International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Comparison of Prolonged Slow Expiration Technique and Lung Squeezing Technique on Saturation of Peripheral Oxygen (SpO2) and Respiratory Rate (RR) in Infants with Acute Respiratory Distress Syndrome: An Experimental Study

Dr. Payal Patodiya (PT)[1], Dr. Priyaranjan Chaudhary[2]

[1,2]M.P.T. cardio-pulmonary conditions, C.U. Shah Physiotherapy college, Surendranagar

Abstract:

Background: ARDS is characterized by acute hypoxemic respiratory failure, reduced lung compliance, and bilateral radiographic infiltrates with no clinical evidence of cardiogenic pulmonary oedema. Incidence of ARDS in India, October 2014 varies considerably in clinical trials with a range from 4 to 79 cases per 100 000 persons per year.

Objectives: To compare the effectiveness of prolonged slow expiration technique and lung squeezing technique along with conventional chest physiotherapy on saturation of peripheral oxygen (SpO2) and respiratory rate (RR) in infants with acute respiratory distress syndrome.

Design: An experimental Design

Methodology: This study includes 30 participants with ARDS by using a convenience sampling method. The participants were randomly divided into three groups by a random allocation method, Group A (N=10) was treated with conventional physical therapy. Group B (N=10) was treated with prolonged slow expiration technique along with conventional physical therapy. Group C (N=10) was treated with lung squeezing technique along with conventional physical therapy. The participants were treated and improvement was assessed in SpO2 and RR for oxygenation.

Results: Data was analyzed using SPSS version 26.0. A significant improvement in SpO2 ($p<0.05$), and RR ($p<0.05$) between pre and post-treatment stages in all three groups was found. Group C showed a more significant difference than Group A and B in terms of SpO2 and RR.

Conclusion: This study concluded that LST and PSE both techniques are superior to the CCP in improving oxygenation and reducing respiratory rate, But LST was more effective than PSE in maintaining oxygenation and respiratory rate which leads to fewer days of stay in the hospital.

1. Introduction

Respiratory disorders are the most common reason for admission to a neonatal intensive care unit (NICU) and are a major source of neonatal mortality and morbidity.[1]

Within the first minute of life, the new born must clear the foetal lung fluid from the airways and establish a gas exchange. Although most infants complete this transition without problems but inadequate initiation of respiration at birth can be catastrophic to both the respiratory and cardiovascular system.[1]
Acute respiratory distress syndrome (ARDS) is an inflammatory process of the lungs that develops in response to pulmonary and extrapulmonary insults to the alveolar-capillary membrane, resulting in increased permeability and subsequent interstitial and alveolar oedema.[2]
Clinically, ARDS is characterized by acute hypoxemic respiratory failure, reduced lung compliance, and bilateral radiographic infiltrates with no clinical evidence of cardiogenic pulmonary oedema.[2]
Incidence of ARDS in India, in October 2014 varies considerably in clinical trials with a range from 4 to 79 cases per 100000 persons per year. Consequently, mortality is also highly variable from about 40% to 60% in severe ARDS .[2]
Between 2016 and 2020 children with ARDS in India had a prevalence of 7.8% of total admissions. Nearly a third of each patient had mild (29%), moderate (36%), and severe (35%) ARDS.[3]
Respiratory distress is one of the commonest disorders encountered within the first 42-78 hours. It occurs in about 0.96% to 12% of live births and is responsible for about 20% of neonatal mortality.[4]
Lung parenchyma is formed from millions of interdependent alveoli, which share the alveolar volume throughout the lung, preventing overdistension during inspiration and collapse during expiration. This allows for parenchymal stress during inspiration to be somewhat homogenized, despite variability in alveolar size and location. In ARDS, increased permeability and loss of surfactant cause some alveoli to become flooded and unrecruitable or poorly recruitable. As a result lung volume remaining for gas exchange shrinks, and lung compliance is reduced.[5]
Acute respiratory distress syndrome (ARDS) is a devastating disease primarily characterized by a disruption of the alveolar-capillary membrane resulting in pulmonary oedema, an influx of immune cells (e.g., polymorphonuclear neutrophils), protein-rich fluid, massive inflammation, activation of coagulation pathways and dysfunction of surfactant.[6]
ARDS is a rapidly progressive form of respiratory failure characterized by severe hypoxemia and non-hydrostatic pulmonary oedema. It is a life-threatening acute clinical syndrome of pulmonary insufficiency with high mortality and the common reason for admission to the intensive care unit (ICU).[4]
Most cases of acute respiratory distress syndrome are associated with pneumonia or sepsis. It is estimated that 7.1% of all patients admitted to an intensive care unit and 16.1% of all patients on mechanical ventilation develop acute lung injury or acute respiratory distress syndrome.[7]

Common causes of respiratory distress in neonate[8]	
1.	Hyaline membrane disease
2.	Meconium aspiration syndrome
3.	Transient tachypnoea of the new-born
4.	Congenital or acquired pneumonia
5.	Persistent pulmonary hypertension of the new-born
6.	Air leaks
7.	Congenital anomalies of the upper airway (choanal atresia), gut (tracheoesophageal fistula, congenital diaphragmatic hernia), or lungs (lobar emphysema, congenital cystic adenomatoid malformation, cysts)
8.	Cardiac shock or congenital heart disease (CHD)
9.	Hematological causes (severe anemia, polycythemia)

10.	Neurological causes leading to hyperventilation like seizures

The pathophysiology of ARDS is not completely understood. Initially, a direct pulmonary or indirect extrapulmonary insult is believed to cause a proliferation of inflammatory mediators that promote neutrophil accumulation in the microcirculation of the lung. These neutrophils activate and migrate in large numbers across the vascular endothelial and alveolar epithelial surfaces releasing proteases, cytokines, and reactive oxygen species. This migration and mediator release lead to pathologic vascular permeability, gaps in the alveolar epithelial barrier, and necrosis of type I and II alveolar cells. This in turn leads to pulmonary oedema, hyaline membrane formation, and loss of surfactant that decreases pulmonary compliance and makes air exchange difficult.[7]

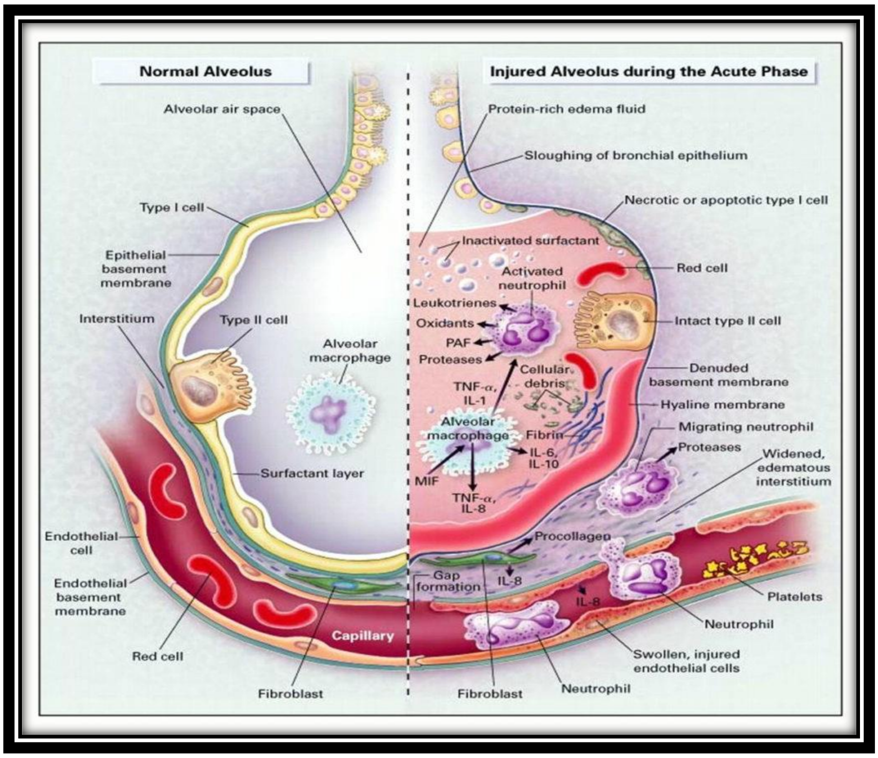


FIGURE 1.1: NORMAL VS. PATHOLOGICAL ALVEOLI

Pathogenesis involves inflammatory injury to the lung endothelium and epithelium, which causes a marked increase in lung vascular and epithelial permeability and the passage of protein-rich oedema fluid into the air spaces. The initial lung injury can be compounded by ventilator-associated lung injury, particularly when high tidal volumes and inflation pressures are used.[5] Pathologically ARDS is characterized by diffuse alveolar damage, alveolar capillary leakage, and protein-rich pulmonary oedema leading to clinical manifestation of dyspnoea, poor lung compliance, severe hypoxemia, and diffuse bilateral infiltrates on chest radiograph.[4]

The key histologic changes in ARDS reveal the presence of alveolar oedema in areas of a diseased lung. The type 1 pneumocyte and vascular endothelium are injured, which results in the leaking of proteinaceous fluid and blood into the alveolar airspace. Other findings may include alveolar hemorrhage, pulmonary capillary congestion, interstitial oedema, and hyaline membrane formation. None of these changes are specific to the disease.[9]

New born with respiratory distress commonly exhibit tachypnoea with a respiratory rate of more than 60 respirations per minute. They may present with grunting, retractions, nasal flaring, and cyanosis.[10]

Increased work of breathing results from mismatched pulmonary mechanics from increased airway resistance (Δpressure/volumetric flow), decreased lung compliance (Δvolume/pressure), or both. Airway resistance increases when there is an obstruction of air flow. The critical importance of airway radius is indicated in the equation $R= V(8l\eta/ \pi r)$, where R is resistance, V is flow, l is length, η is viscosity, and r is a radius. If the airway radius is halved, resistance increases.[11]

Nasal flaring is a compensatory symptom that increases upper airway diameter and reduces resistance and work of breathing. *Retractions are* evident by the use of accessory muscles in the neck, rib cage, sternum, or abdomen. it occurs when lung compliance is poor or airway resistance is high.[11] *Noisy breathing* may indicate increased airway resistance and the type of noise auscultated may help localize airway obstruction. *Stertor* is a sonorous snoring sound heard over extra thoracic airways that indicate nasopharyngeal obstruction. *Stridor* is a high-pitched, monophonic breath sound that indicates obstruction at the larynx, glottis, or subglottic area. *Wheezing* may also be high pitched but is typically polyphonic and is heard on expiration, it indicates tracheobronchial obstruction. *Grunting* is an expiratory sound caused by a sudden closure of the glottis during expiration in an attempt to maintain FRC and prevent alveolar atelectasis. Because lung compliance is worse at very low or very high FRC, achieving and maintaining physiologic FRC is essential in the management of respiratory disorders with poor compliance, such as RDS or TTN.[11]

Many risk factors are involved in the increasing number of term infants delivered by elective cesarean section has also increased the incidence. Additionally, the risk decreases with each advancing week of gestation. At 37 weeks, the chances are three times greater than at 39-40 weeks gestation.[12]

Several etiological factors associated with the development of ARDS are identified with sepsis, pneumonia, aspiration of gastric contents, severe trauma, and multiple transfusions accounting for most cases.[4]

The diagnosis of ARDS is made based on the following criteria: acute onset, bilateral lung infiltrates on chest radiography of a non-cardiac origin, and a pao_2/fio_2 ratio < 300 mmhg.[9]

Mild ARDS	Pao_2/Fio_2 ratio = 200 to 300 mmHg with PEEP > 5 cm H_2O
Moderate ARDS	Pao_2/Fio_2 ratio = 100 to 200 mmHg with PEEP > 5 cm H_2O
Severe ARDS	Pao_2/Fio_2 ratio < 100 mmHg with PEEP > 5 cm H_2O

Chest radiography is helpful in the diagnosis. Blood cultures, serial complete blood counts, and c-reactive protein measurements are useful for the evaluation of sepsis.[12]

Continuous positive airway pressure and surfactant represent the first and second-line treatment for respiratory distress syndrome in preterm neonates.[13]

Corticosteroids have been studied as a pharmacological therapy for ARDS. They act to decrease overall lung inflammation in ARDS and may reduce the risk of death in severe ARDS. However, the use of corticosteroids in critically ill patients is also associated with important adverse events, including hypernatremia, hyperglycemia, and neuromuscular weakness.[14]

There is a growing need for recognition of the role of physiotherapy in short-and long term care of ICU patients including those of ARDS.[4]

With advances in the management of cardiopulmonary conditions, chest physiotherapy (CPT) has become an integral part of airway management in neonatal intensive care settings (NICU) as a supportive treatment. Various manual techniques are used in neonatal settings, including postural drainage, percussion, and vibration. These techniques are thought to promote the clearance of secretions by augmenting the effect of gravity on bronchial clearance.[15]

The role of physiotherapy in ARDS is to decrease patient dependence on the ventilator, improve residual function, improve oxygenation, improve perfusion, restore physical independence, decrease the risk of complications, and improve the quality of life.[4]

Basic physiotherapy interventions (conventional chest physiotherapy) consist of chest manipulations which include vibration, percussion, suctioning (open and close) to clear the retained pulmonary secretions, positioning (supine, prone, alternate side-lying) to improve oxygenation, to decrease the incidence of ventilator-associated pneumonia and to improve ventilation-perfusion mismatch and active or passive mobilization to prevent deconditioning.[4]

Recent development in the therapeutic approach to ARDS includes refinements of mechanical ventilator support with an emphasis on protective lung ventilation using low tidal volumes and increased positive end-expiratory pressure with the use of recruitment maneuvers to promote the reopening of collapsed lung alveoli.[4]

Chest physiotherapy aims to optimize the ventilation-perfusion ratio, increase lung volumes, reduce the work of breathing, minimize the work of the heart, and enhance mucociliary clearance.[4]

Percussion is used to the augmenting mobilization of secretions by mechanically dislodging viscous or adherent mucus from airways by the transmission of an energy wave through the chest wall.[4]

Vibration is used in conjunction with percussion to help move secretions to larger airways manually by vibrating the chest wall during expiration.[4]

Chest physiotherapy is commonly employed in the treatment of infants with respiratory diseases. Almost all physiotherapy techniques available for infants are derived from adult studies, but the infant respiratory system is different from the adult respiratory system and the effects of chest physiotherapy may not be the same. New chest physiotherapy techniques were developed specifically for infants in accordance with their physiological characteristics.[16]

A few newer techniques include prolonged slow expiration technique, expiratory flow increased technique, lung squeeze technique, and reflex rolling using Vojta therapy.[17]

Prolonged slow expiration (PSE) is one of these new techniques, employed in clinical practice in infants. PSE is used in several countries, mainly in Europe. In 2001, some possible benefits of PSE were described, including improved secretion clearance and reduced hyperinflation.[16] In PSE, pressure is exerted on the thorax and abdomen to prolong the expiratory phase and thus promote secretion clearance.[16]

In the prolonged slow expiration technique, intrathoracic pressure increases slowly by means of thoracoabdominal compression to prevent bronchial collapse and disruption of the flow that occurs during forced expirations.[16] This pressure difference improves pulmonary air flow from the alveoli to the trachea, which removes mucus.[18]

Although PSE has been described in the literature since the 1990s, the studies have mostly focused on the clinical aspects of the technique, such as respiratory distress, SpO_2, and heart rate frequency.[18]

However, it is known that tidal volume and expiratory reserve volume (ERV) are better variables for assessing the results of this technique. PSE has been reported to change the tidal volume, ERV, and airway resistance, but there have been no reports of the reliability of this technique based on these variables.[18]

Lung squeezing technique (LST) differs from conventional chest vibration and percussion, as each set of “lung squeezes” consists of three to four cumulative chest compressions.[15]

The lung squeezing technique (LST) provides small amplitude oscillatory chest wall compression performed on the whole hemithorax that restores the homogeneous inflation of the lungs.[17]

The lung squeezing technique (LST) is used to restore homogeneous inflation of the lungs using small amplitude oscillatory chest wall compressions.[19]

In respiratory physical therapy, lung squeezing is a method used to promote the transport of secretions from the airway to the mouth to help patients easily spit them out. This method is less painful than suctioning and tapping for patients and effectively promotes expectoration. However, significant training is necessary to acquire skills such as the ability to correctly time a patient's breathing, apply the proper amount of pressure and apply pressure in the correct direction to induce expectoration.[20]

In terms of timing, the peak pressure was mostly consistent with the pressure being gradually applied from the start of exhalation and rapidly released after the peak. This timing may be the most important factor in developing a successful squeezing technique. Respiration is passively induced by dilation and contraction of the thorax. Respiratory muscle contractions induce inhalation and are followed by a pause at the end of the inspiratory phase. Exhalation is achieved by the relaxation of the respiratory muscles.[20]

Cilia lining the airway move synchronously 500 to 1000 times per minute to transport secretions toward the mouth. The mucus moves at 20 mm/minute in the trachea and 5 mm/minute in the peripheral airway. Thus, it is important to identify the point at which exhalation changes to inhalation. The pressing direction is from the upper lung region toward the bifurcation of the trachea. The thorax does not simply move up and down during breathing but moves inward toward the bifurcation of the trachea during exhalation.[20]

Clinical scores and vital sign measurements are important in clinical practice to correctly assess and classify patients, especially for early recognition of severe medical conditions. Adequate clinical assessment is also part of clinical algorithms, which require the identification of simple and objective criteria, justifying the initiation of particular interventions. Several childhood disease management guidelines, including those proposed by the world health organization (WHO), such as the integrated management of childhood illness manual, incorporate the respiratory rate (RR) as an important criterion for the assessment of sick children. Indeed the assessment of RR is part of the clinical assessment.[21]

Pulse oximetry in clinical practice has allowed for simple, non-invasive, and reasonably accurate estimation of arterial oxygen saturation. Pulse oximetry is routinely used in the emergency department, the pediatric ward, and pediatric intensive and perioperative care.[22]

The feasibility and reliability of pulse oximetry during neonatal resuscitation have been proven in several studies. Use of new generation devices and sensors of appropriate size, as well as probe attachment to a preductal location (i.e. right upper extremity), preferably before connecting the probe to the device, might result in more accurate and timely readings.[22]

The estimation of arterial hemoglobin oxygen saturation by pulse oximetry (SpO_2) is based on the specific characteristics of oxygenated and deoxygenated hemoglobin (oxyhemoglobin and deoxyhemoglobin respectively) concerning light absorption in the red and infrared spectra. Deoxyhaemoglobin is characterized by greater red-light absorption (wavelength range: 600 –750 nm) in comparison to oxyhemoglobin, whereas oxyhemoglobin exhibits higher absorption in the infrared spectrum (850 –1000 nm). By obtaining the ratio of light absorption in the red and infrared spectra and then calculating the ratio of these 2 ratios (ratio of absorption ratios), the percentage of oxyhemoglobin can be calculated.[22]

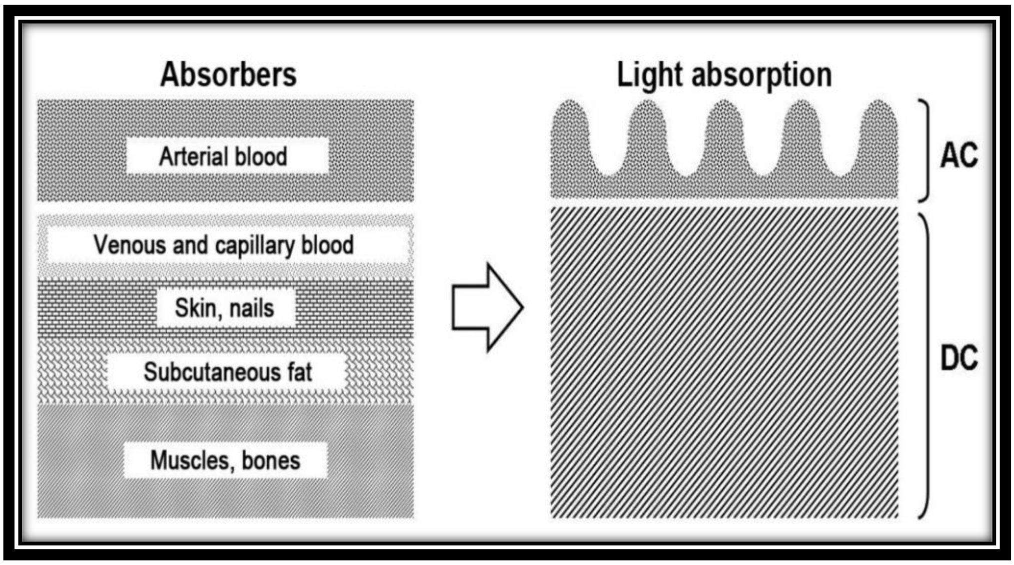


FIGURE 1.2: THE PRINCIPLE OF OPERATION OF PULSE OXIMETRY[22]

Pulse oximetry has become widely available in various aspects of pediatric care. It is routinely found in the emergency department and the pediatric ward, and it is regarded as an essential element of patient monitoring in pediatric intensive and perioperative care. It's used in the assessment of respiratory and hemodynamic parameters in advanced pediatric care settings.[22]

Respiratory rate (RR) though regarded as critically important for the diagnosis and management of respiratory and non–respiratory diseases.[23]

The RR was recorded by observation for 60 seconds on each visit. Either a sleep or awake and content.[24]

Repeated RR counts offer reliable results if done for a full minute.[21]

In settings where routine examination of RR is advisable to include a fully chrono metered 1 min-long count, or preferably, calculate the average of multiple counts.[23]

1.1 NEED AND SIGNIFICANCE OF THE STUDY

There is a growing need for recognition of the role of chest physiotherapy in short-and long-term care of ICU patients including those of ARDS.

Gopal Krishna et al. had done research on Physiotherapy Practice Patterns for Acute Respiratory Distress Syndrome in Intensive Care Units in India -A national Survey. The objective was to determine the practice patterns of physiotherapists for ARDS in the Intensive care unit in India. And reported that the assessment and treatment techniques were similar for certain measures for both ventilated and non-ventilated acute respiratory distress syndrome patients. Treatment predominately focuses on airway clearance techniques like percussion, vibration, postural drainage, and airway suction.

With advances in ICU management, chest physiotherapy (CPT) has become an integral part of airway management.

Currently, in most hospital settings, chest physiotherapy is given as a supportive therapy to treat infants with ARDS. But according to current literature new techniques have given encouraging clinical results.[16]

A study that was conducted to check the efficacy of the prolonged slow expiration technique in infants concluded that PSE technique is safe without adverse effects.[17]

Another study that was conducted to check the efficacy of the lung squeezing technique in infants concluded that LST improves respiratory system compliance in preterm infants with respiratory distress syndrome who require mechanical ventilation.[9]
In the literature, no study compared the effect of the PSE technique and LST. Hence, my study is directed to compare the prolonged slow expiration technique and lung squeezing technique.
The results of this study will be helpful for the patients and cardiopulmonary physiotherapists to select an effective and safer treatment procedure and will also establish a preference between these two techniques.

2. AIMS AND OBJECTIVES OF THE STUDY

2.1 AIM OF THE STUDY

To compare the effectiveness of prolonged slow expiration technique and lung squeezing technique along with conventional chest physiotherapy on saturation of peripheral oxygen (SpO_2) and respiratory rate (RR) in infants with acute respiratory distress syndrome.

2.2 OBJECTIVES OF THE STUDY

- To evaluate the effect of conventional chest physiotherapy on saturation of peripheral oxygen (SpO_2) and respiratory rate (RR) in infants with acute respiratory distress syndrome.
- To evaluate the effect of prolonged slow expiration technique along with conventional chest physiotherapy on saturation of peripheral oxygen (SpO_2) and respiratory rate (RR) in infants with acute respiratory distress syndrome.
- To evaluate the effect of lung squeezing technique along with conventional chest physiotherapy on saturation of peripheral oxygen (SpO_2) and respiratory rate (RR) in infants with acute respiratory distress syndrome.
- To compare the effectiveness of prolonged slow expiration technique and lung squeezing technique along with conventional chest physiotherapy on saturation of peripheral oxygen (SpO_2) and respiratory rate (RR) in infants with acute respiratory distress syndrome.

2.3 HYPOTHESIS

2.3.1 Null hypothesis [H_0]

[**H_0]1** = There is no statistically significant effect of conventional chest physiotherapy on peripheral oxygen (SpO_2) and respiratory rate in participants with ARDS.
[H_0]2 = There is no statistically significant effect of prolonged slow expiration technique along with conventional chest physiotherapy on peripheral oxygen (SpO_2) and respiratory rate in participants with ARDS.
[H_0]3 = There is no statistically significant effect of the lung squeezing technique along with conventional chest physiotherapy on peripheral oxygen (SpO_2) and respiratory rate in participants with ARDS.
[H_0]4 = There is no statistically significant difference between the effects of prolonged slow expiration technique and lung squeezing technique along with conventional chest physiotherapy on peripheral oxygen (SpO_2) and respiratory rate in participants with ARDS.

2.3.2 Experimental hypothesis [H_1]

[H_1]1 = There is a statistically significant effect of conventional chest physiotherapy on peripheral oxygen (SpO_2) and respiratory rate in participants with ARDS.

[H$_1$]2 = There is a statistically significant effect of prolonged slow expiration technique along with conventional chest physiotherapy on peripheral oxygen (SpO_2) and respiratory rate in participants with ARDS.
[H$_1$]3 = There is a statistically significant effect of the lung squeezing technique along with conventional chest physiotherapy on peripheral oxygen (SpO_2) and respiratory rate in participants with ARDS.
[H$_1$]4 = There is a statistically significant difference between the effects of prolonged slow expiration technique and lung squeezing technique along with conventional chest physiotherapy on peripheral oxygen (SpO_2) and respiratory rate in participants with ARDS.

3. REVIEW OF LITERATURE

Márcia C. Pires Nogueira et al. (2019) conducted a study on **"is prolonged slow expiration a reproducible airway clearance technique?"** The objective of this study was to assess the reliability and agreement between physical therapists during the application of PSE in infants with wheezing. The study included 19 infants. 3 did not complete the study. Thus, 16 infants were evaluated. The mean age was 59 weeks (SD = 26 weeks) and 11 were male. 8 infants had abnormalities in the lung function test. Out of those, 6 had moderate and 2 had mild lung obstructive disease. This study concluded that there was no difference between the ERV values measured during the application of PSE in infants with wheezing, indicating that it is a reliable technique. Additionally, there was good agreement on the procedure between physical therapists. The variability of PSE was found to be approximately 30% of the ERV and PSE was a reproducible chest physical therapy technique between physical therapists.[18]

Enrique Conesa-Segura et al. (2018) conducted a study on **"prolonged slow expiration technique improves recovery from acute bronchiolitis in infants: fibarrix randomized controlled trial"** Objective was to examine the effect of prolonged slow expiration respiratory physiotherapy treatment on the acute bronchiolitis severity scale and O_2 saturation at short-time and medical discharge in infants and the hospital stay. A total of 80 patients were randomized and 71 completed the study (39 in the experimental group and 32 in the control group). This study concluded that Prolonged slow expiration physiotherapy reduces acute bronchiolitis severity scale scores and does not change O_2 saturation. Infants in the respiratory treatment group stay less days in the hospital than infants in the control group and no adverse events were detected.[17]

Shanmugananth. E et al. (2017) had done a study on **"effect of lung squeezing technique and reflex rolling on infants with acute respiratory distress syndrom**e" Total of 22 participants were recruited consecutively and allocated into two groups through the odd-even method. Group A was treated with lung squeezing technique and conventional physiotherapy, and group B was treated with reflex rolling along with conventional physiotherapy. Outcomes included respiratory rate and oxygen saturation they were tested at baseline as a pre-test and post-test measurements were taken after the treatment duration of 5 days. This study concluded that both reflex rolling and LST are safe and effective in improving saturation of peripheral oxygen (SpO_2) and reducing RR in preterm neonates with respiratory distress syndrome though it has also been analyzed that reflex rolling shows more effectiveness while comparing through mean values. Thereby present study result can be considered and suggested for clinical implementation.[17]

Rahul Magazine et al. (2017) had done a study on "**epidemiological profile of acute respiratory distress syndrome patients: a tertiary care experience**" Aim was to study the epidemiological profile of ARDS patients. The study concluded that pneumonia is the most common etiology followed by tropical infections in the causation of ARDS in our hospital. The presence of pre-existing comorbidity, surgery prior to ARDS, higher severity scores at admission, and organ failure scores are frequently associated with poor survival.[25]

Rashmi Nigam et al. (2017) had done a study on **"physiotherapy practice patterns for acute respiratory distress syndrome in intensive care unit in India."** The objective was to determine the practice patterns of physiotherapists for ARDS in the intensive care unit in India, in which 600 questionnaires were sent via email to cardiopulmonary physiotherapists. The questionnaire addressed the assessment and treatment techniques of ventilated and nonventilated ARDS patients. Results showed that a total of 252 completed questionnaires were returned with a response rate of 42%. The assessment and treatment techniques used were almost similar for ventilated and non-ventilated patients. More than 75% of the responders monitored vital and ventilatory parameters and respiratory impairments for both ventilated and non-ventilated patients. An objective measure of dyspnoea was taken by less than 70% of responders with minimal attention given to functional exercise capacity, measures of function, and health-related quality of life measures. Supine positioning (81.7%) was used more in ventilated patients whereas upright position (75%) was used more in non-ventilated patients. 75% of responders use secretion clearance and manual techniques for both ventilated and non-ventilated patients. In nonventilated patients, breathing strategies were used by 85% of responders, 86.1% performed ambulation and more than 60% of physiotherapists used strength training. The study concluded that the assessment and treatment techniques were similar for certain measures for both ventilated and non-ventilated acute respiratory distress syndrome patients. Assessment predominately focuses on vital signs and ventilator parameters monitoring and impairment measures for ventilated and non-ventilated patients with little attention given to functional exercise capacity, measures of function, and health-related quality of life measures. Treatment predominately focuses on body positioning, airway clearance techniques, manual techniques, and range of motion exercises for ventilated patients and in addition to all those breathing strategies and functional training for non-ventilated patients.[3]

Rasha A. Mohamed et al. (2014) had done a study on **"is chest physiotherapy effective for extremely preterm newborns with respiratory distress syndrome? : A randomized controlled study"** Total of 60 extremely preterm neonates with respiratory distress syndrome and mechanically ventilated were enrolled in the study. Two equal groups (control and study) were there. The control group received medical treatment, routine suctioning, and positioning while the study group received the same medical treatment in addition to the selected chest physical therapy program. Arterial blood gases and vital signs were measured. Cranial ultrasound and chest x-ray were done to diagnose any cerebral injuries or rib fractures. All measurements were recorded pre-treatment, after 2 days, and after 7 days (post-treatment). This study concluded that no adverse effects regarding cerebral injuries or rib fractures were recorded. Therefore, CPT is a safe and effective line of treatment for extremely preterm mechanically ventilated neonates with respiratory distress syndrome.[26]

Neha J. Thacker et al. (2014) had done a study on **"effect of lung squeezing technique for correcting atelectasis in mechanically ventilated preterm infants with respiratory distress syndrome"** The objective of the study is to test the efficacy of the lung squeezing technique with that of conventional chest physiotherapy for correcting atelectasis in mechanically ventilated preterm infants with RDS. A total of 30 infants with gestational age < 37 weeks were included (15 in LST, 15 in CCP). This study concluded that LST is more effective in correcting atelectasis as compared to the CCP technique in mechanically ventilated preterm infants with CCP.[27]

Jaitty Kole et al. (2014) had done a study on **"effect of lung squeeze technique and reflex rolling on oxygenation in preterm neonates with respiratory problems: a randomized controlled trial"** The objective of the study was to compare the effectiveness of CPT, LST, and reflex rolling on oxygenation in preterm neonates with respiratory problems, in terms of blood gases and oxygen saturation. A total of 60 neonates with RDS were included and pneumonia with a gestational age of 30 to 37 weeks under O_2 therapy. The participants were randomly allocated into 3 groups. Group A received CPT, group B received LST with CPT and group C received reflex rolling with CPT for 20 minutes duration per session at 0, 4th, and 8th hour, three sessions per day, for period of 2 weeks. Pre and post-intervention values of pulse oximetry and arterial blood gas were recorded to analyze oxygenation. Chest x-rays were taken on day 1st and last day. The results showed within-group improvements in SpO_2 and PaO_2 which were statistically significant ($p < 0.001$) on day 1, and post-intervention on the last day for all the groups whereas between groups comparisons showed no significant difference with p values 0.480 and 0.258 respectively. Chest radiographs demonstrated re-expansion of collapsed airways. This study concluded that the three treatment techniques viz. CPT, LST technique and reflex rolling are safe and effective for improving oxygenation in preterm neonates with respiratory problems and can be used in clinical settings.[28]

Tejas Chokshi et al. (2013) had done **"Practice patterns of physiotherapists in neonatal intensive care units: a national survey"** Objective was to determine the practice pattern of physiotherapists in the neonatal intensive care units (ICU) in India with ARDS to cardiopulmonary and neuromuscular physiotherapy. This study concluded that the practice patterns of physiotherapists working in NICUs involve both chest physiotherapy as well neuromuscular physiotherapy. Chest physiotherapy assessment has been found to focus mainly on vital parameters which involve an assessment of heart rate, respiratory rate, and SpO_2. Treatment is found to predominantly focus on airway clearance techniques like percussion, vibration, postural drainage, and airway suction. For neuromuscular physiotherapy strategies preferred by most physiotherapists were parent education, passive range of motion exercise, therapeutic handling, and positioning.[29]

Edward D. Chan et al. (2013) had done a study on **"pulse oximetry: understanding its basic principles facilitates appreciation of its limitations"** Discussed how pulse oximeters are able to distinguish oxygenated hemoglobin from deoxygenated hemoglobin and how they are able to recognize oxygen saturation only from the arterial compartment of blood. Based on these principles, also discussed the various conditions that can cause spurious readings and the mechanisms underlying them.[30]

Miguel lanaspa, et al. (2013) had done a study on "**high reliability in respiratory rate assessment in children with respiratory symptomatology in a rural area in Mozambique**." The objective of the study was to determine the reliability of RR assessment counted three times during a full minute by independent observers in children in a developing country setting. A total of 55 participants were enrolled in the study. Participant ages ranged from 10 days to 7 years (median 22 months). Agreement for RR count was high (intraclass correlation coefficient of 0.95; 95% confidence interval: 0.93–0.97). Agreement for the presence of tachypnoea was also high (kappa coefficient of 0.83, $p < 0.001$). However, a single reading would have misclassified 5–11% of the participants as non-tachypnoeic. Repeated RR counts offer reliable results if done for a full minute. Patients not fulfilling the tachypnoea criterion but with a high RR count should have the measurement repeated. This study concluded that in settings where routine examination of RR includes a 1 min evaluation, repeated respiratory counts within a time-lapse of no more than 30 min. offers reliable results with little interobserver variability, regardless of whether the child is calm, crying, or feeding.[15]

Evelim l. F. D. Gomes, **et al. (2012)** had done a study on **"chest physical therapy is effective in reducing the clinical score in bronchiolitis: Randomized controlled trial**" The objective of the study was to evaluate the effectiveness of chest physical therapy (CCP) in reducing the clinical score in infants with acute viral bronchiolitis (AVB). Randomized controlled trial of 30 previously healthy infants (mean age 4.08 SD +3.0 months) with AVB and positive for the respiratory syncytial virus (RSV), evaluated at three moments: at admission, then at 48 and 72 hours after admission. Group 1 - new chest physical therapy (prolonged slow expiration (PSE) and clearance rhino pharyngeal retrograde, Group 2 - conventional chest physical therapy (modified postural drainage, expiratory compression, vibration, and percussion) and Group 3 - aspiration of the upper airways. The outcomes of interest were the wang's clinical score (CS) and its components: retractions (RE), respiratory rate (RR), wheezing, and general conditions. The result was the CS on admission was reduced in Group 1 (7.0-4.0) and Group 2 (7.5-5.5) but was unchanged in Group 3 (7.5-7.0). We observed a change within 48 hours after hospitalization in Group 1 (5.5-3.0) and Group 2 (4.0-2.0) in 72 hours, there was a change in Group 1 (2.0-1.0). This study concluded that chest physiotherapy was effective in reducing the CS in infants with AVB compared with upper airway suction only. After 48 hours of admission, both techniques were effective and NCPT techniques were also effective in the 72 hours after hospitalization compared with CCPT techniques.[31]

Chiharu Akazawa, et al. (2012) conducted a study on **"standardization of the squeezing technique for expectoration in terms of timing, pressure, and direction"** This study aimed to standardize the timing of breathing, pressure, and direction of pressing for removing secretions retained in the airway. A total of 9 respiratory therapists with work experience of 5 to >21 years cooperated to establish the standard values. A model to record the timing, pressure, and direction of pressing during compression was prepared. Sixty sensors were arranged corresponding to a handprint on the right chest, the site of pressing, on a mannequin, and the respiratory therapists performed compression using this model. Timing is based on the waveforms, the subjects gradually increased the pressure, held their position after reaching the peak, and then sharply reduced the force. Pressure: the compression strength varied among the subjects, but the mean peak sensor value was 400–900, corresponding to about 1–2 kg/cm^2. The direction of pressing: the pressure was transmitted from the shoulder side toward the bronchial bifurcation. This study concluded that we converted the squeezing technique to numerical values by using a human body model and standardized the timing, pressure, and direction of squeezing. Training with visual representations of these indices as stand ARDS for squeezing technique.[20]

Fernanda De Cordoba Lanza, et al. (2012) conducted a study on **"impact of the prolonged slow expiratory maneuver on respiratory mechanics in wheezing infants"** Objective was to evaluate changes in respiratory mechanics and tidal volume (Vt) in wheezing infants in spontaneous ventilation after performing the technique known as the prolonged slow expiratory (PSE) maneuver. A total of 22 infants were included, 4 did not complete the study so 18 infants were evaluated. This study concluded that this respiratory therapy technique is able to induce significant changes in Vt and RR in infants with recurrent wheezing even in the absence of exacerbations. The fact that the variables related to respiratory mechanics remained unchanged indicates that the technique is safe to apply in this group of patients. Studies involving symptomatic infants are needed in order to quantify the functional effects of the technique.[32]

Fernanda C Lanza et al. (2011) conducted a study on **"prolonged slow expiration technique in infants: effects on tidal volume, peak expiratory flow, and expiratory reserve volume"** The objective of the study is to describe PSE's effects on respiratory mechanics in infants. A total of 22 patients were screened and 18 completed the study (9 male, 9 female). This study concluded that results confirm previous assumptions about PSE in infants that V_t was reduced during PSE. PEF was maintained as expected in slow techniques. PSE promoted sigh breaths, thereby demonstrating that the change in volume caused by PSE stimulates the hering-breuer deflation reflex. Another important finding was that PSE deflates the lung to ERV.[10]

Ivor Wong et al. (2006) conducted a study on **"effects of lung squeezing technique on lung mechanics in mechanically-ventilated preterm infants with respiratory distress syndrome".** Aim was to investigate the effect of LST on the parameters of lung mechanics in preterm infants on mechanical ventilation. The objective of the study was to assess the effect of the lung squeezing technique in improving the distribution of ventilation in infants with ARDS. A total of 11 preterm infants on mechanical ventilation were enrolled. Serial measurements on static respiratory system compliance (CRS) and resistance (RRS) by an airway occlusion technique with passive flow-volume analysis were performed before and immediately after LST and repeated 4 hours later to assess the carryover effect. CRS improved by 21% (0.92 ± 0.37 ml/cmH_2O/kg vs. Baseline 0.76 ± 0.33 ml/cmH_2O/kg, $p = 0.023$) immediately after LST. Split group analysis showed that only the lower CRS group had a significant carryover effect at 4 hours post-LST ($p = 0.046$). LST increases total respiratory system compliance, possibly through decompression of the overdistended lung units and recruitment of atelectatic alveoli. This study concluded that LST improves respiratory system compliance in preterm infants with respiratory distress syndrome who require mechanical ventilation.[9]

Sunit Singhi et al. (2003) conducted a study on "**counting respiratory rate in infants under 2 months: Comparison between observation and auscultation"** This study concluded that our data support the assumption that observation is as reliable as auscultation for counting RR.[14]

Ivor Wong et al. (2003) conducted a study on **"Randomized comparison of two physiotherapy regimens for correcting atelectasis in ventilated pre-term neonates"** The objective was to compare the effectiveness and safety of using LST with the conventional percussion and vibration (PDPV) protocol for correcting atelectasis in ventilated neonates. 56 pre-term neonates were randomized into an experimental group ($n = 26$) treated with the lung squeezing protocol and a control group ($n = 30$) treated with the conventional percussion and vibration protocol. The groups were pre-stratified according to the mode of ventilation: high-frequency oscillatory ventilation (HFOV) or conventional mechanical ventilation (CMV). This study concluded that LST was more effective for correcting lung atelectasis in pre-term neonates than PDPV.[19]

Lt Col K. Nagendra et al. (1988) conducted a study on **"incidence and etiology of respiratory distress in new-born"** Screening of 1986 consecutive live births was done for evidence of respiratory distress by administering Downe's scoring in a prospective study at level n nursery of a medical college. A detailed antenatal, natal, and postnatal history along with a detailed examination supported by relevant investigations was carried out to arrive at the etiological diagnosis of respiratory distress syndrome (RDS). A total of 48 newborns developed RDS during the observation period. The incidence of RDS was 2.42%. Out of these 40.4% were < 1500gm, 16.6% were above 2500 gm, and the rest were between 1500-2000gm. Preterm was thirty times more prone to develop RDS than full-term neonates. There was no significant difference in the incidence of RDS in male and female neonates. The commonest cause of RDS was hyaline membrane disease (HMD) at 18.8% followed by transient tachypnoea of the newborn at 14.5% and meconium aspiration syndrome (MAS) at 12.5%. HMD was predominantly seen in the preterm at the gestational age of 29 to 32 weeks, transient tachypnoea of the newborn was seen equally in a term as well as preterm neonates, whereas MAS was more common in the term than in the preterm neonates.

K J Barrington et al. (1988) conducted a study on **"Evaluation of pulse oximetry as a continuous monitoring technique in the neonatal intensive care unit"** Tested a number of pulse oximeters in a neonatal ICU to assess their performance as continuous monitoring. This study concluded that pulse oximeters are a valuable adjunct to clinical oxygen monitoring and when properly applied and reliably indicating the infant's HR, will accurately reflect arterial saturation ($r = 0.8, p<0.0001$). ECG synchronization appears to reduce motion artifact when the ECG r-wave is detected.[18]

Nicolina Bertone, et al. (1988) conducted a study on **"The role of physiotherapy in a neonatal intensive care unit"** This study concluded that the physiotherapist is seen to be an essential member of the neonatal team because of the varied skills brought to the infant's management by this professional.[20]

Ginny W. Henderson et al. (1988) conducted a study on **"accuracy and reliability of pulse oximetry in premature neonates with respiratory distress"** A total of 15 premature infants with ARDS were taken. Pulse oximetry oxygen saturation readings closely approximated arterial oxygen saturation values analyzed by an anil 282 co-oximeter. This study concluded that the accuracy and reliability of pulse oximetry within the 85% to 95% saturation range in premature infants with respiratory distress over a wide range of carbohemoglobin concentrations.[22]

Ivor Wong (nga Chung) et al. (1988) conducted a study on **"lung squeezing technique as a volume recruitment maneuver in correcting lung atelectasis for preterm infants on mechanical ventilation"** Aim was to promote clearance of airway secretions and recruitment of the under-ventilated alveoli. A total of 56 preterm infants on mechanical ventilation presenting with lung atelectasis were enrolled in the study and were randomly assigned to 2 groups. Group A (n=26) was treated with a physiotherapy protocol using the LST as a lung volume recruitment maneuver. Group B (n=30) received conventional physiotherapy using PDPV on the alternate side with the infant lying at the postural drainage position. The outcome indicators were a number of treatment sessions to attain re-opening of the collapsed lobes and the recurrence rate of lung collapse within 3 days. The occurrence of adverse hemodynamic response during treatment was also compared 11 additional preterm infants without lung atelectasis was enrolled in a lung mechanics study, using the single breath occlusion technique. The changes in respiratory system compliance and resistance immediately and 4 hours after LST were investigated. This study concluded that the LST is more effective in correcting lung atelectasis in ventilated preterm infants than the conventional PDPV regimen. LST is superior to PDPV in achieving both first re-expansion and complete resolution of atelectasis and is effective in infants ventilated by either high frequency or conventional ventilation. We observed no major adverse effects caused by LST and there was no significant difference in hemodynamic disturbances when compared to PDPV.[33]

4. MATERIALS AND METHODOLOGY

4.1 STUDY DESIGN: An experimental study
4.2 SAMPLING METHOD: Convenience sampling method
4.3 STUDY POPULATION: ARDS patients
4.4 SAMPLE SIZE: 30 infants with ARDS [Group A: 10, Group B: 10, Group C: 10]
4.5 STUDY SETTING: Neonatal intensive care unit
4.6 STUDY DURATION: 1 year
4.7 TREATMENT DURATION: 2 times a day, for 4 days

4.8 SELECTION CRITERIA

4.8.1 INCLUSION CRITERIA:[34,35]

- 30 – 37 weeks of gestation age, admitted to NICU with a diagnosis of ARDS.
- No major airway interventions like manual hyperinflation or bronchial lavage were performed in the previous 12 hours.
- Absence of any segmental or lobar collapse confirmed on chest x-ray.
- Absence of major congenital malformation.
- Informed assent form signed by parents.

4.8.2 EXCLUSIONCRITERIA:[34,35]

- Infants with other respiratory and cardiac congenital or neurological anomalies.
- Infants with seizure.
- Infants underwent a surgical procedure.
- Infants with genetic syndromes.

4.9 OUTCOME MEASURES

- Peripheral oxygen saturation (SpO_2): SpO_2 was measured with the pediatric pulse oximeter.[22]
- Respiratory rate (RR): Respiratory rate was taken by counting abdominal movement for one minute.[21]
- Length of hospital stay[36,6]

4.10. TOOLS USED IN THE STUDY

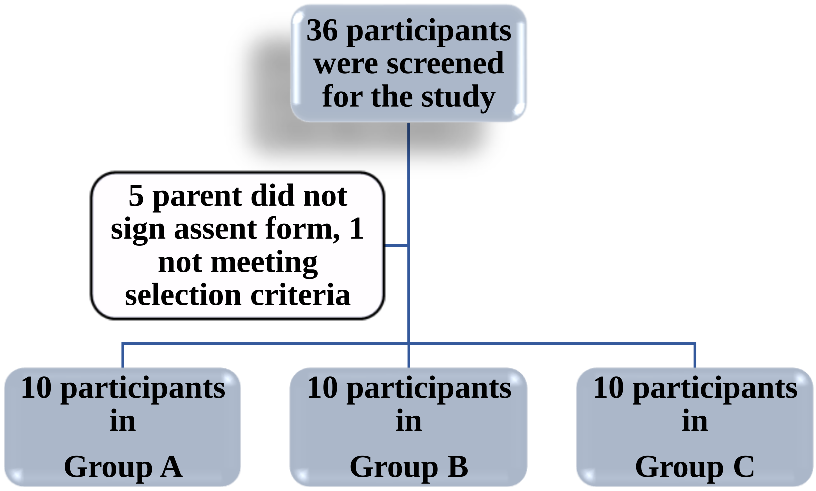
- Assessment sheet.
- Assent form.
- Stethoscope.
- Pulse oximeter.
- Pen-pencil.
- Piece of cotton gauze.

PHOTOGRAPH 4.1: TOOLS OF THE STUDY

4.11]SAMPLING PROCEDURE

After getting ethical approval, purpose and plan of the research were explained to neonatologist. After receiving medical request for chest physiotherapy, details and purpose of the study were explained to all infant's parents and then a parental assent form was obtained. After that, infants with ARDS were screened and selected for inclusion and exclusion criteria. Then infants who fulfilled the selection criteria underwent detailed assessment.

Participants were randomly divided into three groups, 10 participants in each Group A, Group B, and Group C. Group A received Conventional chest Physiotherapy. Group B received a Prolonged slow expiration technique along with Conventional chest Physiotherapy. Group C received Lung squeezing technique along with Conventional chest Physiotherapy.



FLOW CHART OF SAMPLING PROCEDURE

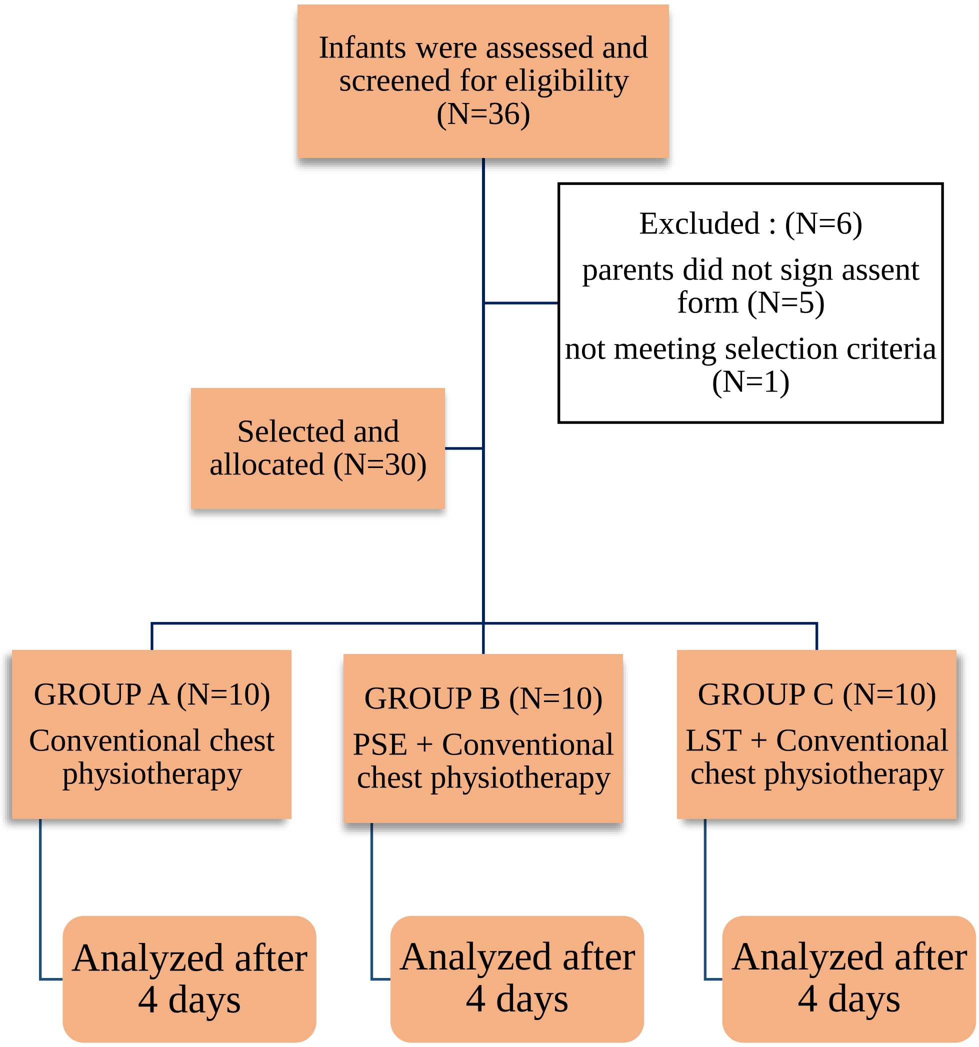
4.11.1 DATA COLLECTION PROCEDURE

After receiving a medical request for chest physiotherapy, information related to research and treatment protocol was explained to the patient's parents and a signed assent form was taken. Then detailed assessment procedure was done based on the assessment sheet. Birth weight, gestational age, APGAR, mode of delivery, vital signs, respiratory assessment, related other conditions, and detailed assessment were obtained. Randomly allocated into group A (n=10), group B (n=10), and group C (n=10) by using a computerized generated method. Outcome measures were taken at the beginning of treatment, immediately after the 8^{th} session of treatment, and after 4 hours of the 8^{th} session of the treatment programme.

Group A received CCP, group B received PSE + CCP, and group C received LST + CCP.

All subjects were assessed by SpO_2, RR, and length of hospital stay.

All groups were treated 2 times a day, for 4 days.



ALLOCATION CHART

4.12 TREATMENT INTERVENTION

GROUP A: CONVENTIONAL CHEST PHYSIOTHERAPY[34,37]

CCP included postural drainage, percussion, vibration, and tracheal stimulation.

Postural drainage was performed as per the involvement of the lungs.

Percussion was given with tenting of fingers (first three or four fingers of one hand with slight elevation of the middle finger), with lying down on the right side and lying down on the left side with 5 minutes duration on each side.

Vibration consisted of quick rhythmic movements with enough intensity to cause a vibration of the airway. Vibration was given through the manual vibratory motion of the therapist's fingers on the infant's chest wall. The vibration was performed with the hand spread, positioned bilaterally on the thorax, the wrist and elbow remain immobile, impelling the vibratory movement with a mechanical effort by the arm and shoulder muscles. This procedure was performed for 5 minutes.

A cough was induced, when necessary, by applying finger pressure to the trachea.

Treatment was carried out 2 times a day for 4 days.

International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

PHOTOGRAPH 4.2: PDPV FOR UPPER LOBE (LEFT SIDE)

PHOTOGRAPH 4.3: PDPV FOR MIDDLE LOBE (LEFT SIDE)

PHOTOGRAPH 4.4: PDPV FOR LOWER LOBE (LEFT SIDE)

GROUP B: PROLONGED SLOW EXPIRATION TECHNIQUE[38,39] ALONG WITH CONVENTIONAL CHEST PHYSIOTHERAPY

Conventional chest physiotherapy was the same as group A.

The therapist placed the hypothenar region of one hand under the sternal notch of the infant's chest and the hypothenar region of the other hand below the umbilicus of the infant's abdomen.

At the end of the expiratory phase, gentle pressure was applied with both hands to take the patient to the expiratory reserve volume. The hand on the chest moves in the craniocaudal direction and the other in the opposite direction. This pressure was kept for two or three breathing cycles without exceeding five cycles. This technique was repeated between 30 and 33 times, with a rest time between applications of about 5 or 10 spontaneous breaths.

There were three sequences of PSE maneuver (named A, B, and C) in a continuous period of 120 sec. The interval between the sequences was 30 sec.

A cough was induced, when necessary, by applying finger pressure to the trachea.

Treatment was carried out 2 times a day for 4 days.

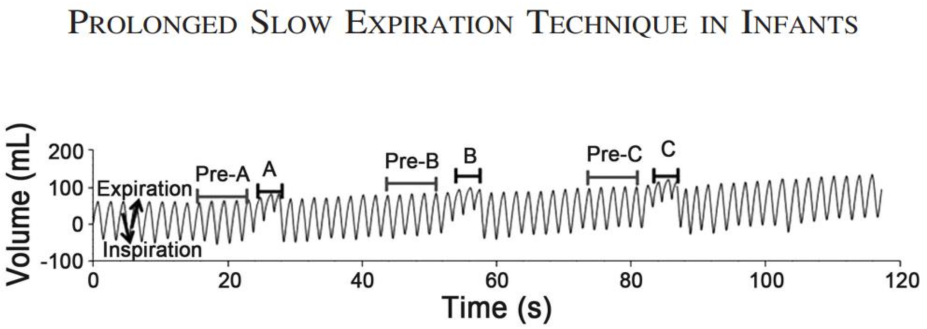


FIGURE 4.1 :Volume-time curve during normal breathing and prolonged slow expiration. Pre-A, Pre-B, and Pre-C are the 5 normal breaths before the PSE sequences (A, B, and C).

PHOTOGRAPH 4.5: PROLONGED SLOW EXPIRATION TECHNIQUE

GROUP C: LUNG SQUEEZING TECHNIQUE [15] ALONG WITH CONVENTIONAL CHEST PHYSIOTHERAPY

Conventional chest physiotherapy was the same as group A.

LST was performed with one hand placed on the posterolateral aspect of the hemithorax and the other hand covering the anterior chest extending from the lower ribs to above the clavicle of the infant.

Each set of "lung squeezes" consisted of 3-4 cumulative chest compressions lasting for 5 seconds, followed by a gentle slow "release phase" with the chest wall completely released; these compressions were performed successively for 5 minutes on one hemithorax, then 5 minutes on the other hemithorax. These compressions were given without vibration.

In order to minimize potentially deleterious effect of lowering the end-expiratory lung volume, the delivery of the chest compressions would not be intended to be in synchrony with the infant's breathing pattern, and full range compression from full inspiration to end expiration should avoid.

A cough was induced, when necessary, by applying finger pressure to the trachea.

Treatment was carried out 2 times a day for 4 days.

PHOTOGRAPH 4.6: LST (RIGHT SIDE)

5. RESULTS AND INTERPRETATION

For statistical analysis, data were obtained at the beginning of treatment, immediately after the 8^{th} session of treatment, and after 4 hours of the 8^{th} session (total 4 days) of the treatment programme. Mean and standard deviation of pre and post-test values of SpO_2, RR in GROUP A, GROUP B, and GROUP C were done. Length of hospital stay was counted for all the groups.

Statistical analysis was done by using SPSS (statistical package for social science) version 26.0 at the first step. Before applying statistical tests, data were screened for normal distribution using the Shapiro-Wilk test. Descriptive analysis was done to find out the means and standard deviation. The intra-group comparison was done using ANOVA with repeated measures, for comparison between pre-value, immediately after value, and after 4 hours value of SpO_2 and RR. Inter-group comparison was done by using One-Way ANOVA with Post hoc (follows normality) for SpO_2, RR, and length of hospital stay. The significance level adopted for the statistical test was a 95% confidence level.

TABLE 5.1: DEMOGRAPHIC DETAILS (AGE DISTRIBUTION)

DEMOGRAPHIC DETAILS		GROUP A	GROUP B	GROUP C
AGE (DAYS)	Mean	5.3	5.2	5.9
	SD	+3.19	+3.15	+3.14

GRAPH 5.1: AGE DISTRIBUTION

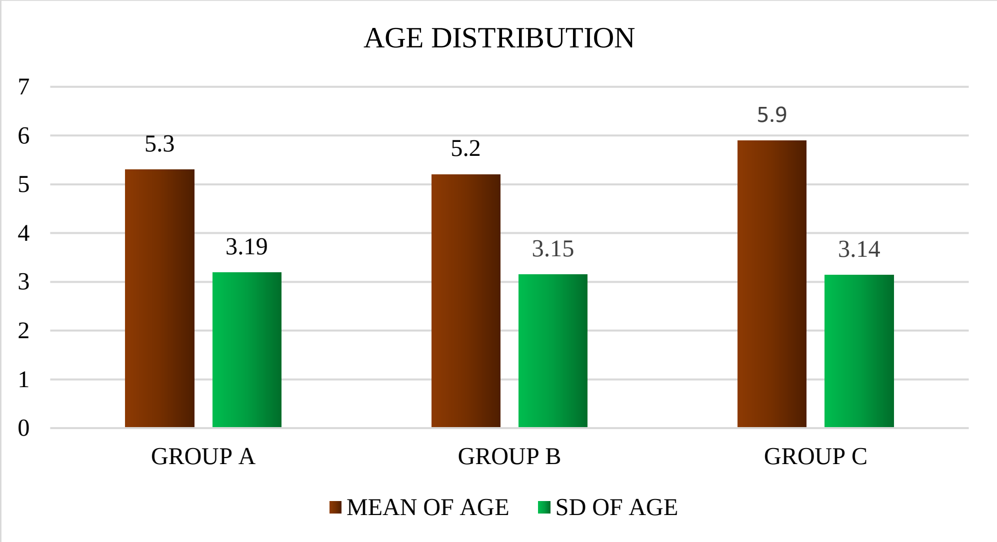
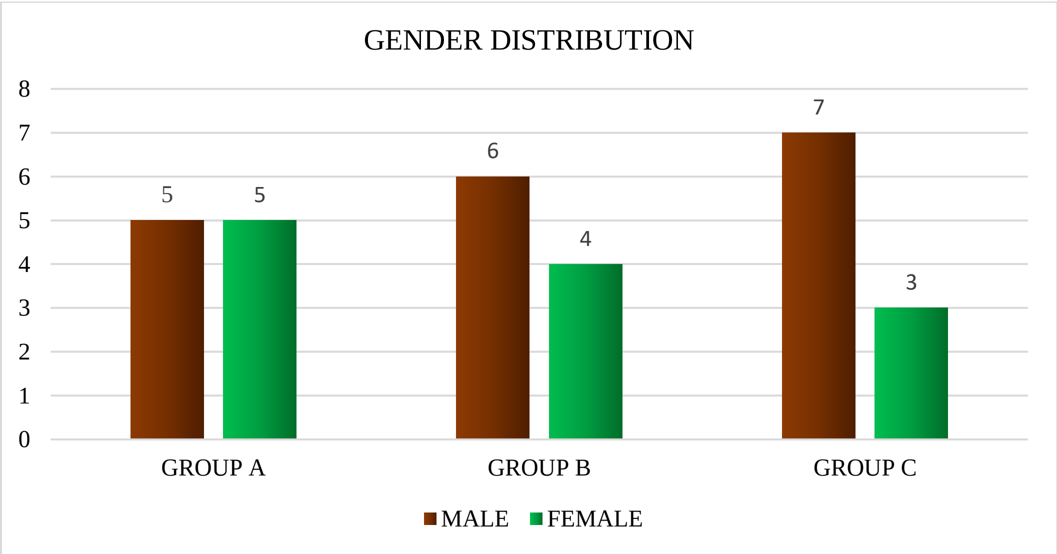


Table 5.1 and Graph 5.1 show the **mean and +SD** of age Group A (5.3+3.19), Group B (5.2+ 3.15), and Group C (5.9+3.14). No statistically significant difference was found between the ages of the participants in all groups, proving that the groups are homogenous in terms of age.

TABLE 5.2: GENDER DISTRIBUTION

DEMOGRAPHIC DETAILS		GROUP A	GROUP B	GROUP C	PERCENTAGE
GENDER	Male	5	6	7	60.00%
	Female	5	4	3	40.00%

GRAPH 5.2: GENDER DISTRIBUTION



GRAPH 5.3: GENDER DISTRIBUTION

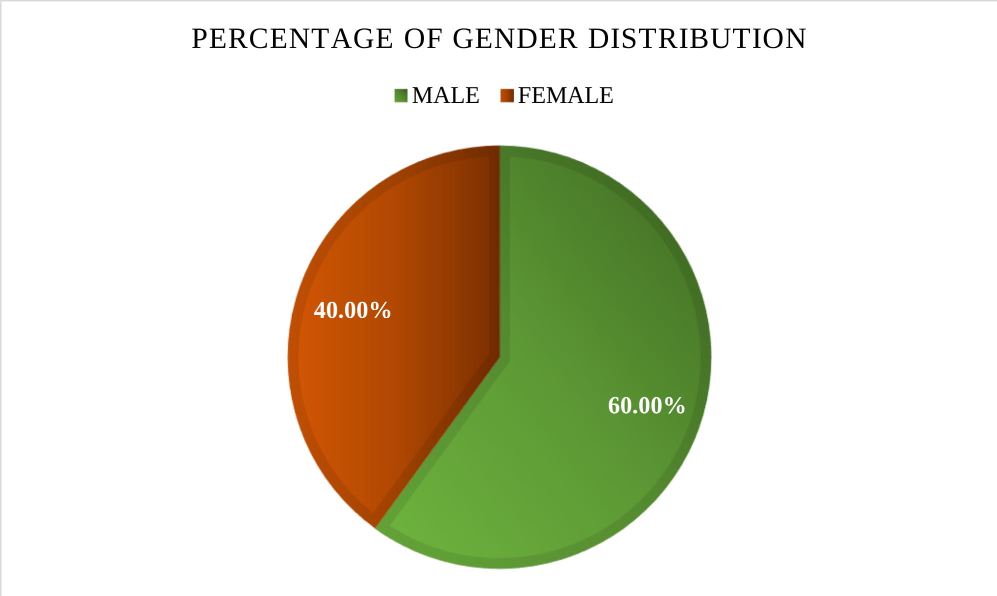
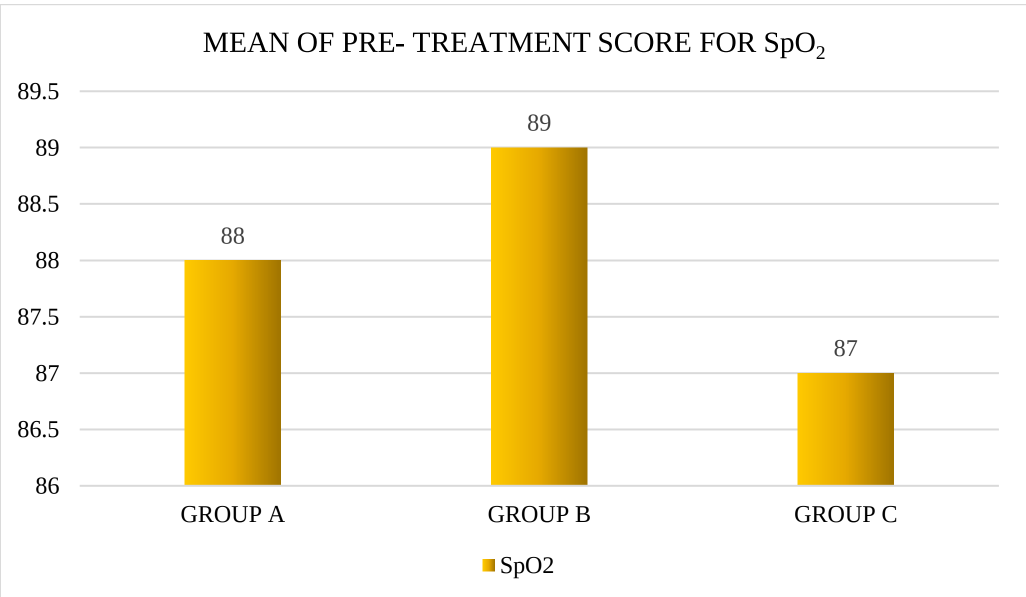


Table 5.2, Graph 5.2 and 5.3 shows the gender distribution among Group A, Group B, and Group C. A total of 30 participants: 18 males and 12 females participated in the study. Out of 30 participants, Group A consists of 5 males and 5 females, Group B consists of 6 males and 4 females, and Group C consists of 7 males and 3 females.

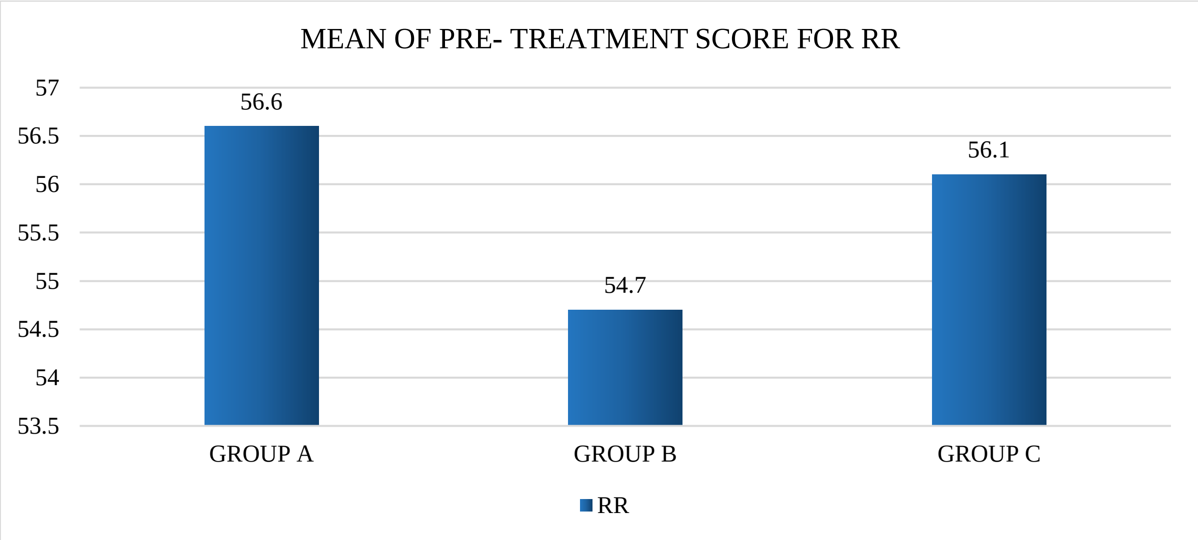
TABLE 5.3: INTER-GROUP COMPARISON OF PRE-TREATMENT SCORE OF SpO_2, RR

GROUP	GROUP A		GROUP B		GROUP C		F VALUE	p-VALUE
	Mean	SD	Mean	SD	Mean	SD		
SpO_2	88.00	+4.23	89.00	+4.055	87.40	+4.81	0.34	0.71
RR	56.60	+6.56	54.70	+5.65	56.10	+5.30	0.28	0.75

GRAPH 5.4: INTER-GROUP COMPARISON OF MEAN OF PRE-TREATMENT SCORE FOR SpO_2



GRAPH 5.5: INTER-GROUP COMPARISON OF MEAN OF PRE-TREATMENT SCORE FOR RR

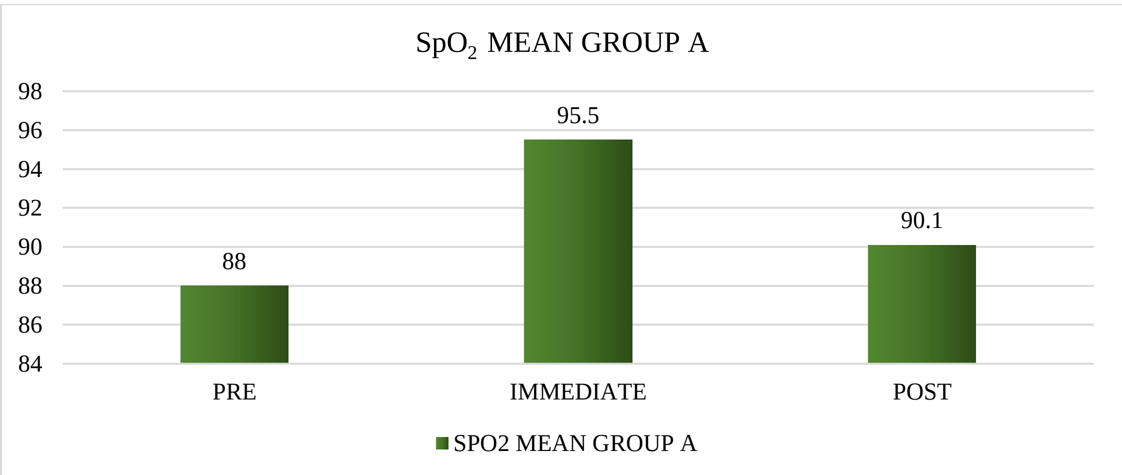


The above table 5.3, graphs 5.4 and 5.5 shows inter-group comparison of pre-treatment scores of SpO_2 and RR for group A, Group B, and Group C. The p-value is >0.05 which shows there is no statistically significant difference between the pre-treatment score of SpO_2 and RR. Hence it proves the pre-treatment data are homogenous.

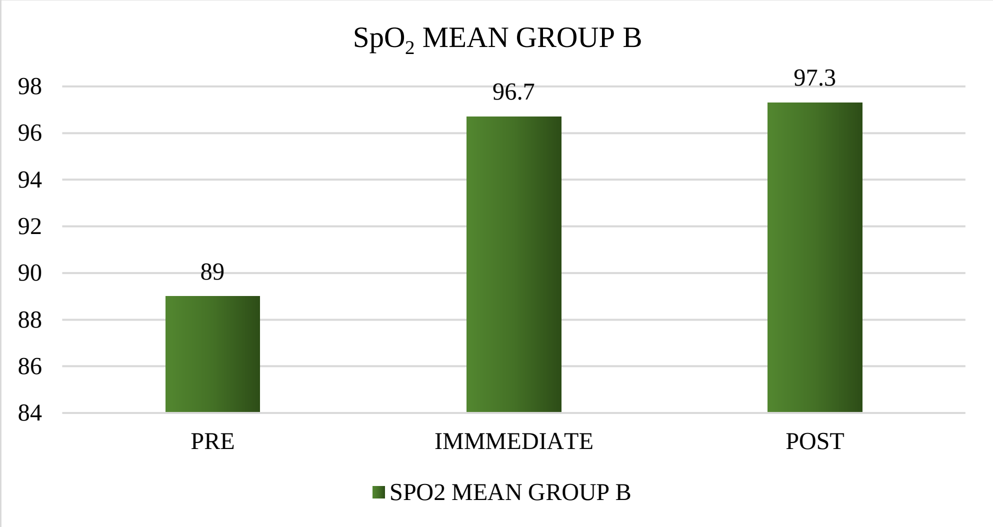
TABLE 5.4: INTRA GROUP COMPARISON OF PRE, IMMEDIATE & POST-TREATMENT OF SpO_2

GROUP	PRE		IMMEDIATE (After 8th session)		POST (After 4 hours of the 8th session)		P-VALUE
	Mean	SD	Mean	SD	Mean	SD	
GROUP A	88.00	+4.24	95.50	+2.95	90.10	+4.202	0.04
GROUP B	89.00	+4.05	96.70	+2.58	97.30	+2.058	0.03
GROUP C	87.40	+4.81	95.20	+2.20	98.00	+1.56	0.03

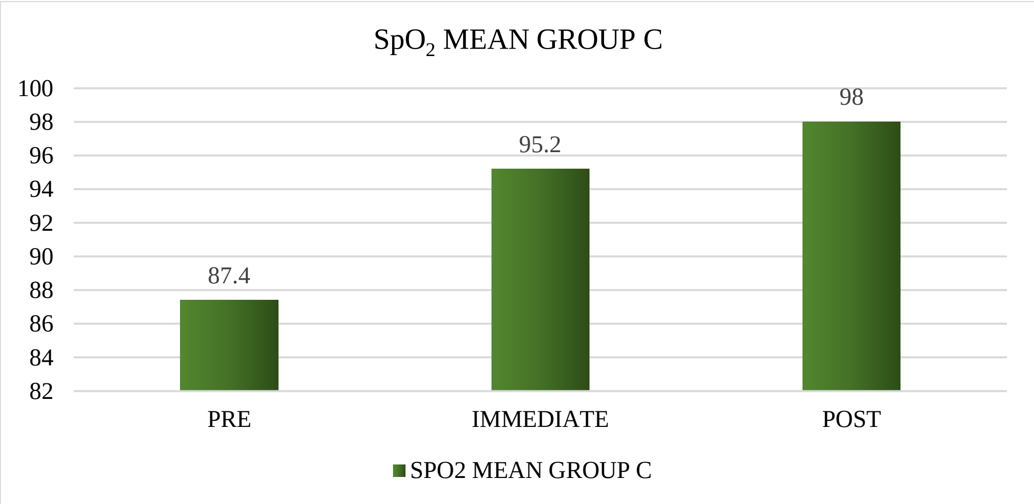
GRAPH 5.6: INTRA GROUP COMPARISON OF SpO_2 (GROUP A)



GRAPH 5.7-: INTRA GROUP COMPARISON OF SpO_2 (GROUP B)



GRAPH 5.8: INTRA GROUP COMPARISON OF SpO_2 (GROUP C)

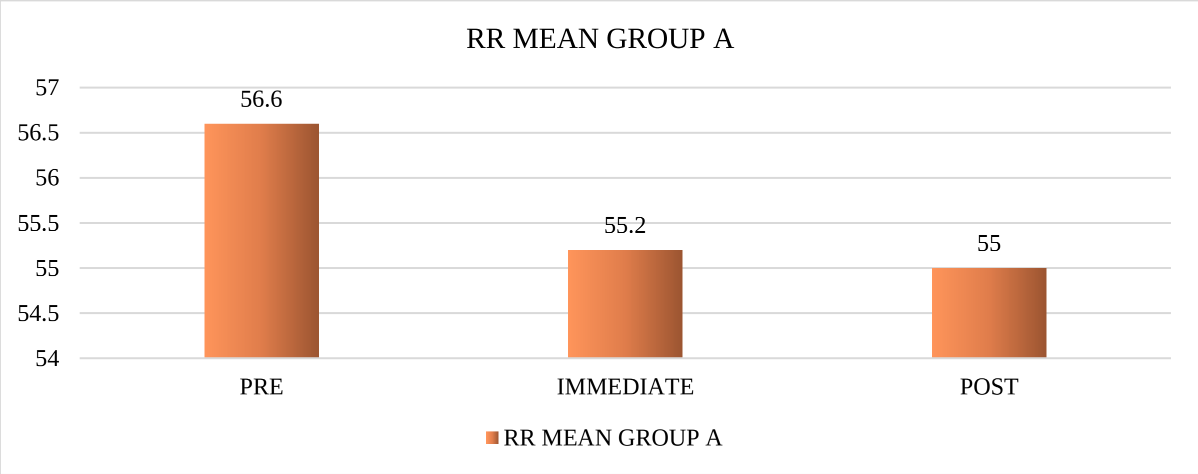


The above table 5.4, Graph 5.6, 5.7, and 5.8 shows the intra-group comparison of pre, immediate after & post-treatment scores of SpO_2 (Group A, B, and C) using ANOVA with repeated measures test. The p-value is <0.05 which shows significant differences in all groups. It shows that the treatment of Group A, B, and C is effective. So null hypothesis H_01, H_02, and H_03 are rejected and alternate hypothesis H_11, H_12, and H_13 are accepted.

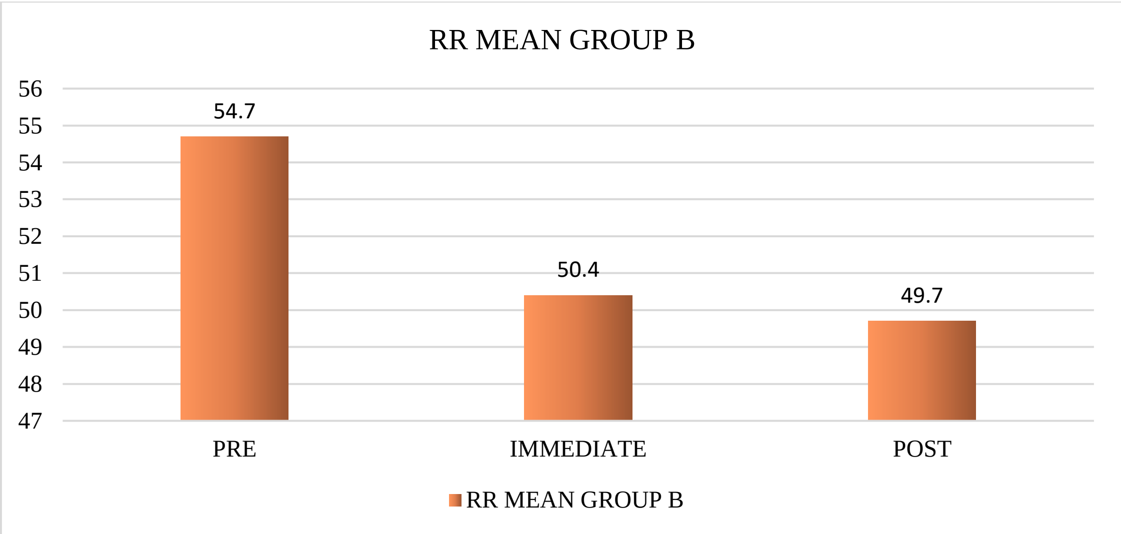
TABLE 5.5: INTRA GROUP COMPARISON OF PRE, IMMEDIATE & POST-TREATMENT OF RR

GROUP	PRE		IMMEDIATE (After 8th session)		POST (After 4 hours of the 8th session)		P-VALUE
	Mean	SD	Mean	SD	Mean	SD	
GROUP A	56.60	+6.56	55.20	+0.17	55.00	+5.12	0.04
GROUP B	54.70	+5.65	50.40	+0.00	49.70	+3.05	0.02
GROUP C	56.10	+5.30	53.00	+0.03	51.00	+4.83	0.03

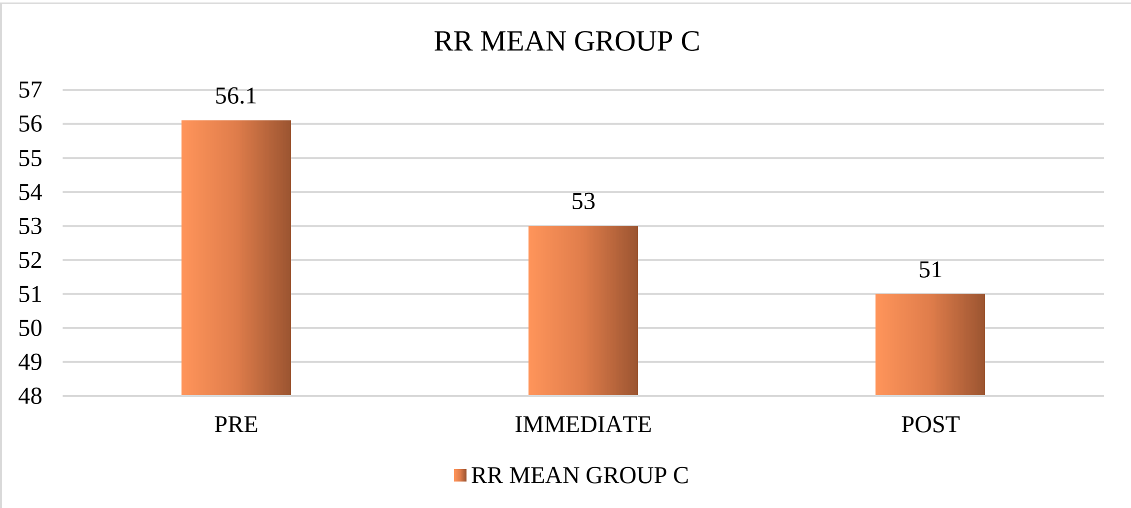
GRAPH 5.9: INTRA-GROUP COMPARISON OF RR (GROUP A)



GRAPH 5.10: INTRA-GROUP COMPARISON OF RR (GROUP B)



GRAPH 5.11: INTRA-GROUP COMPARISON OF RR (GROUP C)



The above table 5.5, Graph 5.9, 5.10, and 5.11 shows the intra-group comparison of pre, immediate & post-treatment scores of RR (Group A, B, and C) using ANOVA with repeated measures test. The p-value is <0.05 which shows significant differences in all groups. It shows that treatment is effective. So null hypothesis H_01, H_02, and H_03 are rejected and alternate hypothesis H_11, H_12, and H_13 are accepted.

TABLE 5.6: INTER-GROUP COMPARISON OF PRE AND IMMEDIATE AFTER TREATMENT OF SPO_2, RR (GROUP A, B & C)

Variable	GROUP A		GROUP B		GROUP C		P-value
	Mean difference	SD	Mean difference	SD	Mean difference	SD	
SPO_2	2.50	+1.78	7.70	+1.82	7.80	+3.45	0.00
RR	-1.20	+2.04	-4.30	+3.19	-3.10	+5.95	0.29

GRAPH 5.12: INTER-GROUP COMPARISON OF PRE AND IMMEDIATE AFTER TREATMENT OF SPO_2, RR (GROUP A, B & C)

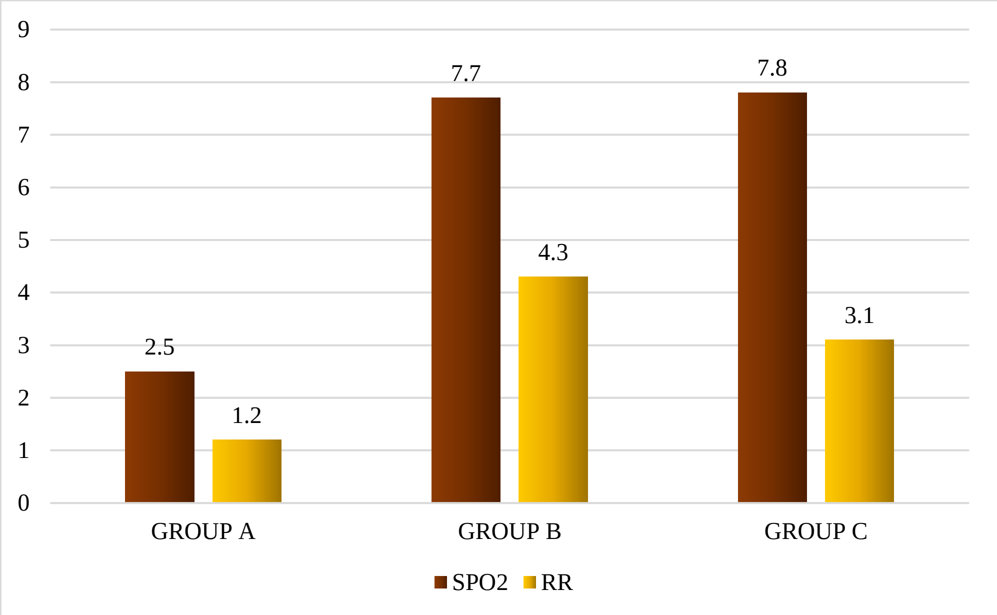


Table 5.6 and graph 5.12 shows inter-group comparison of the mean difference of pre and immediate scores of SpO_2, RR using One-Way ANOVA with Post hoc test for Group A, B & C. p-value is <0.05 which shows significant differences in all groups.

It shows that the treatment of Group C is more effective in improving SpO_2 followed by Group B and A.
It shows that the treatment of Group B is more effective in improving RR followed by Group C and A.

TABLE 5.7: INTER-GROUP COMPARISON OF IMMEDIATE AFTER AND POST (AFTER 4 HOURS OF THE 8TH SESSION)-TREATMENTOF SPO_2, RR (GROUP A, B & C)

Variable	GROUP A		GROUP B		GROUP C		P-value
	Mean difference	SD	Mean difference	SD	Mean difference	SD	
SPO_2	-0.40	+2.67	0.60	+1.07	2.80	+2.20	0.06
RR	-0.40	+3.77	-0.70	+1.05	-2.00	+1.05	0.32

GRAPH 5.13: INTER-GROUP COMPARISON OF IMMEDIATE AFTER AND POST (AFTER 4 HOURS OF THE 8TH SESSION)-TREATMENT OF SPO_2, RR (GROUP A, B & C)

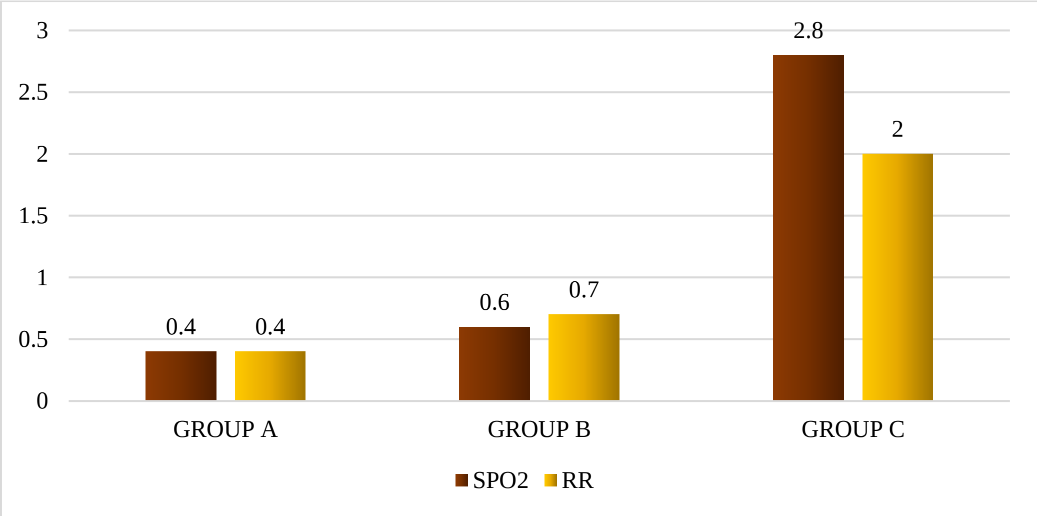


Table 5.7 and graph 5.13 shows inter-group comparison of the mean difference of immediate after and post scores of SPO_2, RR using One-Way ANOVA with Post hoc test for Group A, B & C. p-value is <0.05 which shows significant differences in all groups.
It shows that the treatment of Group C is more effective in maintaining SpO_2 than followed by Group B and Group A. It shows that the treatment of Group C is more effective in maintaining RR followed by Group B and Group A.

TABLE 5.8: INTER-GROUP COMPARISON OF LENGTH OF HOSPITAL STAY (GROUP A, B & C)

Variable	GROUP A		GROUP B		GROUP C		P-value
	Mean	SD	Mean	SD	Mean	SD	0.67
HS	8.30	+2.35	8.10	+1.5	8.00	+1.3	

GRAPH 5.14: INTER-GROUP COMPARISON OF LENGTH OF HOSPITAL STAY (GROUP A, B & C)

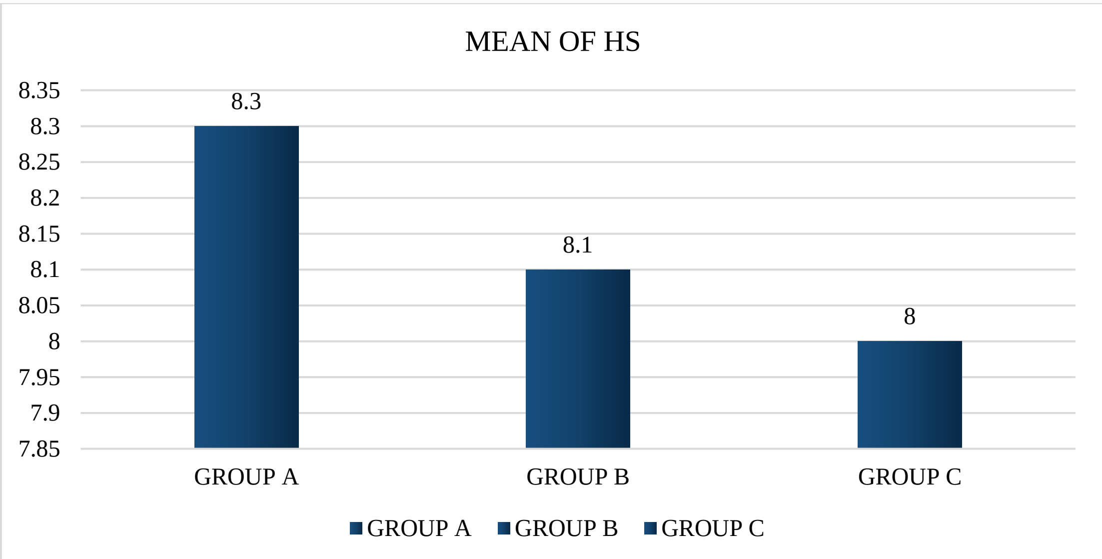


Table 5.8 and graph 5.14 shows inter-group comparison of the mean difference in length of hospital stay using One-Way ANOVA with Post-hoc test for Group A, B & C. p-value is <0.05 which shows significant differences in all three groups.
It shows that the treatment of Group C is more effective by means of measuring the length of hospital stay in Group B and Group A.

6. DISCUSSION

chest physiotherapy for infants with respiratory dysfunction is a growing need in the specialty of cardio-pulmonary physiotherapy practice. As many treatment methods are currently used to treat these kinds of patients and also there is a need of finding out a correct technique that suits patients' condition for appropriate treatment methods that are less potentially painful & as less stressful as intervention.
Research conducted by **Gopal Krishna et al. (2020)** on Physiotherapy Practice Patterns for Acute Respiratory Distress Syndrome in Intensive Care Unit in India -A National Survey. The objective was to determine the practice patterns of physiotherapists for acute respiratory distress syndrome (ARDS) in the Intensive care unit in India. Reported that the assessment and treatment techniques were similar for certain measures for both ventilated and non-ventilated acute respiratory distress syndrome patients. Treatment predominately focuses on percussion, vibration, postural drainage, and range of motion exercises for ventilated patients and in addition to all those breathing strategies and functional training for non-ventilated patients.
In the literature, PSE and LST showed significant effectiveness but these both techniques were not compared before. So, the purpose of this study was to compare the effect of prolonged slow expiration technique and lung squeezing technique on SpO_2 and RR among infants with ARDS on respiratory functions. This present study analyzed the effects of these both techniques along with conventional chest physiotherapy on SpO_2 and RR among infants with ARDS admitted in NICU.
A total of 36 participants were assessed for the study. Among them, 30 participants were recruited and were divided into 3 Groups: group A, group B, and group C. group A received CCP, group B received PSE + CCP, and group C received LST + CCP.
The mean age of group A was 5.3, +3.19 (mean, + SD), group B was 5.2, +3.15 (mean, + SD) and group B was 5.9, +3.14 (mean, +SD). There was no statistically significant difference so groups were homogenous in terms of age.
Group A consists of 5 males and 5 females, Group B consists of 6 males and 4 females, and Group C consists of 7 males and 3 females. 18 male and 12 female participants were included in this study. The normality test was done using the Shapiro-Wilk test.
SpO_2 and RR were analyzed at the beginning of treatment, immediately after the 8^{th} session of treatment, and after 4 hours of the 8^{th} session of treatment to assess oxygenation in the infants & length of hospital stay was used as a secondary outcome measure.
After the completion of 4 days of treatment sessions data scores were collected and all data were evaluated statistically in SPSS software version 26.0.
Based on the analysis of demographic data age, and gender distribution showed homogeneity in all 3 Groups. Inter-group comparison of pre-treatment score data for SpO_2 and RR for Group A, Group B, and Group C showed homogeneity ($p=0.962$, $p=0.679$, and $p=0.674$ respectively).
The result of the pre-treatment score of all three groups at baseline shows $p>0.05$, indicating that there is no statistically significant difference between the pre-treatment scores of SpO_2 And RR. Hence it proves

that both groups were homogenous at baseline.

Intra-group comparison of the mean of pre, immediately after the 8^{th} session, and after 4 hours of the 8^{th} session (total 4 days) data of SpO_2 for Group A, B, and C showed statistically significant improvement ($p=0.04$ for Group A, $p=0.03$ for Group B and $p=0.03$ for Group C).

Intra-group comparison of the mean of pre, immediately after the 8^{th} session, and after 4 hours of the 8^{th} session (total 4 days) data of RR for Group A, B, and C showed statistically significant improvement ($p=0.04$ for Group A, $p=0.02$ for Group B and $p=0.03$ for Group C).

Intra-group comparison of the mean of pre, immediate after the 8^{th} session and after 4 hours of the 8^{th} session (total 4 days) data of SpO_2 and RR proved by ANOVA with repeated measures which show a significant difference in pre, immediate after 8^{th} session and after 4 hours of 8^{th} session after a total 4 days (total 8 sessions) of treatment of groups, p-value < 0.05 in each group. This means that conventional chest physiotherapy, PSE along with conventional chest physiotherapy, and LST along with chest physiotherapy both are effective in improving & maintaining oxygenation and reducing & maintaining RR.

So null hypothesis H_01, H_02, and H_03 are rejected and alternate hypothesis H_11, H_12, and H_13 are accepted.

Inter-group comparison of a score of difference between pre and immediate after 8^{th} session data of SpO_2 showed statistically significant effectiveness ($p=0.00$). Inter-group comparison of a score of difference between, immediately after the 8^{th} session and after 4 hours of the 8^{th} session (total 4 days) data of SpO_2 showed statistically significant effectiveness ($p=0.06$).

Inter-group comparison of a score of difference between pre and immediate after 8^{th} session data of ($p=0.29$) and Inter-group comparison of a score of difference between, immediate after the 8^{th} session and after 4 hours of the 8^{th} session (total 4 days) data of RR ($p=0.32$). It shows that the treatment of Group C is more effective in maintaining SpO_2 than followed by Group B and Group A.

Inter-group comparison of the mean of pre, immediate after the 8^{th} session, and after 4 hours of the 8^{th} session (total 4 days) data of SpO_2 and RR proved by One-Way ANOVA with Post hoc test.

Inter-group comparison of a score of the length of hospital stay analysis showed statistically significant effectiveness ($p=0.67$). It also shows that the treatment of Group C is more effective by means of measuring the length of hospital stay than Group B and Group A.

Basic physiotherapy interventions consist of chest manipulations which include vibration, percussion, suctioning to clear the retained pulmonary secretions, positioning (supine, prone, alternate side-lying) to improve oxygenation, to decrease the incidence of ventilator-associated pneumonia and to improve ventilation-perfusion mismatch and active or passive mobilization to prevent deconditioning.[4]

For the effect of the PSE technique, the result was explained by a possible mechanism where pressure is exerted on the thorax and abdomen to prolong the expiratory phase which evokes sigh breaths easily in infants because of the immaturity of the pulmonary receptors and obtained lung deflation helps secretions to flow from larger airways where tracheal stimulation can move secretions to the trachea and then out of the mouth.[31] Intrathoracic pressure increases slowly by means of thoracoabdominal compression to prevent bronchial collapse and disruption of the flow that occurs during forced expirations.[16] This pressure difference improves pulmonary airflow from the alveoli to the trachea, which removes mucus.[18]

Evelim L. F. D. Gomes et al. The impact of this specific technique (PSE) in addition to the deflation of ERV is the increase in tidal volume resulting from subsequent activation of the Hering-Breuer reflex by a prolonged expiratory time and sighs, which in the infant is clinically important because the inherent differences between the infant and adult making the respiratory system more likely to develop muscle fatigue and discomfort.[31]

Fernanda C. Lanza et al. The reduction in lung volume is physiologically associated with the protective reflex of the airways, which restores lung volume by sigh breathing (Hering-Breuer deflation reflex). It has been presumed that PSE can evoke sigh breaths, but it has not been objectively determined until the present study. Sighing may benefit these patients by improving alveolar ventilation and lung volume[16]

Luciana M. et al. stated that improvement in SpO_2 and reduction in RR in AVB infants with the activation of the hering-Breuer reflex.[31]

This study used PDPV as a CPT intervention. Chest percussions help unstick mucus from the lungs so that it can be coughed out. vibration in addition to percussion, which caused thinning and loosening of secretions with further movement of these secretions to the larger airways.

LST helps to "squeeze" secretions from distal airways with changes in the intrathoracic pressures, and the formation of central mucus globules that are easier to expectorate, freeing the adhesive secretions from the airway walls. With effective percussion, SpO_2 improved as secretions move into the larger airways. LST facilitates the emptying of the hyperinflated lung units. This decompression effect may be due to a cephalad bias in airflow and greater peak expiratory airflow when compared to inspiratory airflow and demonstrated to promote re-expansion of atelectatic lung regions as well as the similar effect on bronchial clearance, which may also be a secondary effect of the cephalad bias in airflow generated during LST.[35] Suctioning following these two techniques was done if needed, as when obstructive secretions were present.

In **2003 Tai Fai Fok.** stated that LST was more effective than conventional Postural Drainage Percussion Vibration (PDPV) for the re-expansion of lung Atelectasis among the ventilated pre-term neonates in our study.[19]

Lung squeezing technique known to improve respiratory system compliance and lung mechanics in preterm infants, it is suggested that lung squeezing can also be used as an intervention to enhance distribution of ventilation in mechanically ventilated respiratory distress syndrome infants[17] increase in compliance following LST in the neonates may occur as a result of the recruitment of atelectatic lung units and a more homogeneous distribution of ventilation within the lung units .[27]

Rasha A. Mohmed et al. stated that chest physiotherapy is effective for newborns with ARDS. He was treating neonates with lung squeezing technique, postural drainage, suctioning, and positioning. The result of this study showed that changes were in the form of increasing in SAP, DAP, PH, and PaO_2 & decreasing in HR, RR, and $PaCO_2$. Also showed significant improvement after treatment in vital signs and ABG analysis.[26] Though, this study was supporting LST, which is effective in improving SpO_2 and reducing RR in infants with ARDS and LST is also safe as well as an effective line of treatment technique to use during the NICU management of infants with ARDS.[26]

Neha J Thacker et al. conducted a study on the effect of the lung squeezing technique for correcting atelectasis in mechanically ventilated preterm infants with respiratory distress syndrome and they concluded that LST is more effective in correcting atelectasis as compared to the CCP technique in mechanically ventilated preterm infants with RDS. Also, LST is a less stressful physiologically and practically more convenient technique than the CCP technique.[27] **Ivor Wong et al.** stated that with the use of LST, full re-expansion occurred in preterm neonates with atelectasis without any additional adverse effects. That is supporting the present study as LST was effective in infants with ARDS without any adverse effects.[35]

Ivor Wong et al. conducted a study on the effects of the lung squeezing technique on lung mechanics in mechanically-ventilated preterm infants with respiratory distress syndrome. The purpose of the study was to investigate the effect of LST on parameters of lung mechanics in preterm infants on mechanical ventilation. Found that the lung squeezing technique (LST) was more effective in correcting lung atelectasis when compared to percussion and vibration given in modified drainage positions.[15] Result of this study supports the present study on the effectiveness of LST.

IMITATIONS OF THE STUDY

- Study consisted of a smaller sample size.
- No long-term follow-up was taken.
- All the participants were not on the same medications in NICU.

6.1. SCOPE FOR THE FUTURE STUDY

- The study can be revised by involving a larger sample size.
- The study can be done with some other respiratory disorders in NICU.
- The study can be carried out by comparing different treatment methods.
- The same study can be done with a longer treatment duration.
- The same study can be done by measuring ABG analysis.

7. CONCLUSION

The obtained results showed a significant improvement in oxygenation and respiratory rate in all three groups that received CPT, PSE, and LST. The results also showed that LST along with CCP and PSE along with CCP are superior to the CCP in improving oxygenation and reducing respiratory rate, But LST is superior to PSE in maintaining oxygenation and respiratory rate that leads to fewer days of stay in hospital.

In comparison to PSE, this study finds that LST combined with CCP is a safer and more efficient treatment for infants with ARDS.

8. SUMMARY

This study aimed to compare the effectiveness of prolonged slow expiration technique and lung squeezing technique along with conventional chest physiotherapy on saturation of peripheral oxygen (SpO_2) and respiratory rate (RR) in infants with acute respiratory distress syndrome.

30 infants with ARDS were enrolled in the study. After fulfilling the selection criteria allocated into 3 groups. Group A (10 infants) received CCP, group B (10 infants) received PSE + CCP, and group C (10 infants) received LST + CCP.

The first 4 days of data were collected and analyzed statistically by One-Way ANOVA with Post hoc test, and ANOVA with repeated measures ($p<0.05$). outcome measures of the study were SpO_2, RR, and length of hospital stay.

This study suggests that LST and PSE both are more effective than CCP.

In addition to that LST is a safe, effective treatment and does not have any side effect, whereas PSE were seen less effective in reducing RR and it has been seen that after a treatment session of PSE on the next day abdominal distention was seen in 3 patients.

9. REFERENCES

1. Hillman NH, Lam HS. 19 - Respiratory Disorders in the Newborn [Internet]. Ninth Edit. Kendig's Disorders of the Respiratory Tract in Children. Elsevier Inc.; 338-366.e6 p. Available from: https://doi.org/10.1016/B978-0-323-44887-1.00019-5
2. Villar J, Blanco J, Kacmarek RM. Current incidence and outcome of acute respiratory distress syndrome. Curr Opin Crit Care [Internet]. 2016 [cited 2022 Feb 18];22(1):1–6. Available from: https://journals.lww.com/co-criticalcare/Fulltext/2016/02000/Current_incidence_and_outcome_of_the_acute.2.aspx
3. Solomon R. Pediatric Acute Respiratory Distress Syndrome in India : Time for Collaborative Study ? 2022;
4. Nigam R, Alaparthi GK, Krishnan KS, Zulfeequer CP. Physiotherapy practice patterns for acute respiratory distress syndrome in intensive care unit in India - A survey. Online J Heal Allied Sci. 2017;16(1).
5. Powezka K, Khan T, Narlawar R, Antoniou GA. Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-company ' s public news and information website . Elsevier hereby grants permission to make all its COVID-19-r. 2020;(January).
6. Tamburro RF, Kneyber MCJ, Injury L, Conference C. Pulmonary Specific Ancillary Treatment for Pediatric Acute Respiratory Distress Syndrome: Proceedings From the Pediatric Acute Lung Injury Consensus Conference. 2015;61–72.
7. Saguil A, Fargo M, Eisenhower DD. Acute Respiratory Distress Syndrome: Diagnosis and Management A. 2012 [cited 2022 Feb 20];85. Available from: www.aafp.org/afp.
8. Mathai SS, Raju U, Kanitkar M. Management of respiratory distress in the newborn. Med J Armed Forces India [Internet]. 2007;63(3):269–72. Available from: http://dx.doi.org/10.1016/S0377-1237(07)80152-3
9. Diamond M, Feliciano HLP, Sanghavi D, Mahapatra S. Acute Respiratory Distress Syndrome. StatsPearls[Internet] [Internet]. 2021 Nov 9 [cited 2022 Feb 18]; Available from: https://www.ncbi.nlm.nih.gov/books/NBK436002/
10. Hermansen CL, Mahajan A. Newborn Respiratory Distress. Am Fam Physician [Internet]. 2015 Dec 1 [cited 2022 Feb 20];92(11):994–1002. Available from: http://radiopaedia.org/articles/neonatal-respiratory-distress-causes.
11. Reuter S, Moser C, Baack M. Respiratory Distress in the Newborn. 2014;35(10):417–29.
12. Edwards MO, Kotecha SJ, Kotecha S. Respiratory Distress of the Term Newborn Infant. Paediatr Respir Rev. 2013 Mar 1;14(1):29–37.
13. De Luca D, Autilio C, Pezza L, Shankar-Aguilera S, Tingay DG, Carnielli VP. Personalized Medicine for the Management of RDS in Preterm Neonates. Neonatology. 2021;118(2):127–38.
14. Diagnosis and management of acute respiratory distress syndrome. 2021;193(21):761–8.
15. Wong I, Fok TF. Effects of lung squeezing technique on lung mechanics in mechanically-ventilated preterm infants with respiratory distress syndrome. Hong Kong Physiother J [Internet]. 2006;24(1):39–46. Available from: http://dx.doi.org/10.1016/S1013-7025(07)70007-6
16. Lanza FC, Wandalsen G, dela Bianca AC, Cruz CL, Postiaux G, Solé D. Prolonged slow expiration technique in infants: Effects on tidal volume, peak expiratory flow, and expiratory reserve volume. Respir Care. 2011;56(12):1930–5.

17. Elayaperumal S, Rekha K, Laxmi PD. Effect of lung squeezing technique and reflex rolling on infants with acute respiratory distress syndrome EFFECT OF LUNG SQUEEZING TECHNIQUE AND REFLEX ROLLING ON INFANTS WITH ACUTE RESPIRATORY DISTRESS SYNDROME. 2017;(April):10–6.
18. Nogueira MCP, Ribeiro SNS, Silva ÉP, Guimarães CL, Wandalsen GF, Solé D, et al. Is Prolonged Slow Expiration a Reproducible Airway Clearance Technique? Phys Ther [Internet]. 2019 Sep 1 [cited 2022 Feb 28];99(9):1224–30. Available from: https://academic.oup.com/ptj/article/99/9/1224/5514017
19. Christian PS, Cardiopulmonary MPT. Chest physiotherapy for infants. Int J Physiother Res [Internet]. 2014;2(5):699–705. Available from: www.ijmhr.org/ijpr.html
20. A C, E T, T A. Standardization of the Squeezing Technique for Expectoration in Terms of Timing , Pressure , and Direction. 2012;11–3.
21. Lanaspa M, Valim C, Acacio S, Almendinger K, Ahmad R, Wiegand R, et al. High Reliability in Respiratory Rate Assessment in Children with Respiratory Symptomatology in a Rural Area in Mozambique. [cited 2022 Feb 21]; Available from: https://academic.oup.com/tropej/article/60/2/93/1657964
22. Fouzas S, Priftis KN, Anthracopoulos MB. Pulse Oximetry in Pediatric Practice Pulse Oximetry in Pediatric Practice Sotirios Fouzas , Kostas N . Priftis and Michael B . Anthracopoulos The online version of this article , along with updated information and services , is located on the World Wide W. 2011;(September).
23. Njeru CM, Ansermino JM, Macharia WM, Dunsmuir DT. Variability of respiratory rate measurements in neonates- every minute counts. BMC Pediatr [Internet]. 2022;1–6. Available from: https://doi.org/10.1186/s12887-021-03087-z
24. Bhandari A, Singhi S, Bhalla AK, Narang A. Respiratory rates of Indian infants under 2 months of age. https://doi.org/101080/02724936199811747969 [Internet]. 2016 [cited 2022 Feb 22];18(4):329–34. Available from: https://www.tandfonline.com/doi/abs/10.1080/02724936.1998.11747969
25. Magazine R, Rao S, Chogtu B, Venkateswaran R, Shahul HA. Epidemiological profile of acute respiratory distress syndrome patients : A tertiary care experience. 2017;38–42.
26. Science M, Mohamed RA. Is Chest Physiotherapy Effective For Extremely Preterm Newborns With Respiratory Distress Syndrome ? : Randomized Controlled Study. 2014;1–6.
27. Thacker NJ, Patel NS. I nternational J ournal of A llied M edical S ciences and C linical R esearch (IJAMSCR) Effect of lung squeezing technique for correcting atelectasis in mechanically ventilated preterm infants with respiratory distress syndrome. 2014;2(4):433–8.
28. Article O. Effect of lung squeeze technique and re fl ex rolling on oxygenation in preterm neonates with respiratory problems : A randomized controlled trial. 2022;
29. Chokshi T, Alaparthi GK, Krishnan S, Vaishali K, Zulfeequer CP. Practice patterns of physiotherapists in neonatal intensive care units : A national survey.
30. Chan ED, Chan MM, Chan MM. Pulse oximetry : Understanding its basic principles facilitates appreciation of its limitations. Respir Med [Internet]. 2013;107(6):789–99. Available from: http://dx.doi.org/10.1016/j.rmed.2013.02.004
31. Postiaux G, Medeiros DRL, Monteiro KKDS, Sampaio LMM, Costa D. Chest physical therapy is effective in reducing the clinical score in bronchiolitis : randomized controlled trial. 2012;16(June):241–7.

32. Lanza FDC, Wandalsen GF. Original Article. 2013;39(October 2012):69–75.
33. 5 Ji. 1998;(June).
34. Giannantonio C, Papacci P, Ciarniello R, Ghennet Tesfagabir M, Purcaro V, Cota F, et al. Chest physiotherapy in preterm infants with lung diseases. 2010 [cited 2022 Feb 23]; Available from: www.graphpad.com
35. Wong I, Fok TF. Randomized comparison of two physiotherapy regimens for correcting atelectasis in ventilated pre-term neonates. Hong Kong Physiother J. 2003;21(1):43–50.
36. Hough JL, Flenady V, Johnston L, Woodgate PG. Chest physiotherapy for reducing respiratory morbidity in infants requiring ventilatory support. Cochrane Database Syst Rev. 2008;(3).
37. A. Pryor J, A. Webber B. To John R Plant OBE whose enthusiasm and interest have always encouraged the development of the Physiotherapy Department at Royal. New York. 2001;
38. Conesa-Segura E, Reyes-Dominguez SB, Ríos-Díaz J, Ruiz-Pacheco MÁ, Palazón-Carpe C, Sánchez-Solís M. Prolonged slow expiration technique improves recovery from acute bronchiolitis in infants: FIBARRIX randomized controlled trial. Clin Rehabil. 2019;33(3):504–15.
39. Lievens L, Vandenplas Y, Vanlaethem S, Ginderdeuren F Van. Prolonged Slow Expiration Technique and Gastroesophageal Reflux in Infants Under the Age of 1 Year. 2021;9(September):1–7.

ANNEXURE - 1

ASSENT FORM OF THE PARTICIPANT

સંમતિ પત્ર

COMPARISON OF PROLONGED SLOW EXPIRATION TECHNIQUE AND LUNG SQUEEZING TECHNIQUE ON SATURATION OF PERIPHERAL OXYGEN (SpO_2) AND RESPIRATORY RATE (RR) IN INFANTS WITH ACUTE RESPIRATORY DISTRESS SYNDROME: AN EXPERIMENTAL STUDY

Name of patient: Age/Gender:

દર્દી નું નામ: ઉંમર/જાતિ:

Name of the participant parent :

દર્દીના માતા-પિતાનું નામ :

I have been explained about the research and the treatment, that will be given to my infant for this research. I had time to think and decide that my infant will participate in this research project. I agreed to participate and I am giving this consent without any force. I can discontinue the study at any time without any reason I will inform the research team about my decision. My infant's identity would not get disclosed in the research.

મને સંશોધન અને સારવાર વિશે સમજાવવામાં આવ્યું છે, જે આ સંશોધન માટે મારા શિશુને આપવામાં આવશે. મારી પાસે વિચારવાનો અને નક્કી કરવાનો સમય હતો કે મારું શિશુ આ રિસર્ચ પ્રોજેક્ટમાં ભાગ લેશે. હું ભાગ લેવા માટે સંમત છું અને હું આ સંમતિ કોઈપણ બળ વિના આપી રહ્યો છું. હું કોઈપણ કારણ વગર કોઈપણ સમયે અભ્યાસ બંધ કરી શકું છું હું મારા નિર્ણય વિશે રિસર્ચ ટીમને જાણ કરીશ. સંશોધનમાં મારા શિશુની ઓળખ જાહેર કરવામાં આવશે નહીં.

Signature of Patient's parent: Signature of Researcher:

દર્દીના માતા-પિતાની સહી: સંશોધનકારની સહી :

Date :

ANNEXURE-II
ASSESSMENT FORM

DATE :

DEMOGRAPHIC DETAILS :
Patient name:
Age:
Sex:
Gestational age:
Address:
Date of birth:
Date of examination:
Religion:
Referring pediatrician:
APGAR score:
Present complains:

HISTORY:
History of present illness:
Birth weight:
Socioeconomic history:
Any overcrowding area-
Socioeconomic deprivation-
History of parental smoking:
History of breastfeeding:
Hereditary abnormality:
MATERNAL HISTORY:
Age of mother at the time of baby's birth _____ year
Age of father at the time of baby's birth _____ year
Age of mother at the time of marriage _____ year
Consanguineous marriage - yes/no
Maternal illness - yes/no
History of insulin-dependent diabetes - yes/no
History of hypertension – yes/no
History of infection – yes/no
History of previous pregnancy - yes/no
FAMILY HISTORY:
Siblings:
BIRTH HISTORY:
Pre-term/full-term/post-term:
History of respiratory distress:

History of cardiac abnormality:
History of infection:
Type-
Mode of delivery:
Birth presentation:
History of delay cry:
History of the place of delivery:

GENERAL APPEARANCE:

General condition: irritable/lethargic/poor feeding
Lines & external appliances:
Peripheral oedema:

VITAL SIGNS:

Heart rate - ________beats/minute
Respiratory rate - ________breaths/ minute
Blood pressure - ________mm hg
Spo_2 - ________%

RESPIRATORY ASSESSMENT:

Recession:
Subcostal-
Sternal-
Nasal flaring:
Tachypnoea:
Respiratory pattern:
Expiratory grunting:
Head bobbing:
Use of accessory muscle:
Abnormal breath sound:
Crackles-
Wheeze-

DOWN'S SCORING SYSTEM FOR RESPIRATORY DISTRESS			
	0	1	2
Cyanosis	none	In-room air	In 40% FIO_2
Retraction	none	Mild	Severe
Grunting	none	Audible with stethoscope	Audible without stethoscope
Air entry	Clear	Decreased/delayed	Barely audible
Respiratory rate	Under 60	60-80	Over 80 or apnea

INTERPRETATION:
Score: >4 = clinical respiratory distress; monitor arterial blood gases
>8 = impending respiratory failure

PALPATION:

Fever:
Capillary refilling time - ________seconds

AUSCULTATION:
Breath sounds: normal/abnormal/adventitious
INVESTIGATION:
Saturation of peripheral oxygen:
Chest x-ray
TREATMENT PLAN:

ANNEXURE III
DATA COLLECTION FORM

Name:
Age:
Gender:
Height:
Weight:
OPD NO:
Group:

NO.	VARIABLES	PRE-MEASURES	POST MEASURES
1	SpO_2		
2	RR		
3	length of hospital stay		