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THE PHYSIOTHERAPIST'S ROLE IN INTENSIVE CARE PEDIATRICS, A REVIEW OF THE EVIDENCE SUPPORTING MECHANICALLY VENTILATED PATIENTS RESPIRATORY AND REHABILITATION INTERVENTIONS

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ABSTRACT

Background: *In the Pediatric ICUs, many of the children are ventilated and this creates issues such as breathing difficulties and excessive stays on the immobile bed. Physiotherapists contribute a lot to the treatment of such patients and not much concrete evidence supports their actions.*

Objective: *I needed to know what physiotherapists actually do with kids on ventilators in the PICU and particularly with regard to breathing and rehabilitation.*

Methods: *I was using PubMed, Google Scholar, Scopus, PEDro database. The search keywords were such terms as intensive care, pediatrics, physical therapy specialty, physical therapists, ventilators and mechanical. Papers in English were only retained that discussed kids on invasive ventilators within the PICU that received PT. I excluded articles on adults or neonates or non-invasive ventilation. Following a three-step filtering, five articles remained to undergo last review.*

Findings: *The articles indicated that such treatments as chest physiotherapy (CPT), manual hyperinflation (MHI), vibrations, saline swaps, and tube cleaning (ETT suction) were prevalent. Peak expiratory flow and tidal volumes appeared to be raised by MHI and vibrations. ETT suction assisted partially in lung performance and other times led to slight oxygen decline and slow cardiac rhythm. Expiratory flow increases technique (EFIT) was useful in delivering oxygen with no significant drawbacks. CPT also increased the volume of lung air in the lungs.*

Conclusion: *PICUs cannot become without physiotherapists who are needed to get the kids on ventilators breathing and moving once again. CT can be beneficial to the breathing but one should monitor any side effects. More large-sized research involving standardized methods of doing things would really be needed to validate these results and inform day-to-day practice.*

Keywords: *Pediatric intensive care, mechanical ventilation, chest physiotherapy, physical therapists, respiratory interventions, rehabilitation.*

1. INTRODUCTION

In the PICU, patients are usually admitted due to acute medical diseases, accidents, or life-threatening surgical cases [1]. The number of such patients needing mechanical ventilations over 24 hours is high and thus predisposes them to other complications like acute lobar atelectasis and respiratory infections [3]. Adult studies have established that chronic immobility induced by mechanical ventilation may result in weakness and atrophy of the muscles [4].

The primary physiotherapy intervention in ICU is typically chest physiotherapy (CPT) and it forms a component of usual care to patients on mechanical ventilation, both adults and children [5]. CPT is designed to get rid of the excess secretions and usually includes positioning, percussion, vibration, saline instillation, oropharyngeal or endotracheal suction, and manual hyperinflation [6]. Nevertheless, the physiotherapy in pediatric acute care has limited evidence base [7].

The physiotherapists are important members of a multidisciplinary team in most ICUs in Australia and globally since they major in respiratory and functional care [8]. CPT typically takes the center stage in these units and is regarded as the normative care of both adult and pediatric patients under mechanical ventilation [9]. CPT goals of eliminating the excessive secretions are accomplished by positioning, percussion, vibrations, saline instillation, suction and manual hyperinflation [10].

The neonatal medicine has seen progress and thus more of the extremely preterm babies survive the neonatal period. PICU and NICU patients have higher risks of long-term comorbidities because of the higher incidence of morbidities, such as impaired lung performance and developmental delays [11]. Rehabilitation has therefore become a component of the normal physiotherapy intervention in NICUs and adult ICUs of patients on mechanical ventilation. There seems to be no way to increase the risk of patients and still mobilize them early [12].

Likewise, the advancement in neonatal care in the recent past has seen an increase in the survival rates of very premature babies [13]. These premature babies are at increased risks of impaired lung performance and delayed development, and comorbidities that are chronic are more common among PICU/NICU infants [14]. Subsequently, rehabilitation has become an integral part of care in both NICUs and adult ICUs in patients on mechanical ventilation [10]. Early rehabilitation within the adult ICU has been demonstrated to enhance the quality of life, functional outcome, and shorten the length of stay [15].

Although these have been advanced, there is still a high discrepancy in provision of care to the mechanically ventilated PICU patients. This research aims to explain the extent of the role of physiotherapists in the treatment of pediatric ICU patients under mechanical ventilation, paying attention to respiratory and rehabilitation care.

2. METHODOLOGY

2.1 Search Strategy

Keywords Used

To conduct this study, I turned to the Medical Subject Headings (MeSH) to get the keywords that are relevant to my study and I also dragged in some terms out of relevant articles. I was able to search by the following terms: intensive care; pediatrics; physical therapy specialty; physical therapists; ventilators; mechanical.

Database Search

Systematic searches were done in the following electronic databases:

- PubMed
- Google Scholar
- Scopus
- PEDro (Physiotherapy Evidence Database)

2.2 Eligibility Criteria

Inclusion Criteria

- The articles in English
- Both articles involving invasively ventilated patients admitted to PICU and physiotherapy administered by a qualified physiotherapist.
- Qualitative and quantitative designs of study.

Exclusion Criteria

A study was eliminated when it had the following on the sample:

- Adults older than 18 years

- Adult or neonatal ICU Patients.
- Non-invasive ventilated patients
- Patients that had left the ICU on mechanical ventilation
- Patients that are not getting an intervention with a physiotherapist.

There were no limitations in terms of year of publication or quality of a methodology according to the scores of a critical appraisal tool.

2.3 Study Selection and Data Extraction

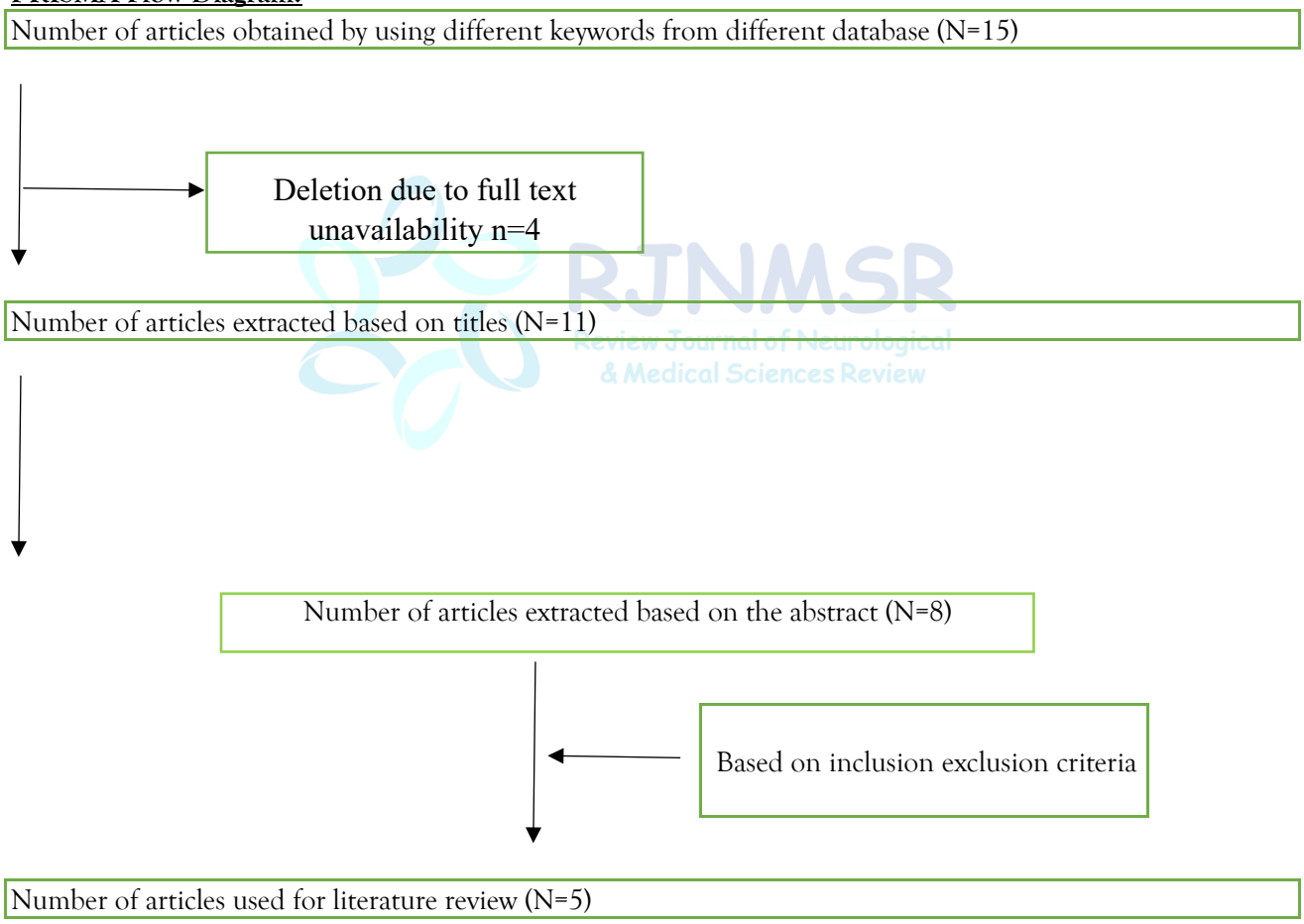
I used the given keywords to get the articles in various databases, and the final result was 15 articles in the preliminary pool. I took into consideration a three-step screening procedure that was developed with the help of the inclusion-exclusion criteria:

Stage 1 (Title screening): 11 articles were not removed.

Stage 2 (Abstract screening): 8 articles were held.

Stage 3 (Full-text analysis depending on inclusion/exclusion criteria): 5 articles were included. Four articles were eliminated on the basis of the unavailability of the full-text. The fifth literature review included five studies, which fulfilled the inclusion criteria.

PRISMA Flow Diagram:



3. RESULTS

3.1 Study Characteristics

Table 1 summarizes the characteristics and key findings of the five included studies. The studies encompassed diverse age ranges from 7 days to 16 years, with sample sizes ranging from N=22 to N=105. Study designs included observational studies (single group, pre- and post-test), randomized crossover trials, and quasi-experimental designs.

Table 1: Summary of Included Studies

Sr.No.	Title / Author / Year	Study Design	Sample Size Age Range	Interventions	Statistically Significant Outcomes	Adverse Event
1	The unique contribution of manual chest compression-vibration to airflow during physiotherapy in sedated, fully ventilated children / Gregson et al.	Observational: single group, pre-& post-test	N=105; 7 days to 15.9 years; Mixed conditions	MHI, vibrations, saline, ETT suction; protocol determined by assessment	MHI increases PEF & tidal volumes; vibrations cause further increases and create an expiratory flow bias	Not reported
2	Simultaneous measurement of force and respiratory profiles during chest physiotherapy in ventilated children / Gregson et al.	Observational	N=55; 7 days to 13.7 years; Mixed conditions	Customized sensing mats combined with respiratory profile monitor	Peak expiratory flow increased significantly during manual inflations both with and without chest wall vibrations ($p < 0.05$)	No adverse events

Sr.No.	Title / Author / Year	Study Design	Sample Size Age Range	Interventions	Statistically Significant Outcomes	Adverse Event
3	Effect of endotracheal suction on lung dynamics in mechanically ventilated pediatric patients / Morrow et al.	Observational	N=78; 0.3 to 25 months; Mixed conditions	1 pass of ETT suction with pre-oxygenation	Overall reduction in compliance and tidal volume	Self-limiting O_2 desaturations and episodes of bradycardia
4	Effect of expiratory flow increase technique on pulmonary functions of infants on mechanical ventilation / Almeida et al.	Observational	N=22; 1 to 1 months; Obstructive acute respiratory failure	40 EFITs, ETT suction	Statistically significant improvements in oxygenation	No adverse events
5	The influence of physiotherapy and suction on respiratory dead space in ventilated children	Randomized crossover (quasi-experimental)	N=75; 3 days to 16 years; Mixed conditions	"Suction" (MHI, suction, saline, pre-oxygenation) vs "CPT" ("suction", vibrations, percussions, compressions, or postural drainage); Protocol determined by assessment	Significant increases in dead space post-CPT	Not reported

3.2 Respiratory Interventions

Vibrations and Manual Hyperinflation (MHI):

According to Gregson and colleagues, MHI is capable of significantly increasing peak expiratory flow (PEF) and tidal volumes in kids under mechanical ventilation. PEF increased further when vibrations of the chest-wall were included, generating an expiratory flow bias potentially used to loosen the secretions. To establish the statistical significance of the results (p 0.05), they used custom sensing pads and respiratory profile monitoring.

Endotracheal Tube (ETT) Suction

Morrow et al. studied the effects of suctioning the ETT on the dynamic of the lungs. Their results were that one suctioning following pre-oxygenation reduced lung compliance and tidal volume. As much as suction was effective in clearing the secretions, it was associated with transient hypoxia saturation and occasional bradycardia. These were self-limiting and self-resolving events that did not require additional treatment.

Expiratory Flow Increase Technique (EFIT)

The test group of Almeida consisted of infants with the obstructive acute respiratory failure who needed mechanical ventilation. They carried out 40 EFIT sessions and then ETT suction and noted that oxygenation improved significantly. Notably, there were no adverse events noted indicating that there is a favorable safety profile of this particular technique in the population under investigation.

3.3 Effect on Dead Space Respiratory.

Some randomized crossover study examined the effect of various physiotherapy interventions on respiratory dead space in ventilated children. A comparison between suction (MHI, suction, saline, pre-oxygenation) and CPT (suction, vibrations, percussions, compressions, or, postural drainage) revealed that CPT augmented dead space. This may have repercussion on the ventilatory efficiency and gas exchange among mechanically ventilated pediatric patients receiving chest physiotherapy.

4. DISCUSSION

4.1 The role of the Physiotherapists in the PICU

Pediatric intensive care unit physiotherapists do not only deal with breathing but gave the full package to the ventilated children. This literature review indicates the possible role of physiotherapy to significantly affect breathing rates and security.

4.2 The Effectiveness of the Chest Physiotherapy Interventions.

There are numerous methods of the chest physiotherapy that focus on the removal of secretions, the compliance of the lungs, and the prevention of such issues as atelectasis or ventilator-associated pneumonia. The author of the work by Gregson demonstrates the use of manual hyperinflations and vibrations to enhance PEF and tidal volumes with a solid foundation. All these are likely to occur due to the recruitment of collapsed alveoli, displacement of secretions between peripheral and central airways as well as an increase in mucociliary clearance.

The expiratory flow bias caused due to vibrations is of particular interest as it corresponds to the theoretical foundation of expelling secretions. Vibrations aid in pushing out the secretions by creating greater expiratory compared to inspiratory flow rates that enable the movement of the secretions to bigger airways which can be removed more easily by suction or coughing by the patient.

4.3 Risk-Benefit Considerations

The physiotherapy is associated with evident respiratory advantages, yet they should be evaluated by the clinicians against potential harms. As Morrow study demonstrates, ETT suction is dualistic since it is required to dislodge secretions, but it temporarily reduces lung compliance and tidal volume, and may lead to oxygen desaturations and bradycardia. Nonetheless, such incidents are self-mitigating and under appropriate control and pre-oxygenation, suction is a safe and necessary practice.

In contrast, the EFIT by Almeida did not worsen the oxygenation and did not report any adverse events, which indicates that this method might have a positive risk-benefit ratio, especially in infants with obstructive respiratory disease.

4.4 Clinical Implications

There is a significant increase of dead space in the post-CPT period, which is observed in the crossover study, and this must be closely noted. Increased dead space might impair the ventilatory effectiveness, and it might be necessary to modify ventilator settings. Clinicians need to balance the advantages of secretion clearance and the possible adverse effects on gas exchange particularly in patients with low respiratory reserves.

These results add to the significance of creating treatment strategies tailored to each patient according to a careful evaluation of him or her instead of generalizing a single treatment method. The physiotherapists ought to constantly monitor the response of the patients, observe any adverse events, and adjust the therapies.

4.5 Gaps in Evidence and Research Requirements.

Despite the valuable information contained in the included studies, there exist a number of limitations to the generalizability and clinical usability of the information. Variations in study design, demographics of patients (age brackets, underlying illnesses) and intervention are a source of a lot of variability, and it becomes difficult to synthesize evidence. Effectiveness can also not be directly compared because of the absence of standardized outcome measures across research.

4.6 Rehabilitation outside Respiratory care:

Although the respiratory interventions were the primary focus of this review, the increasing importance of rehabilitation as an essential part of ICU physiotherapy should be mentioned. Adult ICU studies indicate that early rehab and mobilization enhance the effectiveness, decrease ICU-acquired weakness and decrease the length of stay. There is early evidence that the same benefits may be extended to children, although the evidence is still limited.

Findings There is an opportunity and a challenge in the PICU with respiratory support and early rehab. Physiotherapists have a conflict between maintaining stable breathing and promoting functional recovery and avoiding the development of complications due to the prolonged immobility.

5. LIMITATIONS

There are some key gaps that emerge when one considers what this narrative review is telling us.

- **Limited Study Pool:** The evidence base consists of only five studies, and thus, the conclusions are somewhat limited and difficult to extrapolate to all PICU kids. The general paucity of the research on the subject of physiotherapy of the mechanically ventilated children demonstrates the extent to which we know very little in this field.
- **Methodological Heterogeneity:** The designs of the studies, ages of the patients, underlying conditions, severity of illness, specific physiotherapy procedures and outcomes measured by the studies, are very varied. This combination introduces noise and complicates the issue of drawing a clear picture out of the data.
- **Lack of Standardized Procedures:** At this point, there is no established evidence-based guideline that guides clinicians on how to administer physiotherapy in PICUs. This implies that various units could carry out things differently thereby distorting the uniformity and reproducibility of the findings.
- **Speedy Scarcity of Data on Long-term Adverse effects**: The major part of the papers was devoted to the short-term physiological variables such as the peak expiratory flow or the oxygen level. They did not actually consider longer-term outcomes like the duration of ventilator stay of the kids, days in ICU, and functional recovery.
- **Publication Bias**: As in any other narrative review, there is a possibility that the studies that had positive outcome are overrepresented since they might be more likely to be published whereas missing are the null or negative studies.
- **Limitations of the search strategy:** Although the authors used various databases and were able to search using the appropriate terms, some studies might have fallen by the wayside even though they might be in un-indexed or grey literature sources.

6. CONCLUSION:

This On the whole, the review demonstrates that physiotherapists have a very critical role when attending to the kids on mechanical ventilation in PICUs. The methods to include are manual hyperinflation, vibrations, and tube suction

techniques, which are important in achieving a better breathing technique, clearing of mucus and averting complexities associated with extended use of ventilators. The data support the use of manual hyperinflation and vibrations in the enhancement of peak expiratory flow and tidal volumes, and the expiratory flow increase method comes with an augmentation of oxygenation without any issues. We do however, see that suctioning has the short term effects of reducing lung compliance temporarily, and having short term side effects such as oxygen level drops and bradycardia, thus close monitoring is essential. Nevertheless, the advantages still have some significant gaps. The weakness of the recommendations is caused by small samples, heterogeneity of the study, and absence of standard protocols. The future research needs to pursue:

- Adequately powered randomized trials comparing the various physiotherapy methods.
- Development and endorsement of standard and evidence-based PICU physiotherapy.
- Research on long-term functional outcomes and the duration of ventilation of kids.
- Investigation of the early benefits of rehab and mobilization in ventilated children.
- Decision on how often and how long physiotherapy should last.

Profiles of patient-specific factors that determine their response and risk of adverse events Identification of patient-specific factors that predict the extent of response and their likelihood of adverse events.

Addressing these priorities and translating the results into the clinical guidelines allows the PICU community to optimize physiotherapy practices in the context of enhanced respiratory recovery and overall healing of critically ill children on ventilators.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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