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Effectiveness of Passive Chest Physiotherapy with and without Mechanical Percussion among in Patients Children

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ABSTRACT

The main cause of damage to lung tissue is pneumonia, a disorder marked by pulmonary inflammation or infection and brought on by a range of infectious agents. **Objectives:** To compare the benefits of mechanical percussions and chest physical therapy for pediatric hospital admission patients. **Methods:** A randomized controlled trial was conducted in the Pediatric Intensive Care Unit and the General Ward of Memon Medical Institute Hospital in Karachi, Pakistan. The study investigated 68 children who experienced lower respiratory tract infections and were hospitalized for an extended duration. The children ranged in age from one month to five years. The exclusion criteria encompassed patients with acute asthma, cystic fibrosis, pulmonary embolism, malignancies, rib fractures, spinal fusion, hemorrhage-prone diseases, recent neurosurgery that precluded head-down positioning, and pulmonary emboli. Participants were randomly allocated to either the experimental group or the control group. The experimental group underwent mechanical percussions during chest physiotherapy, whereas the control group received standard chest physiotherapy. The final assessments included the Modified Respiratory Distress Assessment Instrument (mRDAI), the Face, Legs, Activity, Cry, CONSOL ability (FLACC) scale, the Wang Clinical Severity Score (WCSS), oxygen saturation (SpO2), heart rate, and respiratory rate (RR). Evaluations were conducted both before and after the chest physical therapy session. **Results:** Improved FLACC ratings, a lower heart rate ($p<0.05$), and better scores on the mRDAI all point to notable changes in the experimental group following the intervention. **Conclusions:** Mechanical percussions in chest physical therapy clearly improved heart rate, the mRDAI, and the FLACC.

INTRODUCTION

The main cause of damage to lung tissue is pneumonia, a disorder marked by pulmonary inflammation or infection and brought on by a range of infectious agents, including bacteria, viruses, fungi, and foreign objects aspirated into the lungs [1, 2]. Particularly vulnerable to the high frequency and death rate of pneumonia in low-income countries are children [3]. Every year, pneumonia takes the lives of as many as 4 million people, most of them are young children [4]. In children and adolescents, 329,380 instances of pneumonia were diagnosed over eight years. In this specific setting, the male-to-female ratio is 1:0.8, meaning that for every male, there are roughly 0.8 female [5, 6]. According to official data, pneumonia claims the lives of 80,000 babies and children under five every year [7]. Southeast Asia and Africa are the most affected regions by pediatric pneumonia; each year, an estimated 61 million cases of one illness and 35 million cases of another condition in children under five are reported [8-10]. Breathing becomes more difficult as a result of respiratory infections that generate an accumulation of respiratory secretions in the airways. These infections also exacerbate symptoms by increasing airway resistance [11]. Pneumonia

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is typically diagnosed by looking for symptoms like fever, fast breathing, flared nostrils, coughing, shortness of breath, inward movement of the lower chest wall, and low oxygen saturation. Because of its accuracy, clinical recommendations call for chest radiography as the best method for screening pneumonia [12, 13]. Using techniques like postural drainage, chest percussion, and chest vibration, conventional chest physiotherapy (CPT) helps to clear airways and increase effective coughing [14]. CPT opens muco-ciliary clearance, lowers airway resistance, and increases respiratory efficiency. Children who find it difficult to cough clean their airways could benefit much from postural drainage, vibration, and percussion [15]. Respiratory physiotherapy can change reactions related to exercise, metabolism, respiratory muscle weakness, heart rate, breathing patterns, and oxygen absorption kinetics. It can enhance respiratory compliance in children aged zero to three years [16]. Children's chest physical therapy seeks to increase gas exchange and lower airway resistance, therefore facilitating simpler and more comfortable breathing [17]. LEGA, a mechanical apparatus developed by Formedic Technology SDN BHD in Malaysia, has been utilized as an adjunct for CPT [11]. Challenges associated with juvenile pneumonia can be alleviated by enhancing healthcare personnel's comprehension, implementing effective airway clearance techniques, and ensuring adequate drainage placement [18, 19]. This study provides significant new insights into the management of thoracic issues in pneumonia patients. A survey must be done to address the lack of understanding of the comparative advantages of manual versus mechanical percussions and the need for proper drainage placement in pediatric chest physiotherapy for pneumonia. It is significant to highlight that, to the best of our knowledge, no prior studies on the efficacy of manual vs mechanical percussions and drainage placement in pediatric pneumonia patients have been carried out locally in Pakistan.

This study aims to compare the benefits of mechanical percussions and chest physical therapy for pediatric hospital admission patients.

METHODS

From September 2022 to March 2023, a single-blinded randomized controlled experiment was conducted at Memon Medical Institute Hospital in Karachi, Pakistan, in the Pediatric General Ward and Intensive Care Unit. The Iranian Registry of Clinical Trials, with the identification number IRCT20220804055615N1, and the Institutional Review Board (IRB) of Memon Medical Institute Hospital (IRB/MMIH/2022/07) approved the study protocol. Sixty-eight children were included by a non-probability purposive sampling technique, and randomization was conducted using the sealed envelope method. Sample size was calculated through open epi tool by using the Face Legs Activity Cry CONSOL ability (FLACC) scale, and the confidence level was set at 95%, effect size was 0.5, power was 80% and the type I error rate was set at 5% (alpha level, 0.05) [11]. In all, 68 kids between the ages of one month and five years' old who had prolonged hospital stays for lower respiratory tract infections were included in the research. Excluded from the trial were patients with certain disorders such as cystic fibrosis, acute asthma, pulmonary embolus, malignancies, spinal fusion, hemorrhage-prone conditions, recent neurosurgery that prohibited the head-down position, and rib fractures. Those who met the inclusion criteria were divided at random into two groups: 34 patients made up the experimental group, and 34 more made up the control group. Whereas the experimental group received manual chest physiotherapy in combination with mechanical percussions, the control group underwent routine chest physiotherapy. Results were evaluated using the FLACC scale, Wang Clinical Severity Score (WCSS), Modified respiration Distress Assessment Instrument (mRDAI), oxygen saturation (SpO2), heart rate, and respiration rate (RR). These assessments preceded and followed the session of chest physiotherapy. Every patient involved in the study signed a written informed consent before the examination. Carefully defined inclusion criteria ensured that the selected study participants were only qualified patients. All evaluations were conducted at baseline and subsequent to the intervention. Group A (Experimental) had all 34 members positioned comfortably to offer thorough lung coverage during mechanical percussion chest physiotherapy. LEGA, a mechanical device, is used in this study. The bed levels were adjusted to guarantee appropriate body mechanics, therefore facilitating the effective application of the mechanical percussion technique at a level of 20–50Hz. The section on percussion was supposed to run fifteen to twenty minutes. To maximize patient care and enhance the intervention, mechanical percussions were combined with 15 minutes of nebulization and 10 minutes of positioning methods. Many postures, including lateral, supine, and prone positions, were used to increase the potency of the intervention [18]. Thirty-four teenagers in Group B Control had manual percussion chest physiotherapy while comfortably positioned to maximize treatment of all lung regions. The bed levels were changed to maximize body mechanics and increase the effectiveness of the percussion approach in line with Group A. The section on percussion was supposed to run fifteen to twenty minutes. The session included 15 minutes of nebulization and positioning techniques, including lateral, supine, and prone postures, in order to maximize the favourable outcomes of the intervention [20]. Designed to meet the particular requirements of

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every patient, post-percussion suctioning was done at pressures above 20 kPa. This operation sought to give enough airway passage and lower the risk of probable issues. The whole study was represented (Figure 1).

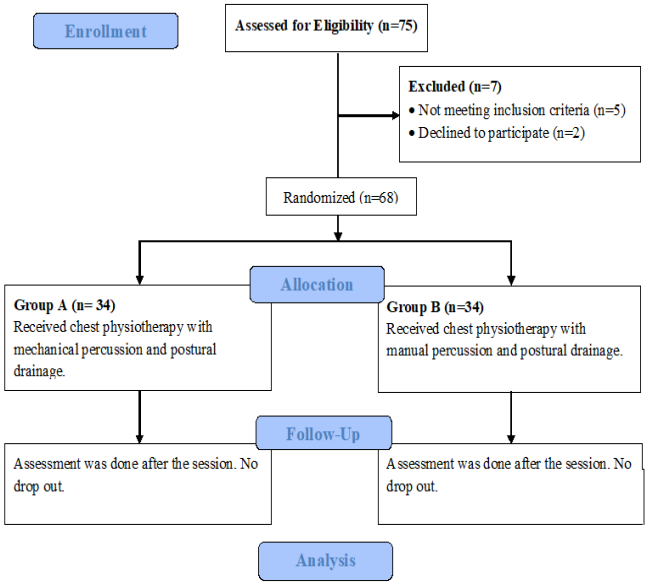

Figure 1: CONSOT flow Representation of Study

RESULTS

Enrolled in the study were 68 children total, ranging in age from birth to five years old. There were 34 youngsters in Group A and 34 children in Group B. Of all the kids in the research, 26 (61.8%) were girls and 42 (61.8%) were boys. The children's respiratory rate was 44.8 ± 15.0 beats per minute, and their average weight was 7.7 ± 4.8 kg. The pneumonia was the predominant diagnosis for the children, accounting for 56 (82.4%) cases (Table 1).

Table 1: Demographic Data of the Participants

Variables		Study Population	Group A, Mechanical	Group B, Manual
		(Mean ± SD), n (%)		
Weight (kg)		7.7 ± 4.8	7.38 ± 4.2	8.01 ± 5.3
Respiratory Rate (b/m)		44.8 ± 15.0	44.3 ± 4.2	45.4 ± 14.9
Gender	Male	42 (61.8%)	21 (61.8%)	21 (61.8%)
	Female	26 (38.2%)	13 (38.2%)	13 (38.2%)
Age	0–3 Months	21 (30.9%)	11 (32.4%)	10 (29.4%)
	3–6 Months	13 (19.1%)	04 (11.8%)	09 (26.5%)
	6–9 Months	11 (16.2%)	06 (17.6%)	05 (14.7%)
	9–12 Months	03 (4.4%)	01 (2.9%)	02 (5.9%)
	1–2 Years	13 (19.1%)	07 (20.6%)	06 (17.6%)
	2–5 Years	07 (10.3%)	05 (14.7%)	02 (5.9%)
Diagnosis	Pneumonia	56 (82.4%)	28 (82.4%)	28 (82.4%)
	Bronchiolitis	10 (14.7%)	06 (17.6%)	04 (11.8%)
	Rad	02 (2.9%)	0 (0%)	02 (5.9%)
Total		68		

RAD: Reactive Airways Disease

The differences in heart rate, respiratory rate, and oxygen saturation (O2 saturation) between the pre-treatment and post-treatment follow-up were evaluated for both Group A and Group B. A significant difference ($p<0.05$) was found in Group A's heart rate, FLACC, and modified respiratory distress assessment instrument (mRDAI) when applying the Mann-Whitney for statistical analysis. However, following the session, there was no discernible change in O2 saturation, Wang clinical severity score (WCSS), or respiratory rate ($p>0.05$). In Group A, the mean score on the modified Respiratory Distress Assessment Instrument (mRDAI) was 28.5 following the session, compared to 30.3 at baseline. In a similar vein, the Wang clinical severity score's (WCSS) mean rank was 30.4 following the session, compared to 31.9 at baseline. The mean rank of oxygen saturation (SPO2) was 35.0 at baseline and 36.5 after the session, while the FLACC score was 30.8 at baseline and 28.2 after the session. The baseline and post-session respiration rates were, respectively, 30.8 and 30.7 (Table 2).

Table 2: Inter-Group Analysis (Mann-Whitney Test)

Variables	Assessment	Group A, Mechanical	Group B, Manual	Median (IQR)	p-Value
		Mean Rank			
mRDAI	At Baseline	30.3	38.7	6.5 (5)	0.08
	After Session	28.5	40.5	4 (2)	0.01*
WCSS	At Baseline	31.9	37.1	6 (5)	0.27
	After Session	30.4	38.6	2 (2)	0.08
FLACC	At Baseline	30.8	38.3	5 (3)	0.11
	After Session	28.2	40.8	0.0 (0)	0.004*
SPO2	At Baseline	35.0	34.0	97 (3)	0.84
	After Session	36.5	32.5	99 (1)	0.38
RR	At Baseline	30.8	38.2	48 (14)	0.12
	After Session	30.7	38.3	38 (13)	0.11

*p<0.005

A significant difference ($p<0.05$) was found in Group A's heart rate, FLACC, and mRDAI when applying the independent sample t-tests for statistical analysis. The youngsters in Group A had a mean heart rate of 132.3 ± 24.1 at baseline and 125.5 ± 20.5 after the session, according to the independent sample test. Group B's mean mRDAI rank was 38.7 at baseline and 40.5 post-session, while Group B's mean WCSS rank was 37.1 at baseline and 38.6 post-session. With a mean rank of SPO2 of 34.0 at baseline and 32.5 after the session, the FLACC score was 38.3 at baseline and 40.8 after the session. After the session, the respiratory rate score was 38.3, compared to 38.2 at baseline. The youngsters in Group B had a mean heart rate of 115.5 ± 26.4 at baseline and 112.9 ± 18.8 after the session, according to the independent sample test. When comparing the experimental group (Group A) to the control group (Group B), the results showed a clinically meaningful improvement in Group A ($p<0.05$) (Table 3).

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Table 3: Inter Group Analysis (Independent Sample t-Test)

Variables	Assessment	Group A, Mechanical	Group B, Manual	Mean Difference	p-Value
Heart Rate	At Baseline	132.3 ± 24.1	115.5 ± 26.4	-16.79	0.08
	After Session	125.5 ± 20.5	112.9 ± 18.8	-12.59	0.01*

*p<0.005

DISCUSSION

Newborns and toddlers with impaired lung function are often at risk for pulmonary infections. These people frequently have symptoms like fever, dyspnea, coughing, and inward chest movement. This investigation aimed to assess the effectiveness of mechanical and manual percussion methods in conjunction with appropriate drainage placement for pediatric patients admitted to hospitals with pneumonia diagnoses [2]. The study found substantial improvements (p<0.05) in the modified Respiratory Distress Assessment Instrument (mRDAI), Face Legs Activity Cry CONSOL ability scale (FLACC), and heart rate through the use of a randomized controlled trial (RCT) design. Notably, children's symptoms improved more when they had mechanical percussion as part of their chest physiotherapy. Importantly, there were no problems or side effects noted over the trial. Hue et al. conducted a study to ascertain if mechanical chest physiotherapy (CPT) utilizing the LEGA-Kid® mechanical percussion device is more effective than manual CPT in pediatric patients with lower respiratory tract infections. The amalgamation of percussion and vibrations produced by the LEGA-Kid apparatus can replicate manual chest physiotherapy, facilitating the dislodgment of loosened secretions. Optimal intrathoracic pressure was attained when the precursor was applied firmly and perpendicularly to the chest wall to induce vocal tremor. The precursor demonstrated the ability to sustain a higher and more stable intrathoracic pressure, akin to the efficacy of three physiotherapists [11]. This helps them to clear their airways. In this study, a good number of the subjects had a pneumonia diagnosis. Whereas the experimental group underwent mechanical chest physiotherapy, the control group received manual chest physiotherapy. Heart rate (p<0.05), the Face Legs Activity Cry CONSOL ability scale (FLACC), and the modified Respiratory Distress Assessment Instrument (mRDAI) showed a clear improvement in the outcomes. Conversely, there is negligible enhancement in respiration rate. In group B, some patients experienced irritation and discomfort, resulting in the FLACC scale values increasing. Therefore, it might be said that mechanical percussion combined with chest physical therapy improves these outcomes more than the control group. Children experiencing a combination of mechanical and manual chest physiotherapy showed alleviation from respiratory discomfort without any recorded side effects, according to earlier research. The study showed how well a combination approach using nebulized hypertonic saline and chest physical therapy removes airway secretions. The therapies in the trial helped to improve rather severe respiratory discomfort. Moreover, it was found that mechanical chest physical treatment reduced respiration rate more effectively than manual chest physical therapy. The findings show that hand and mechanical approaches, together with nebulized hypertonic saline, could be a good way to control children's respiratory discomfort and encourage airway clearing. Mohamed et al. investigated how combining nebulization with chest physical therapy affected pediatric respiratory conditions. The combined strategy proved more effective than nebulization alone, shown by the significant mean variations in heart rate, respiratory rate, and oxygen saturation between the groups seen in the study (p=0.000). The study concludes that nebulization and chest physical therapy may be effective in treating pediatric respiratory disorders. These therapies can alleviate airway obstruction and improve respiratory health [18]. The aforementioned research, along with the current study, provides additional evidence of the efficacy of postural drainage and mechanical percussion in chest physical therapy for airway clearance and secretion removal. Various populations, including children, have exhibited enhanced respiratory outcomes due to these interventions. Notably, none of the research has found any negative impacts of mechanical percussion on kids. Because mechanical percussion did not cause any harm, this study implies that it can be regarded as a safe and effective therapy for clearing children's airways when combined with appropriate treatments like postural drainage. AbdelBasset and Elnegamy looked into the effects of chest physical therapy on hospitalized newborns and children who had pneumonia. The control group received standard pneumonia treatment, whereas the research group received both standard treatment and chest physiotherapy. The study's findings indicate that the group receiving chest physical therapy exhibited significantly elevated oxygen saturation and respiratory rate compared to the control group [4]. In an experimental study assessing the advantages of respiratory physiotherapy for patients with pneumological illnesses, children constituted 50% of the cases, with boys exhibiting the highest prevalence at 60%. The study's findings indicate that postural and autogenic draining techniques enhanced ventilation, regulated the respiratory cycle, facilitated secretion clearance, and restored the patient's state to normalcy. The study found that employing Huffing and Puffing methods was most effective in treating juvenile patients with respiratory difficulties. The study suggests that individuals with pulmonary issues, regardless of age,

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may benefit from respiratory physiotherapy interventions [9]. With 61.8% of the instances, most of the impacted young people in the current study were men, suggesting a higher prevalence in this cohort. For all groups, chest physiotherapy lasted 15 to 20 minutes; following that, each person had an extra inspection. The study found that a more effective therapy approach was mechanical percussion mixed with chest physical therapy. It is crucial to remember, though, that the phrase "(p>0.05)" usually denotes the absence of a statistically significant difference between the treatment groups. To effectively communicate the results, the sentence should be changed to "(p<0.05)" if the goal is to show statistical significance.

CONCLUSIONS

This study concluded that chest issues in pediatric patients can be effectively managed utilizing both techniques: chest physiotherapy with and without mechanical percussion. Nonetheless, the outcomes of chest physiotherapy utilizing mechanical percussions indicated a greater clinical efficacy in enhancing heart rate, the Face Legs Activity Cry CONSOL ability Scale (FLACC), and the modified Respiratory Distress Assessment Instrument(mRDAI).

Authors Contribution

Conceptualization: MA, NR
Methodology: SA, AR, NA
Formal analysis: AK, IK
Writing review and editing: MA, NR, AR

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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