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Review Article

An Evidence-Based Approach To The Role Of Physiotherapy In ICU

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ABSTRACT

Critical care is the branch of medicine that deals with the treatment of patients whose ailments are life-threatening and necessitate round-the-clock attention and monitoring, usually in intensive care units [ICUs]. In the ICU or for critically ill patients, physiotherapy is regarded as an indispensable intervention that prevents and mitigates the negative consequences of prolonged bed rest and mechanical ventilation. It uses a wide range of therapeutic strategies to encourage early mobilization and discharge. Minimizing functional decline due to prolonged immobilization requires early progressive physiotherapy. Early mobilization strategies in adjunct to chest physiotherapy are deemed to be safe and feasible. In developing nations like India, physiotherapists are still primarily responsible for preventing and managing pulmonary problems in ventilated and other critically ill patients. The purpose of this review article is to accentuate the role of a physiotherapist in the care of ICU patients, as well as existing research evidence pertaining to the physiological consequences and effectiveness of various physiotherapy approaches that can be safely administered to the patients early on for a better and faster recovery.

KEY WORDS: Intensive care unit, Physiotherapy, Early mobilization strategies, Chest physiotherapy.

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INTRODUCTION

Within the realms of promotion, prevention, treatment/intervention, habilitation, and rehabilitation, physical therapy is concerned with finding and maximizing quality of life and movement potential [1]. When movement and function are impeded or impacted by aging, accident, disease, condition, or environmental factors, physical therapists are specifically trained health care specialists responsible for the prevention, detection, evaluation, treatment, and rehabilitation [2].

Intensive care, often known as critical care, is a multidisciplinary and interprofessional speciality dedicated to the comprehensive management of patients with acute, life-threatening organ dysfunction or those at risk of acquiring it. Intensive care employs a variety of technologies to support organ systems that are failing, including the lungs, cardiovascular system, and kidneys [3]. Considering the numerous challenges faced in ICU [4], it requires a team of committed individuals to achieve this desired objective and the physiotherapist has established their role in this team [5]. Several developed countries acknowledge physiotherapy to be an integral component in the management of critically ill patients admitted in these ICUs [6]. This can also be seen in the case of developing countries like India, a multicenter survey study [7] done on Indian ICUs revealed that 79% of them had on-call physiotherapy services. The role of physiotherapy in ICU and the different approaches used by the physiotherapist are determined by several aspects such as the nation in which the ICU is situated, local tradition, staffing level, and competence [6].

According to the Chartered Society of Physiotherapy [8] long-term physical and psychological consequences are common in critically ill patients. Patients who have been mechanically ventilated for more than 7 days have severe muscle weakness in 25% of cases, and roughly 90% of long-term ICU survivors have continuing muscle weakness [8]. Long hospitalizations in the intensive care unit are also linked to a lower quality of life, functional deterioration, and an increase in morbidity, mortality, healthcare costs, and hospital stay length [8]. Several studies claim that prolonged inactivity and bed rest due to critical illness leads to 'ICU-acquired muscle weakness' [9-11]. It is strongly linked with increased short- and long-term morbidity, physical impairments, and mortality [12]. Several other adverse effects of prolonged ICU stay may include:

· DVT

· Chest infections

· Muscular atrophy

· Impaired Cardiorespiratory functions

· Pressure ulcers

· Diaphragmatic weakness due to prolonged mechanical ventilation

· Neuropsychiatric complications

The indispensable role of a physiotherapist in ICU is to prevent these wide ranges of multisystem complications through the application of various therapeutic techniques like mobilization, PNF, airway clearance techniques, Positioning strategy, and bed mobility training to name a few. Growing evidence on early physiotherapy intervention indicates that not only it is safe and feasible [13,14] but also decreases the span of ICU stay and duration of mechanical ventilation, as well as improves the functional abilities of the patient [5].

Despite the innumerable benefits of physiotherapy in ICU, there are studies from developing nations like India [7] and Saudi Arabia [15] that show a dearth of available information about the role of Physiotherapists in intensive care units. Despite the emphasis on a multidisciplinary team, a lack of job definition has resulted in the subsumption of many expert physiotherapy services by other professional groups, primarily nursing personnel [7]. Lack of accurate information about the competencies of physiotherapists among other health care professionals can lead to underutilization of the skills and resources of this potential profession [16].

The goal of this review article is to highlight the importance of a physiotherapist in the care of ICU patients, as well as existing research evidence on the physiological consequences and effectiveness of various physiotherapy approaches that can be safely administered to patients early on to help them recover more quickly.

Respiratory Physiotherapy

Secretion Removal Techniques: Patients in critical care units, particularly those who are mechanically ventilated, are at risk of secretion retention. Therapists use a variety of strategies to prevent secretions from accumulating [5]. Postural drainage is commonly used, often regarded as a gold standard technique [17]. It is achieved by positioning a patient so that the bronchus of the affected lung segment is perpendicular to the ground. These positions help the mucociliary transport system remove excess secretions from the tracheobronchial tree by utilizing gravity [18]. To facilitate secretion clearance, chest wall manipulations such as percussion and vibration are frequently performed in gravity-assisted positions. The mechanical energy generated by chest wall manipulations is conveyed to the airways, causing secretions to relax and mobilize [5].

These loosened secretions can then be removed using the airway clearance technique. In stable, non-intubated patients with chronic pulmonary illness, the effectiveness of percussion in improving sputum clearance has been understudied [19]. However, patients who coughed out more than 20 g of sputum had better airway clearance [20]. An efficient method of removing secretion is combining postural drainage techniques with MHI and endotracheal suctioning [21,22]. Hyperinflation is used to prevent pulmonary atelectasis, to recruit collapsed alveoli, increase lung oxygenation, improve lung compliance, and mobilize airway secretions [22,23].

Manual Hyperinflation: Manual hyperinflation [MHI] is a technique that involves using a resuscitator bag to administer a slow deep intake, an inspiratory hold of 2-3 seconds, and a rapid expiration [quick release of the bag] to improve expiratory flow [22,23]. During MHI, the patient is taken off of mechanical ventilation for a short time and given a high tidal volume via a manual resuscitation bag. With no differences in gas exchange or hemodynamic characteristics, manual hyperinflation was linked to enhanced lung compliance and higher sputum retrieval [24]. In patients with acute lung injury following extrapulmonary events, Paratz et al found that MH enhanced gas exchange and respiratory mechanics [25]. Choi and Jones found that MH with suction increased lung compliance in mechanically ventilated patients with diagnosed VAP immediately after therapy and 30 minutes later [26]. A study published in the year 2012 indicates that using MH in combination with Expiratory rib cage compression for 5 days speeds up weaning and ICU release [27].

Other techniques like the active cycle of breathing technique [ACBT] utilize 3 stages - a breathing control phase, a thoracic expansion phase, and a forced expiratory technique respectively. Both spontaneously breathing and intubated patients who are cognizant and understand and obey instructions can benefit from ACBT. It is a versatile approach in which the repetition and order of each component can be adjusted to meet the demands of each patient [22,28]. Another airway clearance procedure is PEP, in which the individual is asked to exhale against their will. The positive pressure created during expiration splints the airway and recruits airway collaterals, preventing it from collapsing. The secretions from the periphery to the central airways are mobilized in this fashion [5].

Incentive Spirometry: To urge patients to breathe deeply, incentive spirometry works on providing visual feedback [28–30]. Incentive Spirometry is employed with patients who are willing to cooperate and follow directions. It is advised for spontaneously breathing patients who have developed atelectasis, weak inspiratory muscle power, and low oxygenation, as well as those who are at risk of acquiring the aforementioned issues [22,28,30].

Breathing Exercises: Breathing exercises are an indispensable part of patient recovery. A recent study shows that diaphragmatic breathing, ACBT, and other ACT helped reduce the dependence of COVID-19 patients on oxygen support [31]. The patient is taught a diaphragmatic breathing pattern in which one hand is placed on the upper belly to facilitate breathing with the lower chest while relaxing the upper lung segments and shoulders [22,30]. Recent research reveals that diaphragmatic breathing can reduce stress levels as indicated by physiologic biomarkers and psychological self-report measures [32]. Another crucial breathing pattern that needs emphasis is Glossopharyngeal breathing. It's a type of positive pressure breathing technique that can help those whose respiratory muscles are deteriorating. In individuals who are entirely ventilator-dependent, glossopharyngeal breathing can maintain ventilation for several hours. It can also be utilized to increase the effectiveness of voice and cough [33].

Inspiratory Muscle Training: According to laboratory research, the overuse of controlled mechanical ventilation in the ICU can result in the development of selective and fast diaphragmatic atrophy [19,34,35]. One of the most important drivers of weaning failure is respiratory muscle weakness, specifically an imbalance between muscular strength and the burden placed on the respiratory system [19]. In order to increase the strength and function of the respiratory muscles, IMT includes inspiration against resistance or pre-targeted pressure thresholds [22,23,28,36]. The number of studies examining the effects of inspiratory muscle training on weaning from mechanical ventilation in the ICU has increased dramatically [37]. A 2015 systematic review [37] included 10 studies involving 394 participants found that select patients in the intensive care unit can benefit from inspiratory muscle training, which can shorten their stay and reduce the amount of time they need noninvasive ventilatory assistance after extubation. Several other studies established a similar conclusion that, IMT increases both inspiratory and expiratory muscle strength in critically sick patients and is safe [38].

Intubated elderly patients benefit from inspiratory muscle training, which increases maximum inspiratory pressure and the index of Tobin, as well as reducing weaning time in some cases [39].

Mechanical insufflation/exsufflation: It's a device that simulates coughing by inflating the lungs to their maximum capacity and then reducing the pressure. When a patient is unable or ineffectively coughing, this approach is used [40]. When combined with assisted cough techniques or thoracoabdominal trust, it is very effective [41].

Body Positioning: One of the most effective therapies for respiratory dysfunction is positioning, which is essentially dictated by gravity's influence [5]. The physiological consequences of body positioning include improving oxygen transfer and hence oxygenation through enhanced Ventilation-Perfusion [V/Q] matching, increasing lung capacity, lowering the labor of breathing, limiting the work of the heart, and improving mucociliary clearance [5,23,28,42]. Patient positioning aids in the prevention of skin breakdown, mobilization of secretions, improved lung aeration, and comfort [43]. The upper region of the pleural space is more negative in the upright posture [5]. Because of the downward acting weight of the lung, pleural pressure is higher in the dependent basilar lung areas. Low volume inhalation is easier than large volume inhalation because the lung is more compliant [5]. On inspiration, the increasing pressure at the base of the lung is minimal, and it has a tiny resting volume. The lung's apex has a high expanding pressure, a larger resting volume, and a minimal volume change during breathing [5]. To reduce the amount of labor required to breathe and to increase lung capacity, it is preferable to be in an upright position. The incidence of nosocomial pneumonia is significantly reduced when critically sick patients are rotated more than 40 degrees [5]. Intubated patients with severe ARDS owing to COVID-19 should be managed with prone ventilation for 12–16 hours per day, according to the WHO [44]. In non-intubated patients with moderate to severe ARDS with Sto2 >95 percent, Ding et al [45] found that early administration of prone positioning paired with noninvasive ventilation or high-flow nasal cannula may minimize the need for intubation. Prone positioning enhanced oxygenation in awake ICU patients with COVID-19 and moderate to severe ARDS, according to Taboada et al [46]. Side-lying with the damaged lung on top improves lung capacity in the topmost lung, which aids in atelectasis resolution [23,29,47]. Drainage from the broncho-pulmonary segments is also easier from this posture [23,29]. Because gravity guides circulation to the bottom lung, keeping the non-affected lung at the bottom has the extra benefit of improving the oxygenation [30,48].

Other breathing treatments, such as Manual Hyperinflation or ventilator hyperinflation, can be used in the side-lying position with the damaged lung uppermost [22]. Therapeutic body positioning must be chosen based on daily evaluation findings and clinical reasons [5].

Early Mobilization: Stiller's [49] definition of mobilization is used for this review, which states that mobilization is a broad term that includes active limb exercises, actively moving or turning in bed, sitting on the edge of the bed, sitting out of bed in a chair [via mechanical lifting machines, slide board, or standing transfer], standing, and walking. Over the last several years, the clinical and scientific literature has paid a lot of attention to the early mobility of patients in the intensive care unit [ICU] [50–54].

Numerous investigations [50,51,54] have found that immobilization causes neuromuscular weakness, muscle atrophies, pressure sores, atelectasis, and pneumonia, as well as orthostatic dysregulation and disrupted micro vascularization on a musculoskeletal, pulmonary, cardiovascular, and endocrine/metabolic level. Skeletal muscle strength may decline by up to 20% after a week of immobility, before increasing with time [5]. Almost all ARDS survivors showed impaired physical function, exercise tolerance, and quality of life in a study conducted by Herridge et al [55]. Immobilization alters venous compliance, increasing the risk of deep venous thrombosis and thromboembolism[56]. Immobilization in critical care units has been shown to lower arousal levels due to changed cerebral electrical activity. The breathing pattern will be affected by altered central nervous system activity, which may have an extra effect on pulmonary function[5].

A review article by Cameron et al.[57] states that early mobilization can be started safely on the first day of ICU admission, even with vasopressors, CRRT, or femoral catheters in place. Schaller et al.[58] conducted a randomized controlled experiment in the surgical intensive care unit to determine the effectiveness of early goal-directed mobilization. They found it to be beneficial since it enhanced patient mobility at discharge and reduced the length of stay in the ICU. When compared to patients who did not receive therapy, Santos et al.[59] found that early mobilization following heart surgery reduced postoperative complications, lowered hospital stay, and improved functional ability. Early mobilization is regarded as an important part of care in neurological disorders like acute stroke, since it leads to better results[60]. Klein et al.[61] conducted comparative research in the neurological ICU to investigate the impact of early mobilization on increasing mobility and clinical outcomes, and discovered that patients' greatest degree of mobility increased without creating serious problems. Alamri et al.[62] did research to see how successful an early mobility regimen for stroke patients in the ICU was. The patients were separated into three groups: unstable and on the ventilator, cooperative and on the ventilator, and cooperative and on the ventilator but being weaned off the ventilator. They were given different treatments. Early mobility treatments improved muscular strength and overall quality of life. Early mobilization was shown to be more helpful than delayed mobilization in participants with moderate to severe acute ischemic stroke, according to Diserens et al.[63], who found an apparent reduction in severe medical consequences with early mobilization. The technique was shown to be safe based on transcranial Doppler and neurological evaluations. Furthermore, Indredavik et al.[64,65] were able to show that early mobilisation in stroke units results in a lower death rate, a shorter hospital stay, and a more frequent return to the home setting. Early mobilization enhances a patient's capacity to walk, according to many studies[66,67]. Early mobilization and positioning also aid in preventing pressure ulcers thus maintaining the skin integrity[18].

Cycling: A study done by Machado et al.[68] investigated the impact of passive cycling combined with traditional physical therapy on peripheral muscle strength, the number of days on a mechanical ventilator, and the length of hospital stay in ICU patients. Early mobilization with passive cycling enhanced peripheral muscular strength in mechanically ventilated patients without affecting the number of days on the ventilator or the duration of stay in the hospital. An RCT to assess the benefits of early mobilization utilizing a bedside cycle ergometer in addition to regular physical therapy was conducted by Santos et al.[69] In critically sick patients undergoing invasive mechanical ventilation, the thickness and architecture of the quadriceps were measured. There was no discernible difference in these results. According to one study[70], during inpatient rehabilitation of intensive care acquired weakness, cycle ergometry, and resistance training improved the efficacy of conventional treatment by improving lower limb muscular strength, walking capacity, and cardiorespiratory fitness. Furthermore, ergometer training may be more effective than resistance training.

Neuro-musculoskeletal Electrical stimulation: Applying EMS around the muscle fibers and at the neuromuscular junction generates contractions that prevent muscle atrophy, improve blood circulation, and alleviate the effects of long periods of immobility without overloading the cardiovascular system, making it a viable alternative for reversing muscle weakness and deconditioning[71]. By improving muscular strength and reducing MV duration, length of stay in the ICU, and total length of stay in the hospital, early deployment of the NMES intervention in ICU patients can avoid ICU-AW and enhance their quality of life[72]. In critically ill patients, Maffiuletti et al.[73] found that NMES combined with standard therapy was more effective than standard care alone in avoiding skeletal-muscle weakening. Falavigna et al.[74] conducted an RCT in critically sick mechanically ventilated patients to investigate the effects of early EMS on ankle joint range of motion and thigh and leg circumference. It was discovered that EMS was efficient in maintaining the amplitude of ankle joint movement [active ankle dorsiflexion], enhancing mobility and function, but not in increasing the strength or cross-sectional area of the muscle stimulated. This might be owing to the stimulation's modest intensity and duration. Fischer et al.[75] investigated the effect of neuromuscular stimulation on muscle layer thickness and functional outcomes in patients who had undergone cardiothoracic surgery and found that it did not affect muscle layer thickness or functional outcomes, but it did contribute to a faster recovery of muscle strength during the ICU stay. Furthermore, according to a review by Baron et al.[76], neuromuscular stimulation in the critical care unit has beneficial effects and is safe to employ.

Virtual Reality/Computer Game based therapy: VR may now be used in critical care units [ICUs] to supplement traditional pain treatment strategies thanks to technological advancements[77]. Video games provide valuable motor learning and training possibilities for the cardiovascular, musculoskeletal, and balance systems. Patients receive immediate visual and audible feedback on their performance, which may aid in technique improvement and give a customized baseline for comparing therapy responses over time[78]. In a study on the usefulness of video games as an extra tool in physical therapy ICU patients, Kho et al.[79] found that virtual reality approaches for balance and endurance training are not only promising but are safe and feasible too. VR has been proved to be a noninvasive and safe therapy for reducing postsurgical stress in ICUs. Patients can engage with the VE[Virtual Environment] on a variety of levels, employing different senses, and are encouraged to get involved in the VE they are experiencing. In this approach, VR can be used to replicate and/or enhance the distractive features of pain therapy. VR in ICUs has a huge social influence on critically ill patients by functioning as an extra support mechanism to prevent and alleviate post-surgical stress[77]. The experimental group reported considerably greater subjective sleep quality than the control group in a randomized control study[80] investigating the effect of VR-mediated sleep quality. In the experimental group, waking time was shorter, deep sleep duration was longer, and sleep efficiency was much higher than in the control group. Tennis and other Nintendo Wii fit exercises help with upper-limb motions and can be done in bed or standing, depending on the patient's capabilities. These activities also help to improve cognitive function[79].

Improving ROM: Joint contractures are a typical side effect in people who have been immobilized for a long time. These contractures are pathologic alterations in the joints that decrease joint flexibility and mobility, resulting in functional disability and increased energy consumption[81,82].

In patients who are unable to move freely, passive ROM or stretching exercises are an essential therapy strategy for maintaining ROM and soft tissue length. It is feasible to better avoid contracture and retain the architecture of muscle fibres by utilizing a continuous passive motion device[83, 84]. Patients with severe burns, trauma or central nerve injury are especially vulnerable to soft tissue contracture, therefore an extra orthosis, such as an ankle-foot orthosis, can help prevent joint contracture and lower muscle tone[85, 84]. However contradicting results were found in a recent study where stretching for less than seven months had no clinically significant impact on joint mobility in adults with or without neurological problems, according to Harvey et. al [86]. In addition, secondary endpoints such as discomfort, spasticity, activity limits, and participation have little or no influence on stretching [86, 87].

In neurological post-acute rehabilitation, serial casting is commonly used to alleviate spastic hypertonia and enhance range of motion. Typically, serial casts are used, which must be replaced every 4 to 7 days, with the primary objective of increasing joint motion. Serial casting can help enhance passive joint motion. [87]. Following up with splints is often necessary, as demonstrated in a work by Moseley et al.[88] serial casting results revealed an average improvement of 22 degrees in elbow mobility. This range of motion, however, had already diminished by 11 degrees the next day and had totally vanished after 4 weeks. According to Khan et al.[89] if prolonged passive stretch fails to provide the desired effects, dynamic splinting or serial casting may be utilized.

Out of bed exercises: These are more functional tasks, such as sitting over the edge of the bed and doing active exercises there, transferring to a chair, sitting in the chair, cycling with an arm or leg ergometer in sitting, standing, marching in place, or walking away from the bed[90].

Dangling/ high sitting is done in aware patients who have recently experienced pulmonary, cardiac, or neuromuscular [stroke] disease that has caused their breathing to be compromised. High sitting provides higher basal ventilation, improved trunk support, reduced cardiac overload, as well as improving stability and balance, and promotes sitting ADL tasks, according to evidence[91]. According to Alamri et al.[62] maintaining appropriate fluid distribution and improving orthostatic tolerance are both aided by upright positioning. A vital element of critical care is getting the patient out of bed and moving about. Dammeyer et al. [43] recommended patients to walk three times per day, but they were unable to discover any empirical data to determine when and for how long ambulation or dangling should be performed for critically sick patients.

Tilt Table: When patients are unable to stand or move safely even with significant help, standing with the assistance of a tilt table is indicated to reintroduce them to the vertical posture[92]. In 2015 prospective cohort research[93], thirty minutes of daily tilt-table standing was found to be safe and to enhance levels of awareness and maximal inspiratory pressures in a sample of 23 patients. The Sara Combilizer is a tilt table and chair that can be adjusted totally horizontal to enable for transfer through a sliding board while still allowing for standing positions[71]. McWilliams et al.[94] evaluated the Sara Combilizer's efficiency in allowing safe and early mobility of critically sick patients and discovered a decrease in mobilization time. It might be a useful supplement to early mobilization methods.

CONCLUSION

Physiotherapy is regarded as a vital intervention for ICU patients. It prevents and mitigates the negative consequences of prolonged bed rest and mechanical ventilation. Evidence supports that early physiotherapy intervention leads to a faster recovery and discharge. The evidence for routine multimodality respiratory physiotherapy for adult intubated patients on mechanical ventilation is positive. Despite the fact that early mobilization in conjunction with chest physiotherapy has been shown to reduce muscle atrophy, mechanical ventilation time, length of hospital stay, and increase functional ability, it is not widely used in many countries. More high-quality research is needed, according to the majority of systematic reviews. Electrical muscle stimulation, cycling, and the Sara Combilizer are newer approaches that have been proved to be safe and effective. In the ICU, video game-based rehabilitation has shown to be effective in increasing patient motor learning and functionality while also reducing post-surgical pain and stress. To corroborate the effectiveness of the present investigations in ICU setup, more randomized controlled trials are needed particularly from the standpoint of developing nations.

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ABBREVIATIONS

ICU – intensive care unit
DVT – deep vein thrombosis
PNF – proprioceptive neuromuscular facilitation
MH – manual hyperinflation
VAP – ventilator – assisted Pneumonia
PEP – positive expiratory pressure
ACBT – active cycle of breathing technique
ACT – airway clearance technique
ARDS – acute respiratory distress syndrome
IMT – inspiratory muscle training
ROM – range of motion
VR – virtual reality
ADL – Activities of daily living
RCT – randomize control trial

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