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Effectiveness of combined chest physiotherapy, nebulization, and therapeutic positioning in improving respiratory status among children with pneumonia: A literature review

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Abstract

Background: Pneumonia remains one of the leading causes of morbidity and mortality among children worldwide, particularly in developing countries. Airway obstruction caused by retained secretions frequently impairs respiratory function, indicating the need for effective evidence-based supportive interventions in addition to pharmacological treatment.

Purpose: To evaluate the effectiveness of combined chest physiotherapy, nebulization, and therapeutic positioning in improving the respiratory status of children with pneumonia.

Methods: A systematic literature review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach. Relevant articles were identified through Google Scholar, PubMed, and Portal Garuda using predefined keywords and Boolean operators. Studies published between 2021 and 2025 that investigated chest physiotherapy, nebulization, positioning, or their combination in pediatric patients with pneumonia were screened according to predetermined inclusion and exclusion criteria. Eleven eligible studies were included and synthesized using narrative analysis.

Results: The reviewed studies consistently demonstrated that combining chest physiotherapy, nebulization, and therapeutic positioning improved respiratory outcomes in children with pneumonia. The interventions increased oxygen saturation, reduced respiratory rate and respiratory distress, enhanced airway clearance through secretion mobilization, and improved patient comfort. Compared with single interventions, combination therapy produced more comprehensive improvements in respiratory function by simultaneously optimizing pulmonary ventilation, airway clearance, and oxygenation.

Conclusion: The combination of chest physiotherapy, nebulization, and therapeutic positioning is an effective evidence-based supportive intervention for improving respiratory status in children with pneumonia. Integrating these interventions into pediatric nursing care may optimize respiratory recovery and complement pharmacological management to achieve better clinical outcomes.

Keywords: Chest Physiotherapy; Children; Nebulization; Pneumonia; Therapeutic Positioning.

INTRODUCTION

Pneumonia is one of the most common acute respiratory infections and remains a major cause of morbidity and mortality among children worldwide, particularly in developing countries. The disease is characterized by inflammation of the pulmonary parenchyma, resulting in impaired gas exchange, accumulation of airway secretions, and decreased

pulmonary ventilation. Children with pneumonia frequently experience respiratory distress manifested by tachypnea, chest wall retractions, decreased oxygen saturation, and increased use of accessory respiratory muscles. If not managed appropriately, pneumonia may progress to severe complications and even death. Pneumonia continues to be a major

Effectiveness of Combined Chest Physiotherapy, Nebulization, and Therapeutic Positioning in Improving Respiratory Status among Children with Pneumonia: A Literature Review

global public health concern among children under five years of age, particularly in low- and middle-income countries. Despite substantial advances in vaccination programs, antimicrobial therapy, and supportive care, pediatric pneumonia remains one of the leading causes of hospitalization and preventable childhood mortality worldwide. Delayed diagnosis and inadequate respiratory management may lead to impaired gas exchange, respiratory failure, prolonged hospitalization, and increased mortality. Therefore, comprehensive management strategies that combine pharmacological treatment with evidence-based supportive interventions are essential to improve clinical outcomes and reduce disease burden (Ma et al., 2025).

The management of pediatric pneumonia extends beyond pharmacological treatment such as antibiotic therapy. Comprehensive nursing and supportive interventions are essential to optimize respiratory function and improve clinical outcomes. Rational antibiotic use has been shown to contribute significantly to clinical improvement; however, pharmacological therapy alone is insufficient to resolve ineffective airway clearance. Chest physiotherapy has therefore become an important non-pharmacological intervention because it facilitates secretion mobilization, improves airway clearance, and enhances pulmonary ventilation.

Recent evidence has highlighted the important role of chest physiotherapy as an adjunctive intervention in the management of pneumonia. Airway clearance techniques, including percussion, vibration, postural drainage, breathing exercises, and positive expiratory pressure (PEP) therapy, facilitate secretion mobilization, improve pulmonary mechanics, enhance oxygenation, and may reduce the duration of hospitalization. These interventions are most effective when integrated with pharmacological treatment and individualized according to the patient's clinical condition (Lodhi et al., 2025; Lubis et al., 2025).

Nebulization therapy is another essential intervention in the management of pediatric pneumonia. This therapy delivers medication directly into the respiratory tract in aerosol form, promoting bronchodilation and liquefaction of airway secretions, thereby facilitating expectoration. Several studies have demonstrated that combining nebulization with

chest physiotherapy provides greater improvement in respiratory status than either intervention alone. Nebulization therapy has also been widely recommended as a supportive treatment for pediatric pneumonia because it delivers aerosolized medication directly to the lower respiratory tract. Nebulized therapy promotes bronchodilation, reduces airway inflammation, and liquefies retained secretions, thereby facilitating airway clearance and improving respiratory function. Furthermore, recent evidence indicates that nebulization combined with mucolytic or corticosteroid therapy provides better clinical outcomes and enhances respiratory recovery compared with conventional treatment alone (He & Huang, 2025; Irshad et al., 2025).

In addition, therapeutic positioning plays a significant role in optimizing respiratory function. Positions such as the prone and lateral positions have been shown to improve oxygen saturation and reduce respiratory rate in children with pneumonia by enhancing ventilation-perfusion distribution. More recently, self-proning has demonstrated effectiveness in improving respiratory function while reducing pneumonia severity and mortality risk. These findings indicate that simple positioning interventions can provide substantial clinical benefits when applied appropriately. Appropriate therapeutic positioning is another evidence-based nursing intervention that contributes to improved oxygenation in children with pneumonia. Positions such as the prone, right lateral, and Semi-Fowler positions optimize ventilation-perfusion matching, increase functional residual capacity, reduce respiratory effort, and improve oxygen saturation. When combined with other supportive respiratory interventions, therapeutic positioning may accelerate respiratory recovery and improve overall patient outcomes (Agustina et al., 2021; Lodhi et al., 2025).

Other supportive respiratory techniques, including pursed-lip breathing, have also been reported to improve oxygenation and breathing patterns in pediatric patients with pneumonia. Nevertheless, these interventions are frequently implemented independently in clinical practice. Consequently, evidence regarding the effectiveness of combining chest physiotherapy, nebulization, and positioning remains limited.

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Effectiveness of Combined Chest Physiotherapy, Nebulization, and Therapeutic Positioning in Improving Respiratory Status among Children with Pneumonia: A Literature Review

Therefore, combining chest physiotherapy, nebulization, and therapeutic positioning is expected to produce synergistic effects in improving the respiratory status of children with pneumonia. Rather than targeting a single aspect of respiratory dysfunction, this integrated intervention simultaneously promotes secretion clearance, enhances pulmonary ventilation, and optimizes oxygen distribution within the lungs. Accordingly, a comprehensive review is necessary to evaluate the effectiveness of this combination therapy in improving respiratory outcomes among pediatric patients with pneumonia.

Ineffective airway clearance is one of the primary clinical problems experienced by children with pneumonia due to excessive mucus production and impaired mucociliary clearance. Persistent secretion retention may lead to airway obstruction, reduced lung compliance, impaired gas exchange, and an increased risk of respiratory complications. Consequently, interventions that facilitate airway clearance are considered essential components of comprehensive pediatric pneumonia management. Recent evidence indicates that airway clearance techniques significantly improve respiratory function and reduce respiratory distress in hospitalized children with pneumonia (Cunha et al., 2024; Rosadi et al., 2022).

Evidence-based nursing practice has become increasingly important in the management of pediatric respiratory diseases. Clinical decision-making should be supported by high-quality scientific evidence to ensure that nursing interventions are both safe and effective. Integrating evidence-based respiratory therapies into routine nursing care has been associated with improved patient outcomes, enhanced quality of care, and reduced healthcare costs (Lodhi et al., 2025; Shkurka et al., 2024).

According to the World Health Organization (WHO), pneumonia remains one of the leading infectious causes of death among children under five years of age, accounting for a substantial proportion of childhood mortality worldwide. Although preventive strategies such as immunization, adequate nutrition, and early antibiotic therapy have contributed to reducing mortality, improving respiratory support through evidence-based nursing interventions remains an important component of comprehensive

pediatric care (World Health Organization, 2025; Ma et al., 2025).

Although numerous studies have investigated the individual effects of chest physiotherapy, nebulization, or therapeutic positioning, limited evidence has comprehensively evaluated the effectiveness of combining these interventions in pediatric patients with pneumonia. Since each intervention targets different physiological mechanisms involved in respiratory recovery, combining them may provide synergistic benefits that optimize respiratory function and improve clinical outcomes. Therefore, further evidence synthesis is needed to evaluate the effectiveness of this combined therapeutic approach (Irshad et al., 2025; Nurhayati & Khotimah, 2023; Lodhi et al., 2025).

RESEARCH METHOD

This study employed a Systematic Literature Review (SLR) using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guideline to identify, screen, evaluate, and synthesize evidence regarding the effectiveness of combined chest physiotherapy, nebulization, and therapeutic positioning in improving the respiratory status of children with pneumonia.

A comprehensive literature search was conducted in three electronic databases, namely PubMed, Google Scholar, and Portal Garuda, to identify relevant studies published between 2021 and 2025. The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords using Boolean operators (AND and OR), including *pneumonia*, *children*, *pediatric pneumonia*, *chest physiotherapy*, *nebulization*, *therapeutic positioning*, *oxygen saturation*, and *respiratory status*.

The inclusion criteria were: (1) original research articles published in English or Indonesian between 2021 and 2025; (2) studies involving children diagnosed with pneumonia; (3) studies evaluating chest physiotherapy, nebulization, therapeutic positioning, or their combination; (4) full-text articles available; and (5) quantitative, quasi-experimental, randomized controlled trial, cohort, or case study designs. Exclusion criteria included duplicate records, review articles, editorials, conference abstracts without full text, studies involving adult populations,

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and articles not directly related to the review objective.

The study selection followed the PRISMA 2020 flow consisting of four stages: identification, screening, eligibility, and inclusion. A total of 85 articles were identified through database searching. After removing duplicates, 72 articles remained for title and abstract screening. Subsequently, 24 full-text articles were assessed for eligibility, and 11 studies met the eligibility criteria and were included in the final review.

Data extraction was performed independently using a standardized extraction form that included the author, publication year, country, study design, sample characteristics, intervention, outcome

measures, and principal findings. The methodological characteristics and outcomes of the included studies were summarized in evidence tables.

The extracted data were synthesized using a narrative synthesis approach by comparing and integrating findings across studies. The synthesis focused on the effectiveness of combined chest physiotherapy, nebulization, and therapeutic positioning in improving respiratory outcomes, including oxygen saturation, respiratory rate, airway clearance, work of breathing, and patient comfort. The review findings were then interpreted to provide evidence-based recommendations for nursing practice in the management of pediatric pneumonia.

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RESEARCH RESULTS

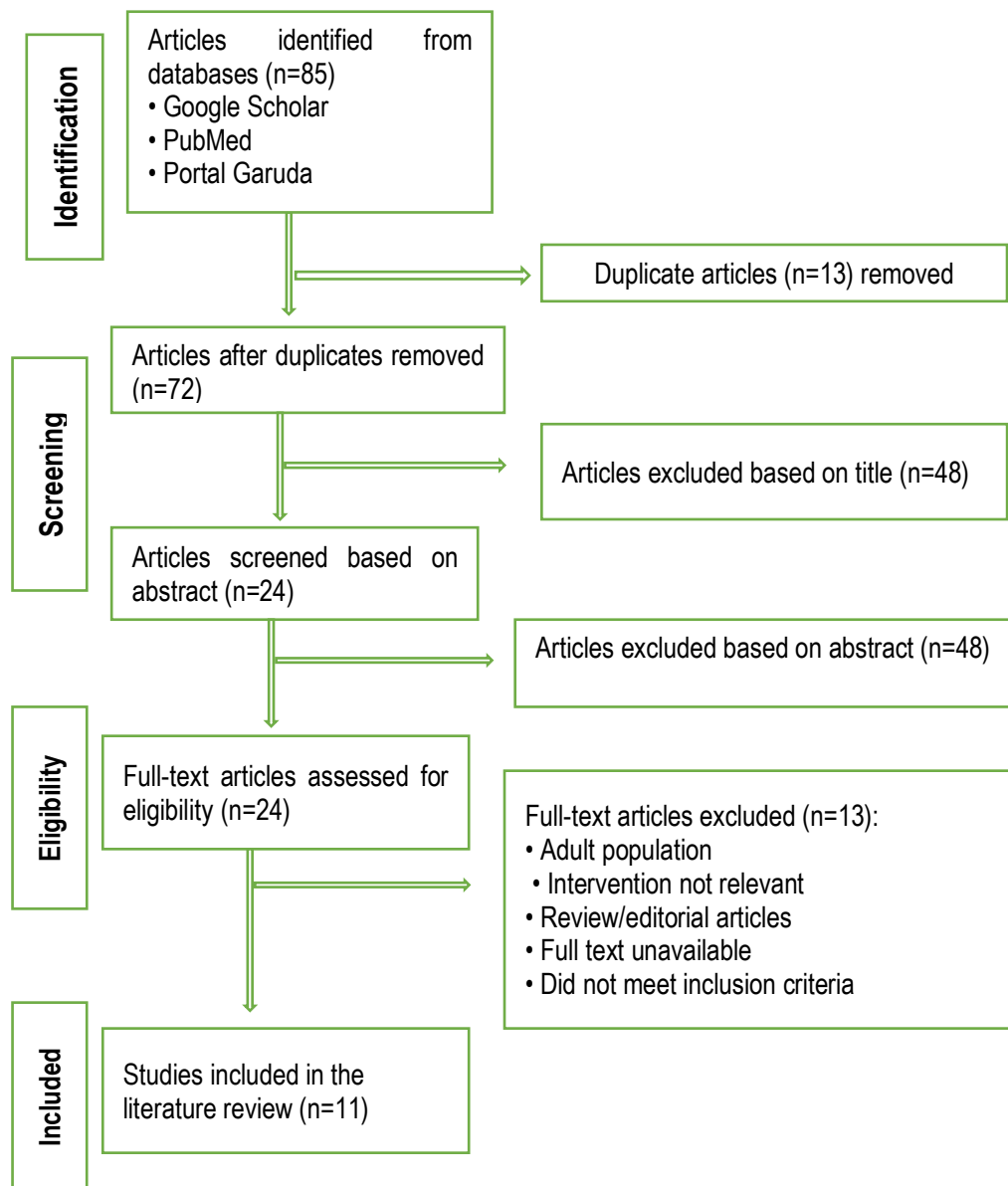


Figure 1. PRISMA Flow Diagram

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Table Summary of Selected Articles

(Author, Year)(Country)	Purpose	Design & Method	Results
(Prasetyo & Rusman, 2023) (Indonesia)	To determine the effectiveness of the Semi-Fowler's position 30° and 45° on changes in oxygen saturation in pneumonia patients on ventilators in the ICU.	A quasi-experimental research design with pre-test in one group (one-group pre-post-test design without control group). In this study, two groups were observed which were observed twice, namely before and after the treatment. Observations before the experiment (O1) are called pre and observations after the experiment (O2) are called post (11). Population is any object that has certain quantity and characteristics determined by the researcher (12). The target population in this study were all pneumonia patients in the ICU.	The 30° and 45° Semi-Fowler positions significantly improved oxygen saturation in patients with pneumonia receiving mechanical ventilation.
(Sundari & Rimbun, 2021) (Indonesia)	To determine the effect of the prone position on toddlers with pneumonia on increasing oxygen saturation.	The research design was a quasi-experiment with pre- and post-tests without control, with a sample of 15 toddlers with pneumonia. Analysis used a paired t-test.	The prone position significantly increased oxygen saturation and improved pulmonary ventilation in children with pneumonia.
(Utami & Risca, 2021)	To analyze the difference in oxygen saturation in Covid-19 patients before and after being placed in a 30° semi-Fowler's position.	This pre-experimental study used a one-group pretest-posttest design and took place at Wongsonegoro Regional Hospital in Semarang. The sample size was 24 respondents. A non-probability sampling technique, namely purposive sampling, was used. The measurement instruments used were the standard operating	The Semi-Fowler position improved oxygen saturation and respiratory patterns as a non-pharmacological intervention.

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Effectiveness of Combined Chest Physiotherapy, Nebulization, and Therapeutic Positioning in Improving Respiratory Status among Children with Pneumonia: A Literature Review

		procedure (SOP) for administering the semi-Fowler's position and an observation sheet.	
(Lestari., 2023) (Indonesia)	To prevent complications and worsening quality of life, the patient underwent nursing intervention therapy using the Pursed Lip Breathing (PLB) technique for children with pneumonia.	This research uses a case study with pre- and post-intervention data. The sample in this case study is three pediatric patients aged 3-5 years who were admitted with pneumonia, an acute respiratory problem.	Pursed-lip breathing improved oxygenation, reduced respiratory rate, and increased patient comfort.
(Irshad et al., 2025) (Indonesia)	To evaluate the effectiveness of nebulization alone versus nebulization combined with chest physiotherapy in improving heart rate (HR), respiratory rate (RR), and oxygen saturation (SpO ₂) among pediatric pneumonia patients.	A randomized controlled trial was conducted over six months in the pediatric ward of PNS Shifa Tertiary Care Hospital, Karachi. Children under four years with a confirmed diagnosis of pneumonia were randomly assigned into two groups: the experimental group received nebulization with chest physiotherapy, while the control group received nebulization only. Clinical outcomes (HR, RR, and SpO ₂) were recorded pre- and post-intervention and analyzed using SPSS version 22. A p-value < 0.05 was considered statistically significant.	Both groups demonstrated significant improvements in respiratory parameters. Nebulization alone produced rapid reductions in HR and RR, while the combination therapy resulted in greater improvements in SpO ₂ , particularly among patients with severe baseline hypoxemia. Statistical analysis confirmed significant differences between groups post-intervention (p < 0.05), highlighting distinct benefits of each approach.
(Kusumaningrum et al., 2023) (Indonesia)	To determine the effectiveness of inhalation medication administration in children with pneumonia experiencing ineffective airway clearance.	The methodology employed in this case study aims to describe and explore the administration of inhalation medication to pediatric pneumonia patients with ineffective airway clearance for 3x24 hours at Dr. Sardjito Yogyakarta General Hospital. After administering inhalation medication for 3x8 hours to children with	Nebulization effectively liquefied airway secretions and improved airway clearance.

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Effectiveness of Combined Chest Physiotherapy, Nebulization, and Therapeutic Positioning in Improving Respiratory Status among Children with Pneumonia: A Literature Review

		pneumonia experiencing ineffective airway clearance, partial resolution of the problem was observed. Inhalation medication administration was effective for pediatric pneumonia patients with ineffective airway clearance, exemplified in the case of An.M.	
(Helena et al., 2023) (Indonesia)	To analyze the differences in airway clearance before and after nebulization and chest physiotherapy in the control and intervention groups in bronchopneumonia children.	The research design used is Quasi-Experimental. A sample of 36 respondents with bronchopneumonia children was divided into two groups, namely control and intervention groups, which were obtained by consecutive sampling. Data collection techniques used observation sheets. The data analysis used in this study is the Mann Whitney Test. The results showed that before chest physiotherapy after nebulization, all respondents had ineffective airway clearance (100%) in both the intervention and control groups.	Combined therapy was more effective than nebulization alone in improving airway clearance.
(Lubis, et al., 2025) (Indonesia)	To systematically review literature (2019–2024) on the effectiveness of chest physiotherapy in improving clinical outcomes, specifically respiratory rate, oxygen saturation, length of hospital stay, and symptomatic recovery in children with pneumonia.	We conducted electronic searches on Google Scholar, NCBI, and accredited Indonesian journals using the keywords “chest physiotherapy” and “pneumonia in children.” From approximately 60 initially identified articles, eight met our inclusion criteria and were reviewed in full. Most studies were quasi-experimental; one was a randomized controlled trial. Study populations ranged from infants (0–5 years) to	Chest physiotherapy improved pulmonary ventilation and facilitated secretion removal.

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		older children (6–12 years). Interventions comprised postural drainage, clapping, vibration, percussion, deep-breathing exercises, and effective coughing techniques.	
(Rosadi et al., 2022) (Indonesia)	To determine the results of giving chest therapy to children with pneumonia and whether they could reduce the symptoms that occur due to pneumonia.	A case study of a 12-year-old child with bacterial pneumonia, therapy was carried out 3 times a week for 8 weeks, measurements using the borg scale and anthropometric measurements of thoracic expansion.	Chest physiotherapy reduced dyspnea and improved respiratory patterns in pediatric pneumonia patients.
(Agustina et al., 2021) (Indonesia)	To identify the effect of right lateral positioning on oxygen saturation and respiratory rate in under-five children with pneumonia.	A quasi-experimental pre-posttest with control group design. Respondents were 32 infants with pneumonia, (right lateral=16 and control group=16), selected by consecutive sampling. Univariate and bivariate analyzes were performed. There was a significant difference in oxygen saturation before and after right lateral position (p-value=0.000) and there was a significant difference in the respiratory rate before and after right lateral position (p-value=0.000).	The right lateral position improved oxygen saturation and reduced respiratory rate.
(Abd El-Monem El-Deeb., 2025) (Egypt)	To evaluate the effect of self-proning on respiratory functions, pneumonia, and mortality risk among patients diagnosed with community-acquired pneumonia	The study used a pre- and post-test quasi-experimental design with a control group, adhering to the Transparent Reporting of Evaluations with Nonrandomized Designs guidelines. It was conducted in the Medical Respiratory Department inpatient wards at the Respiratory Diseases Hospital in Alexandria,	Self-proning improved respiratory function, reduced pneumonia severity, and decreased mortality risk.

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		Egypt. The study recruited 128 patients with community-acquired pneumonia, conveniently assigned to an intervention group (n = 64) and a control group (n = 64). Data were collected using socio-demographic and historical data sheets, respiratory parameters assessment sheets, the confusion uremia respiratory rate and blood pressure (CURB-65) severity of pneumonia score, and the Pneumonia Severity Index.	
(Mukhlisin & Atsalawi, 2026) (Indonesia)	To investigates the integration of humanistic values into Islamic education at Pondok Pesantren Lirboyo and analyzes its influence on students' character formation.	Employing a mixed-methods design, data were gathered through in-depth interviews with 15 teachers and 30 students, structured observations, document analysis, and statistical testing using ANOVA to measure differences in character outcomes across instructional models.	Although the study does not specifically address pneumonia management, it highlights the value of a humanistic approach in healthcare, which supports comprehensive and patient-centered nursing care.

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DISCUSSION

The findings of this literature review consistently demonstrated that the combination of chest physiotherapy, nebulization, and therapeutic positioning significantly improved the respiratory status of children with pneumonia. Improvements were evidenced by increased oxygen saturation, decreased respiratory rate, reduced use of accessory respiratory muscles, enhanced airway clearance, and greater patient comfort during treatment.

Chest physiotherapy was consistently reported to facilitate secretion mobilization, thereby promoting airway clearance and improving pulmonary ventilation. By removing retained secretions, airway obstruction was reduced, allowing more efficient gas exchange and improved respiratory function.

Nebulization therapy played a complementary role by delivering medication directly into the lower respiratory tract in aerosol form. This intervention promoted bronchodilation, reduced airway inflammation, and liquefied thick secretions, making them easier to expectorate. Several studies demonstrated that combining nebulization with chest physiotherapy produced significantly greater improvements in respiratory status than either intervention alone.

Positioning interventions, particularly the prone, right lateral, and Semi-Fowler positions, also contributed substantially to improved oxygenation. These positions enhanced ventilation-perfusion matching within the lungs, resulting in increased oxygen saturation and reduced respiratory rate. Furthermore, self-proning was associated with improved respiratory function, decreased disease severity, and lower mortality risk among patients with pneumonia.

In addition, supportive breathing techniques such as pursed-lip breathing were found to improve breathing efficiency, oxygenation, and patient comfort. Although not included as a primary intervention in the combination therapy, these techniques may further enhance respiratory recovery when integrated into comprehensive nursing care.

Overall, the reviewed studies indicate that combining chest physiotherapy, nebulization, and therapeutic positioning provides synergistic benefits in improving respiratory outcomes among children with pneumonia. This integrated approach supports

pharmacological management by simultaneously enhancing airway clearance, optimizing pulmonary ventilation, improving oxygenation, and increasing patient comfort, thereby contributing to better clinical outcomes.

The findings of this literature review demonstrate that the combination of chest physiotherapy, nebulization, and therapeutic positioning is effective in improving the respiratory status of children with pneumonia. The effectiveness of this combination therapy is not merely additive but synergistic, as each intervention targets different physiological mechanisms while complementing one another to optimize respiratory function.

Chest physiotherapy plays a crucial role in mobilizing pulmonary secretions through percussion, vibration, and postural drainage techniques. These techniques facilitate the removal of retained secretions, reduce airway obstruction, improve alveolar ventilation, and enhance gas exchange. The findings are consistent with previous studies, consistently demonstrate that chest physiotherapy significantly improves pulmonary ventilation and reduces respiratory distress in pediatric patients with pneumonia. Effective secretion clearance also minimizes the risk of atelectasis and secondary respiratory complications (Lubis et al., 2025; Rosadi et al., 2022).

Nebulization therapy complements chest physiotherapy by delivering aerosolized medications directly into the lower respiratory tract. This intervention promotes bronchodilation, reduces airway inflammation, and liquefies thick mucus, making secretions easier to mobilize and expectorate. The effectiveness of nebulization is further enhanced when followed by chest physiotherapy because liquefied secretions can be removed more efficiently. Consistent with the another findings the combination of nebulization and chest physiotherapy produces greater improvements in respiratory status than either intervention alone (Irshad et al., 2025; Helena et al., 2023).

Therapeutic positioning also contributes substantially to improving respiratory function. Positions such as the prone, right lateral, and Semi-Fowler positions optimize ventilation-perfusion matching, increase functional residual capacity, and

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enhance oxygen diffusion within the lungs. Another study reported that the prone position significantly increased oxygen saturation in children with pneumonia (Sundari & Rimbun, 2021). Meanwhile, it has been shown that the right lateral position reduces the respiratory rate and increases oxygen saturation (Agustina et al., 2021). Further research found that the prone position itself improves respiratory function, reduces the severity of pneumonia, and lowers the risk of death, highlighting the important clinical benefits of proper positioning strategies (Abd El-Monem El-Deeb et al., 2025).

In addition to the three primary interventions, supportive breathing techniques such as pursed-lip breathing may further enhance respiratory recovery. This technique prolongs expiration, maintains positive airway pressure, prevents premature airway collapse, and improves ventilation efficiency. Another study reported improvements in oxygenation, respiratory rate, and patient comfort following the implementation of pursed-lip breathing in children with pneumonia. Although this intervention was not included as a primary component of the combined therapy evaluated in this review, it may serve as an effective complementary nursing intervention (Lestari et al., 2023).

Despite the effectiveness of pharmacological treatment, particularly antibiotic therapy, previous studies indicate that medication alone cannot adequately address impaired airway clearance and respiratory dysfunction. Antibiotics eliminate the causative microorganisms but do not directly improve mucus clearance, pulmonary ventilation, or oxygenation. Consequently, integrating pharmacological treatment with evidence-based non-pharmacological interventions is essential for achieving optimal clinical outcomes in pediatric pneumonia.

Overall, this literature review demonstrates that the combination of chest physiotherapy, nebulization, and therapeutic positioning provides significant clinical benefits by improving pulmonary ventilation, facilitating airway clearance, enhancing oxygenation, reducing respiratory effort, and increasing patient comfort. These findings support the implementation of a comprehensive, evidence-based approach to pediatric pneumonia management, in which pharmacological therapy is integrated with

appropriate nursing and supportive respiratory interventions to optimize patient recovery and improve the quality of pediatric healthcare.

CONCLUSION

This literature review demonstrates that combining chest physiotherapy, nebulization, and therapeutic positioning effectively improves respiratory status in children with pneumonia by enhancing airway clearance, pulmonary ventilation, and oxygenation. These interventions provide important evidence-based nursing strategies that complement pharmacological therapy and may improve pediatric clinical outcomes.

SUGGESTION

Future studies should conduct multicenter randomized controlled trials with larger sample sizes to strengthen evidence regarding the effectiveness of combined respiratory interventions in children with pneumonia.

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