Exploring the Use of Inspiratory Muscle Training in ICU Management of Mechanically Ventilated Patients: A Cross Sectional Survey

Shahzeb Muneer[1], Mir Arif Hussain[1], Arfa Shaikh[2], Nabiha Arain[1], Farah Naz[3], Hussain Ali[3]

[1]Begum Nusrat Bhutto Women University, Sukkur
[2]Ziauddin College of Physical Therapy, Faculty of Allied Health Sciences, Ziauddin University,
[3]Indus Hospital & Health Network

ABSTRACT

Background: Mechanical ventilation is a life-saving intervention employed in critically ill patients who are unable to maintain sufficient oxygenation and ventilation by themselves. Inspiratory muscle training (IMT) is an intervention that targets strengthening the respiratory muscles assisting in weaning from mechanical ventilation. The current study intends to investigate the practice of IMT by physiotherapists practicing in ICUs in Karachi, Pakistan.

Methods: It was a cross-sectional survey conducted from March 2024 to October 2024 among physiotherapists working in ICUs of tertiary care hospitals including Dr. Ziauddin Hospital (North and Clifton Campus), Agha Khan Hospital, Liaquat National Hospital and Indus Hospital with at least one-year experience in Karachi. The research involved a hybrid approach, in which the data was collected both in-person and online using self-designed questionnaire. The data collected through the questionnaire was entered into the Statistical Package for the Social Sciences (SPSS) version 23.0. The Chi-square test was used to determine the relationship between the usage of IMT and the type of ICU. A p-value of less than 0.05 was considered statistically significant.

Results: Out of the 100 physiotherapists approached, 95 therapists took part in the survey, resulting in a 95% response rate. The majority of respondents (70.5%) reported not using IMT. The use of IMT was found to be significantly associated with therapists who had more ICU experience (p=0.00).

Conclusion: The study findings highlights the low utilization of IMT by physiotherapists in Karachi's ICUs and the need for more education and training in this area.

Keywords: Intensive Care Unit, Inspiratory Muscle Training, Mechanical Ventilation, Physical Therapy.

INTRODUCTION

Mechanical ventilation is a therapeutic intervention applied to critically ill patients who are incapable of providing adequate oxygenation and ventilation independently. If mechanical ventilation is used for an extended length of time, it can weaken the respiratory muscles, which can lead to poor weaning off of it and increased morbidity and mortality[1]. Weaning off of artificial ventilation can be made easier by using inspiratory muscle training (IMT), a technique that strengthens and increases the endurance of the inspiratory muscles[2].

A targeted approach to strengthen respiratory muscles represents a valuable strategy for healthcare professionals treating patients dependent on mechanical ventilation[3]. This specialized training demands collaboration across disciplines, requiring doctors, nurses, and physical therapists to coordinate efforts reducing sedation and enhancing alertness so patients can actively participate in breathing exercises within comprehensive ventilator-withdrawal protocols. These exercises can be delivered through adjustable mechanical spring-based or electronic devices that create resistance during inhalation.

Research shows inspiratory muscle weakness affects a significant majority of ventilator-

dependent patients in critical care settings[4-5]. A cross-sectional examination of 76 patients ventilated for at least 24 hours revealed that inspiratory muscle weakness occurred almost twice as frequently as limb muscle weakness (63% versus 34%, with 21% experiencing both conditions). This weakness emerges early within 18 hours after ventilation begins and likely stems directly from mechanical ventilation itself[6].
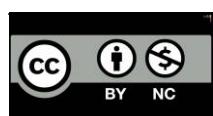
Evidence indicates that respiratory muscle strengthening improves breathing capacity, enhances life quality, and potentially improves ventilator withdrawal outcomes. A comprehensive analysis from 2015 found this training increased maximum breathing pressure and improved successful ventilator withdrawal rates, potentially shortening intensive care stays[7]. A subsequent 2018 review confirmed improvements in respiratory muscle strength and suggested possible reductions in ventilator withdrawal time by approximately 3.2 days[8]. This training approach has proven both safe and feasible for ventilated patients. Recommendations suggest physical therapists should implement strength-focused protocols using devices that provide accurately adjustable resistance. Therapists can measure baseline breathing strength to identify suitable candidates for this intervention and determine appropriate starting resistance levels. However, the optimal measurement technique in critical care environments remains undefined a factor potentially important for precise prescription.

Despite growing evidence supporting improved outcomes, specialized respiratory muscle training appears underutilized in clinical practice. A 2015 French survey revealed only 5% of critical care physical therapists employed evidence-based training methods, while just 16% routinely assessed respiratory muscle strength. Since then, multiple new randomized trials, systematic reviews, and clinical guidelines have emerged supporting this approach for ventilated patients[9]. Furthermore, therapists sometimes finds difficulty in implementing IMT for patients. As reported in a study conducted in 2024 on potential, barriers, and facilitators for implementing IMT as treatment modality for mechanically ventilated patients. On a total of 35 ICU patients, Assessment procedures were completed in nearly 95% of study participants, with diminished inspiratory muscle function identified in approximately 79% of cases.

The rehabilitation program demonstrated strong initial engagement, with 96% of eligible patients beginning their training regimen while still in intensive care. Continuity of care remained strong, with 88.5% maintaining their training protocol after transitioning to regular hospital units. Among patients diagnosed with compromised respiratory muscles, almost three-quarters (73.1%) completed the scheduled follow-up evaluations. Of the twelve therapists interviewed, 41.7% had regular ICU employment. Three themes surfaced when investigating the causes of protocol deviation: professional barriers, external factors, and patient barriers[10]. The current study intends to investigate the practice of IMT by physiotherapists practicing in ICUs in Karachi, Pakistan.

METHODOLOGY

Study Design and Setting
It was a cross-sectional survey conducted among physiotherapists working in ICUs of tertiary care hospitals in Karachi from March 2024 to October 2024.

Participants
The target population for this study were physiotherapists with at least one year of experience in working in ICUs. Non-probability purposive sampling was used to select participants who were asked to participate in the study.

The exclusion criteria were physiotherapists who were on extended leaves (e.g., maternity leave, sabbatical) at the time of study conducted, respondents who have never heard of or used IMT in their clinical practice, and participants affiliated with pediatric ICUs only.

Sample Size
The data was collected from two tertiary care hospitals that were Dr. Ziauddin Hospital (North and Clifton Campus), Agha Khan Hospital, Liaquat National Hospital and Indus Hospital with more than 120 physical therapists working in intensive care units. Based on the selection criteria a sample of 100 was estimated.

Data Collection
The research involved a hybrid approach, in which the data was collected both in-person and online. For the online approach, a google form was designed that include the questionnaire for

assessing the attitude and practices regarding IMMT on mechanically ventilated patients in ICUs along with the consent form. Participants filled out this form, and their responses were recorded automatically. After data collection, the responses were entered into SPSS for analysis.

For physical data collection, participants working in Dr. Ziauddin Hospital (North and Clifton Campus), and Indus Hospital were approached. The visits were arranged at times which were convenient for both the researcher and the participants. A brief overview of the study to the participants along with its benefits and risks were provided. Participants were provided with an informed consent form which includes voluntary participation, confidentiality and the right to withdraw at any point. A structured questionnaire was distributed to participants. All the forms were securely stored after completion to maintain confidentiality. The data of that form was transferred later to a digital format for analysis.

Data Collection Tool
For the purpose of this study, a structured questionnaire was created to gather detailed information regarding the awareness, perception, and use of Inspiratory Muscle Training as a component in the care of ventilated patients in the ICU. The questionnaire was crafted in English and given both in digital and hard copy formats, based on the availability and preferences of the participants. The questionnaire was first sketched based on an audit of literature, clinical guidelines, as well as other studies done in critical care and respiratory therapy disciplines. The reliability and validity of the tool are crucial and were established through pilot testing. Fifteen physiotherapists completing the inclusion criteria were provided with the questionnaire. The validity was tested using Cronbach's Alpha showing 0.823 value indicating strong internal validity of the questionnaire

Data Analysis
The data collected through the questionnaire was entered into the Statistical Package for the Social Sciences (SPSS) version 23.0. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to describe the demographic characteristics of the participants and the usage of IMT. The Chi-square test was used to determine the relationship between the usage of IMT and the type of ICU, the number of years of ICU experience, and the age of the physiotherapists. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations
The Institutional Review Board (IRB) approved this study before it was conducted. The participants were provided with a consent form, and they were informed about the study's purpose, benefits, and potential risks. The participants were also assured of the confidentiality of their responses, and their participation was voluntary. No cash reward was provided in exchange for their participation in the study.

RESULTS

Demographic Characteristics
Out of the 100 physiotherapists initially approached, three were found to be ineligible and two refused to participate, resulting in a 95% response rate from the remaining 95 therapists who took part in the survey

The majority of respondents (70.5%) reported not using IMT, and the reasons for not using it were varied, as illustrated in Figure 02. The use of IMT was found to be significantly associated with therapists who had more ICU experience (p=0.00), as shown in Table-1.

Interestingly, therapists with less than one year of experience were found to use IMT more often (17%), while those with over 10 years of experience used it less frequently (2%). IMT was also found to be significantly associated with the type of ICU in which the therapist worked, with medical ICU (p=0.04), surgical ICU (p=0.005), and neurological ICU (p=0.005) all having a significant association with IMT use.

The techniques used for IMT varied among the respondents, with controlled diaphragmatic breathing (77.9%) and deep breathing techniques (94.7%) being the most commonly used, as depicted in Figure 01. Incentive spirometry (47.4%) was also commonly used, while the threshold device (1.1%), fixed resistance (4.2%), isocapnic hyperpnea (5.3%), and adjusting inspiratory trigger (4.2%) were used less frequently.

Characteristics		Do you use inspiratory muscle training in invasively ventilated patients?				p-value
		Yes		No		
		n	%	n	%	
How old are you?	21-30 yrs	20	71.4	34	50.7	0.062
	31-40 yrs	08	8.6	24	35.8	
	41-50 yrs	00	0.0	09	13.4	
How many years of experience do you have in ICU?	Less than 1 yr.	17	60.7	08	11.9	0.000*
	1-5 yrs	07	25.0	41	61.2	
	6-10 yrs	02	7.1	10	14.9	
	More than 10 yrs	02	7.1	08	11.9	
Do you practice in Medical ICU?	Yes	16	57.1	52	77.6	0.044*
	No	12	42.9	15	22.4	
Do you practice in Surgical ICU?	Yes	13	46.4	51	22.4	0.005*
	No	15	53.6	16	23.9	
Do you practice in Neurological ICU?	Yes	11	39.3	9	13.4	0.005*
	No	17	60.7	58	86.6	

**p<0.05 was considered significant using Pearson Chi Square test*
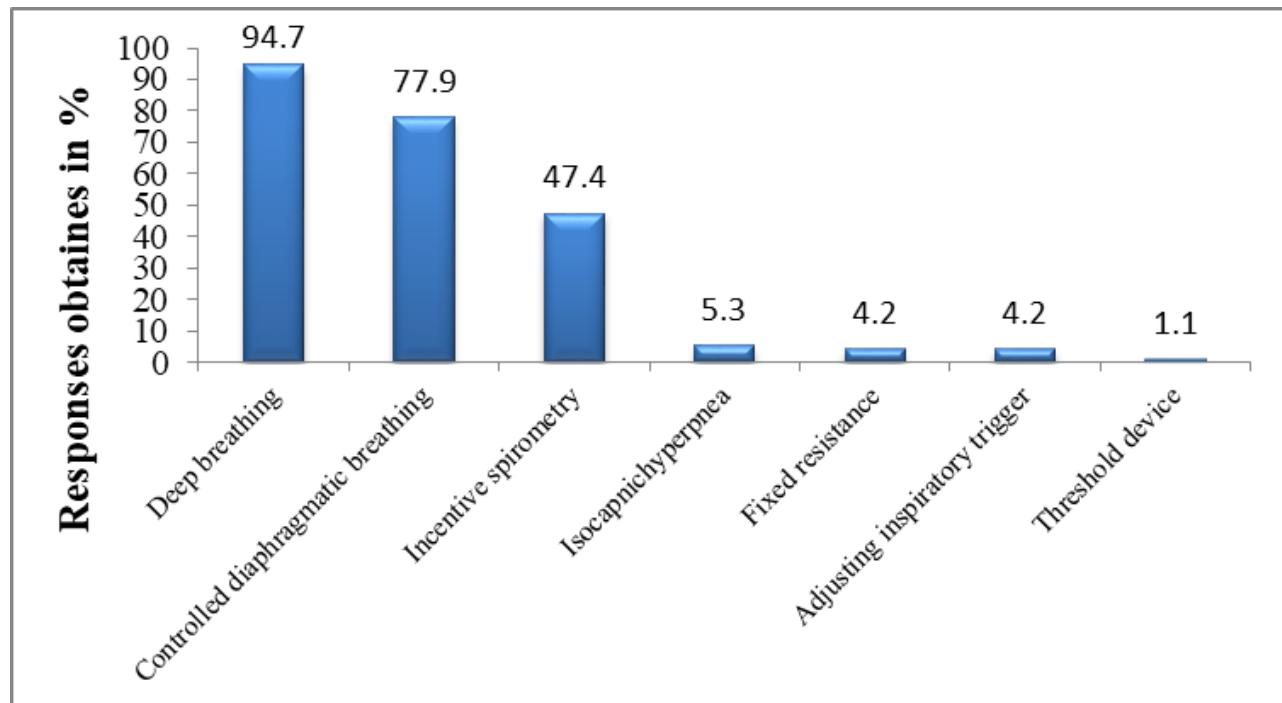
Figure-1 Inspiratory muscles training techniques

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Incentive spirometry (47.4%) was also commonly used, while the threshold device (1.1%), fixed resistance (4.2%), isocapnic hyperpnea (5.3%), and adjusting inspiratory trigger (4.2%) were used less frequently. The utilization of IMT was found to be low (29.5%), and only 21.1% of respondents evaluated MIP. Age did not appear to have a significant impact on the use of IMT. A small proportion of respondents (13.7%) used an electronic manometer to measure MIP, while 11.6% utilized negative inspiratory forced.

The duration of inspiratory occlusion was also found to vary depending on whether the patient was sedated or not. Only 14.7% of respondents kept the inspiratory occlusion open for less than 20 seconds when measuring MIP in sedated patients, while 12.6% kept it open for longer than 20 seconds when measuring MIP in non-sedated patients.

Table-2 Percentage of usage of IMT on different ICUs patients

Intubated and non-sedated patients	16.8%
Intubated and sedated patients	13.7%
Tracheotomized and sedated patients	10.5%
Tracheotomized and non-sedated patients	15.8%

Further it was also identified that use IMT is highest in Intubated and non-sedated patients which is 16.8% and lowest in tracheotomizes and sedated patients which is 10.5% and 13.7% in intubated and sedated patients (Table-2).

The data further revealed that most of the therapists of Karachi do not use inspiratory muscle training because of unawareness of its benefits, and others 63.2% are unaware of how to apply this technique on ventilated patients and 15.8% therapists don't use inspiratory muscle training due to lack of equipment and less literature, others 3.2% does not use cause of lack in human resources (Figure 2).

DISCUSSION

The purpose of this study was to evaluate the utilization of IMT in the treatment of mechanically ventilated patients in Karachi's ICUs. The study found that the use of IMT among physiotherapists in Karachi was low, with only 29.5% of respondents reporting that they used this technique in their practice. This result is consistent with the findings of previous studies that have highlighted the underutilization of IMT by healthcare professionals[11-12]. One of the reasons given by physiotherapists for not using IMT was that they were not familiar with the technique, which highlights the need for more training and education in this area[12].
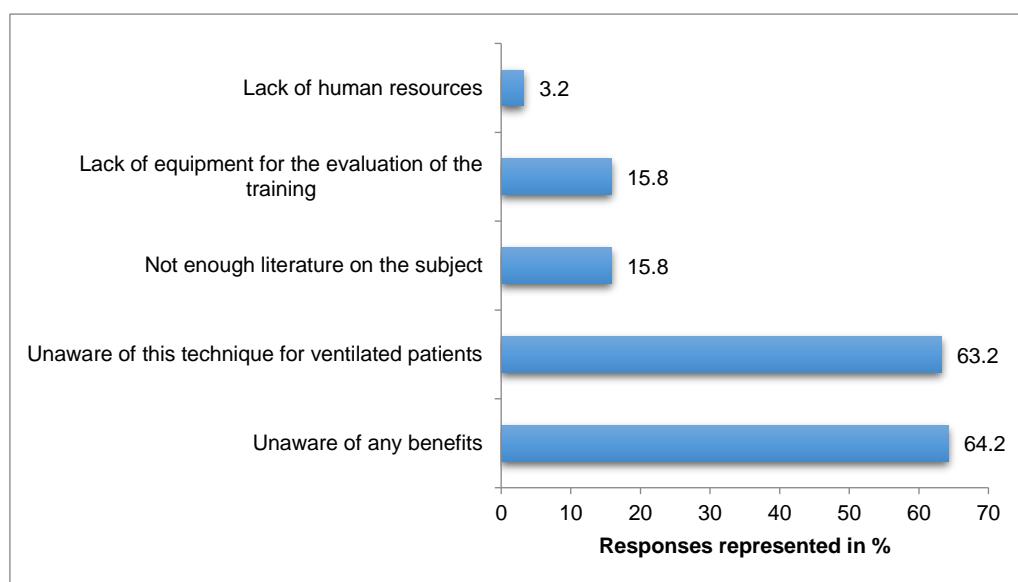

Figure-2 Reasons for NOT use inspiratory muscle training

Interestingly, our study found that therapists who had less than one year of ICU experience were more likely to use IMT than those who had more than ten years of experience. This suggests that newer therapists may be more open to using new techniques and approaches in their practice. Findings were in contradictory to the findings of other studies in which less experiences physical therapist mainly of less than 1.5 to 2 years were more reluctant to use IMT in comparison to experience therapist[13-14].

Another interesting finding was that the use of IMT varied depending on the type of ICU the therapist was working in. Therapists working in surgical, neurological, and medical ICUs were significantly more likely to use IMT in their practice. This variation may be due to the different patient populations in each type of ICU and the associated respiratory complications that arise[15-17]. The study also found that the most commonly used techniques for IMT were controlled diaphragmatic breathing and deep breathing, followed by incentive spirometry. This is consistent with the findings of previous studies that have shown these techniques to be effective in improving inspiratory muscle strength and endurance[18-20]. It is concerning that only 21.1% of respondents reported evaluating Maximum Inspiratory Pressure (MIP), which is an important indicator of respiratory muscle strength. This suggests that there may be a lack of awareness or understanding of the importance of MIP measurement among physiotherapists in Karachi. The research has few limitations. First, the study design was cross-sectional, i.e., it gives a snapshot at a specific point in time and cannot determine causality. Second, the study was conducted in Karachi city alone, and therefore the results may not be applicable to other cities or parts of the country. Thirdly, the study was based on self-reported information, which could be subject to social desirability bias, and therefore lead to under or overestimation of the use of IMT.

Future Recommendations

Future studies ought to look into addressing the study's limitations. First, longitudinal studies should be carried out to determine causality and changes in the application of IMT over time. Second, qualitative studies should also be undertaken to identify patients' views and experience of IMT. Finally, educational and training courses should be created to make physiotherapists and other ICU practitioners more aware of and knowledgeable about IMT.

CONCLUSION

Our research underscores the low usage of IMT among physiotherapists in Karachi ICUs and the necessity for greater education and training in this regard. Further research is also needed to determine the factors that are possibly leading to the underuse of IMT and to discover the possible advantages of this technique in the management of mechanically ventilated patients.

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