vibration

Patients should be advised to always maintain an upright head and neck posture throughout respiratory therapy and when practicable. If accessible, external vibration with oscillation frequencies below 17 Hz may be used to increase mucociliary clearance.

Positioning is efficient, straightforward, and simple to implement. Given the pathophysiology of COVID-19 and the reported V/Q mismatch, positioning may be preferable to alternative methods such as postural drainage. In non-critically sick patients, sitting as well as standing are the optimal postures for maximizing lung function, including FVC, increasing lung compliance and elastic recoil, shifting mediastinal structures, and providing mechanical advantage in forced expiration. Through gravity, targeted placement may improve ventilation, perfusion, oxygenation, and secretion mobilization in certain lung areas of consolidations. In all postures, perfusion is higher to the dependent lung regions. The amount of preferred ventilation varies depending on the position. Two minutes in each position while doing breathing exercises might be enough to ventilate and perfuse the targeted lung segments.

Anecdotal research in hospitals suggests that prone placement of COVID-19 patients during acute treatment is useful. We advocate spending time in all postures, including upright, side- lying, supine, and prone, if practicable, and when possible, guided by imaging results. The site of consolidations visible on imaging or discovered on inspection may help define targeted sites.

Ventilation occurs primarily in the mid plus lower lobes in the upright posture, with perfusion being highest in the lower lobes. In healthy persons, DLCO rises in the supine position, thus patients may rest in this posture on occasion to help with DLCO. The top lobes are likewise better ventilated in the supine posture.

By optimizing the length-tension ratio in the dependent hemidiaphragm and maintaining negative pleural pressure, the side-lying posture preferentially ventilates the dependent lung in adults. The side-lying posture preferentially ventilates the nondependent lung and closes the airway in the dependent areas in young children aged less than 12 years. With enhanced deposition of 13% to the reliant upper lobe, side-lying may be a beneficial posture for inhaled medication delivery prone positioning for 2 minutes may help with ventilation to the dorsal lung by reducing lung compression caused by the heart in the semi-prone posture due to ventral movement of the heart, increased end-expiratory transpulmonary pressure as well as expiratory reserve volume, more homogeneous lung inflation from dorsal to ventral, and better oxygenation. In the ICU, prone posture has been shown to increase gas exchange in patients with ARDS and improve Pa/FiO2 in people on mechanical ventilation, as well as lower cardiovascular comorbidities.

Patients may be urged to stretch three times a day as part of their daily routine. Stretching has been demonstrated to boost compliance by up to 50 milliliters. Neck, pectoralis major, upper chest, lateral chest stretches, as well as flexion and extension, should all be done to mobilize the facet joints. In individuals with ARDS, the dorsal chest wall has been demonstrated to be less compliant [9].

Positive expiratory pressure (PEP)

A valve in the PEP mask/mouthpiece increases the resistance to expiratory airflow. The person takes 12 to 15 breaths via the flow resistor in a row, causing mid-expiratory pressures which are positive in the airways of 10 - 20 cm H2O. The advantage of PEP therapy is that it can improve and promote mucus clearance through one or more mechanisms: stenting the airways to prevent small airway collapse; using collateral ventilation to improve lung recruitment distal to retained secretions; or temporarily boosting functional residual capacity. A FET may then be used to expel the secretions that have been mobilized [12].

Active cycle of breathing techniques (ACBT)

ACBTs help to cleanse the airways, preventing sputum retention and irritation. The forced expiration method (FET) plus chest expansion exercises are two ACBTs. One or two forceful expirations are accompanied by relaxed breathing in the FET. When compared to traditional physiotherapy, ACBTs were related with greater sputum clearance, vital capacity, as well as forced expiratory volume in a meta-analysis of 24 randomized controlled studies [12].

Effects of modalities and conservative management

EzPAP

The EzPAP is a positive expiratory pressure device that treats and prevents atelectasis by delivering a constant expiratory pressure via the mouth using airflow from a flowmeter. SpO2 did not vary between the two groups in a randomized controlled study of 210 postoperative patients randomly assigned to EzPAP or control, however the EzPAP group resumed oxygen treatment less often and had a lower rate of postoperative problems. The EzPAP increased pulmonary oxygenation in individuals at risk of hypoxemia.

Insufflation and exsufflation via mechanical means

Mechanical insufflation/exsufflation is a machine that simulates cough by promoting maximum lung inflate followed by a negative pressure. When a patient is unable to cough or coughs ineptly, this procedure is employed. It's especially effective when combined with aided coughing methods or thoraco-abdominal trust.

Induction of sputum

Despite the fact that sputum induction is not indicated due to the significant risk of aerosol production, critically sick patients (including those with COVID-19) typically have neuromuscular weakness and swallowing difficulty, necessitating its usage [1].

Discussions

COVID-19 is a new disease process that has not been completely characterized. Although there is still no evidence of the efficacy of chest physiotherapy in the specific setting of COVID-19, several established physiotherapy techniques can be safely applied in this subgroup of patients to reduce atelectasis and improve outcomes. All physiotherapy interventions should be carefully organized, and personnel must always wear appropriate personal protective equipment to minimize exposure. Further studies are warranted to confirm the efficacy of CPT techniques in this new critically ill population. Breathing techniques have been shown to help with symptom relief as well as improve respiration in patients. Yogic breathing has shown to have a direct impact over stress related mediators in the body which largely impact the cardiorespiratory system in the body.

Conclusion

It should be mentioned, however, that chest physiotherapy is a customized treatment depending on the patient's specific symptoms. As a result, when patients present with symptoms that could benefit from chest physiotherapy, it may be administered while they are closely monitored for any side consequences. Furthermore, steps such as the use of surgical masks, if available, should be considered to prevent cross-infection when giving chest physiotherapy to patients in the acute stage.

Acknowledgements

The authors gratefully acknowledge the Faculty of Physiotherapy (Dr. Maheen Shad), department of school of health sciences, UMT, Lahore.

Bibliography

1. Battaglini D., *et al*. "Chest physiotherapy: An important adjuvant in critically ill mechanically ventilated patients with COVID-19". *Respiratory Physiology and Neurobiology* 282 (2020): 103529.

2. Abdullahi A. "Safety and Efficacy of Chest Physiotherapy in Patients With COVID-19: A Critical Review". *Frontiers in Medicine (Lausanne)* (2020): 7.

3. Shakerian N., *et al*. "Potential prophylactic and therapeutic effects of respiratory physiotherapy for COVID-19". *Acta Biomedica* 92.1 (2021).

4. Thomas P., *et al*. "Physiotherapy management for COVID-19 in the acute hospital setting: clinical practice recommendations". *Journal of Physiotherapy* 66.2 (2020): 73-82.

5. Abdullahi AJFim. "Safety and efficacy of chest physiotherapy in patients with COVID-19: a critical review". *Frontiers in Medicine (Lausanne)* (2020): 454.

6. Antony Leo Asser P and Soundararajan KJW. "The vital role of physiotherapy during COVID-19: A systematic review". *Work* (2021): 1-7.

7. Andrade-Junior MCd., *et al*. "Skeletal muscle wasting and function impairment in intensive care patients with severe COVID-19". *Frontiers in Physiology* 12 (2021): 207.

8. Rain M., *et al*. "Can Yogic Breathing Techniques Like Simha Kriya and Isha Kriya Regulate COVID-19-Related Stress?" *Frontiers in Physiology* 12 (2021): 1297.

9. Wang TJ., *et al*. "PM and R and pulmonary rehabilitation for COVID-19". *American Journal of Physical Medicine and Rehabilitation* (2020).

10. Shukla M., *et al*. "Breathing exercises and pranayamas to decrease perceived exertion during breath-holding while locked-down due to COVID-19 online randomized study". *Complementary Therapies in Clinical Practice* 41 (2020): 101248.

11. Su M and DAOUD EJC. "EFFECT OF TRENDELENBURG POSITION DURING PRONE POSITION VENTILATION IN SEVEN PATIENTS WITH COVID-19". *Chest* 160.4 (2021): A2360.

12. McCormack P., *et al*. "Autogenic drainage for airway clearance in cystic fibrosis". *Cochrane Library: Cochrane Reviews* 10 (2017).