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The Effectiveness of Combining Chest Physiotherapy and Steam Inhalation With Aromatherapy on Sputum Expectoration and Oxygenation Status In Pneumonia-Infected Toddlers

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ABSTRACT

Background: The leading causes of infant mortality worldwide are asphyxia, pneumonia, diarrhea, and malaria. In Indonesia, in the year 2020, there were 28,158 infant deaths, primarily attributed to congenital heart defects, accidents, diarrhea, and pneumonia. Pneumonia is an acute lower respiratory tract infection (involving the alveoli) caused by pathogens such as bacteria, viruses, or fungi, leading to respiratory distress and limited oxygen intake. Risk factors for pneumonia include inadequate exclusive breastfeeding, a history of prematurity, low birth weight, crowded living conditions, air pollution, incomplete basic immunization, malnutrition, and poverty. In 2017, there were approximately 120 million pneumonia cases worldwide, resulting in 1.3 million deaths. Pneumonia claims the lives of 100 children every hour.
Methods: This study is a quantitative study using a quasi-experimental pre-test post-test with a control group design. The research population includes all toddlers undergoing examinations at the Cibeureum City Health Center in Tasikmalaya, with a sample size of 30 respondents divided into intervention and control groups. The sampling technique used in this study is consecutive sampling based on inclusion criteria. Data analysis was performed using the Wilcoxon Sign Ranks Test for dependent groups and the Mann Whitney test for independent groups. The instruments used were observation sheets related to sputum production and oxygenation status (respiratory rate and oxygen saturation).
Results: The result of this research showed that the significance value for sputum production is 0.007, which is less than the p-value of 0.05. Regarding oxygenation status, including respiratory rate and oxygen saturation, the intervention provided to the intervention group yielded p-values of less than 0.005, specifically 0.001 for respiratory rate and 0.003 for oxygen saturation.
Conclusion: This study demonstrates that the combination of chest physiotherapy and steam inhalation with aromatherapy is effective in improving sputum production, reducing respiratory rate, and increasing oxygen saturation in toddlers with pneumonia. Therefore, it is crucial in nursing care to implement the combination of chest physiotherapy and steam inhalation with aromatherapy.

Keywords: chest physiotherapy; steam inhalation; pneumonia.

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Background. Pneumonia is a respiration tract infection (involving the alveoli) that is acute in nature and caused by pathogens such as bacteria, viruses, or fungi, leading to respiratory disturbance and a limitation in oxygen intake (WHO, 2020). Risk factors for pneumonia include inadequate exclusive breastfeeding, a history of prematurity, low birth weight, crowded living conditions, air pollution, incomplete basic immunization, malnutrition, and poverty (Kasundriya *et al.*, 2020). In 2017, the global pneumonia cases numbered around 120 million, with 1.3 million resulting in fatalities (Rudan *et al.*, 2013). Pneumonia causes the death of 100 children every hour. The highest incidence of pneumonia is found in developing countries, accounting for 20%, compared to 4% in developed nations (Cronan *et al.*, 1982). In Indonesia in 2020, there was a 0.16% mortality rate among toddler pneumonia cases. West Java is among the top 10 provinces with the highest incidence of toddler pneumonia cases (Kemenkes RI Dirjen P2P, 2020). . The prevalence of pneumonia in West Java is 5.5%, which is higher than the national

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prevalence rate of 4.8%. Furthermore, in the city of Tasikmalaya, the prevalence of toddler pneumonia remains high at 57.01% (Alhogbi, 2019).

The management of pneumonia includes antibiotic administration, nebulization, and oxygen therapy (Kemenkes RI, 2019). Additionally, it is crucial to provide education to mothers to enhance their skills in caring for toddlers with pneumonia (Tisnawati and Muchtar, 2020). Chest physiotherapy can also be performed to clinically improve toddlers with pneumonia, leading to changes in respiratory status (Sangadah and Kartawidjaja, 2020). Chest physiotherapy aims to remove secretions, improve respiratory ventilation, enhance the efficiency of respiratory muscles, and provide comfort (Chaves *et al.*, 2019). Steam inhalation can increase respiratory effort (Nuraeni, Wanda and Tri Waluyanti, 2020) and improve airway clearance in children with acute respiratory infections, as indicated by reduced additional breath sounds, decreased cough frequency, and thinner sputum (Pujiningsih and Musniati, 2018). The variables examined in this study have not been extensively researched or discussed in previous studies.

Method. This research is a quantitative study using a quasi-experimental pre-test post-test with a control group design. The research population consists of all toddlers undergoing examinations at the Cibeureum City Health Center in Tasikmalaya, with a sample size of 30 respondents divided into intervention and control groups. The sampling technique employed in this study is consecutive sampling based on inclusion criteria, which are as follows: 1) Willingness to participate as a respondent by signing informed consent, 2) Toddlers diagnosed with pneumonia, 3) Cooperation in following the given interventions. Exclusion criteria include: 1) Toddlers with severe pneumonia and non-pneumonia-related cough, 2) Toddlers with deteriorating conditions.

The instruments of this research was a questionnaire and observation includes personal data, respiratory observation sheets such as respiratory rate, oxygennation saturation, and sputum production.

The data processing in this study involves editing, which includes checking the completeness of the questionnaire data for mothers and toddlers, as well as pre-test and post-test observation sheets. Coding is done by assigning codes to the characteristics of the mother and toddler, such as gender, religion, culture, education, and income. The researcher then processes the data for completeness and data suitability, which will be entered for data analysis. Data analysis in this study includes univariate and bivariate analyses. Univariate analysis involves frequency distribution, while bivariate analysis includes the Wilcoxon Sign Rank Test and Mann Whitney U Test.

Result and Discussion.

Distribution of Characteristics of Toddler and Mother Respondents in the Intervention and Control Groups

The distribution of characteristics of toddler and mother respondents in the intervention and control groups is indicates that the majority of toddlers fall into the toddler age group (13-36 months), with 14 respondents (46.7%). Regarding gender, an equal number of males and females were represented, with 15 respondents each (50%). Immunization status shows that the majority were in the complete category, with 25 respondents (83.3%). Nutrition status indicates that the majority had good (normal) nutrition status, with 25 respondents (83.4%), but there were some cases of poor nutrition in 1 respondent (10%), malnutrition in 3 respondents (33.3%), and overnutrition in 3 respondents (33.3%).

As for the mothers, the majority were in the age range of 31-40 years, with 16 respondents (53.3%), and most of them had the occupation of a housewife (IRT), with 26 respondents (86.7%), and the majority had completed high school education, with 19 respondents (63.3%). In terms of experience in caring for toddlers with pneumonia, the

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majority had no prior experience, with 27 respondents (90%). Concerning receiving information related to pneumonia, the majority of mothers had not received any information, with 24 respondents (80%), and there were two respondents (6.7%) with toddlers who had a history of pneumonia once

The research results indicated that the majority of pneumonia cases occurred in toddlers aged 12-36 months, accounting for 46.7%, while the second most common age group was infants aged 1-12 months, comprising 33.3% of cases. This is related to the physical condition, especially in infants, where those under 1 year of age or younger are at a higher risk of contracting pneumonia. When they do contract pneumonia, it can often be severe. Infants aged 3-11 months are the primary population at risk of pneumonia, while those aged 12-35 months are considered a secondary population at risk (McCollum *et al.*, 2023). Other studies have also shown that the highest risk of pneumonia occurs at a younger age, often coupled with malnutrition (Hooli *et al.*, 2023). Data also indicates that the average age of children infected with adenovirus is 1.7 years, with children aged 1-3 years surviving pneumonia, whereas those under 1 year have a lower survival rate when they contract pneumonia (Xu *et al.*, 2023). References also suggest that younger children are highly vulnerable to infections due to their underdeveloped immune systems, which are not yet capable of effective phagocytosis or pathogen elimination (Marcdante and Kliegman, 2019).

The research findings show that the occurrence of pneumonia in toddlers is equally distributed between males and females, at 50% each. This can be explained by the theory indicating that the microvascular maturation of the lungs occurs between the first few months after birth until the age of 3, which is a phase of postpartum lung development (Ardini-Poleske *et al.*, 2020). Studies have shown that the proportion of females suffering from severe pneumonia is higher than that of males, with a four-fold higher mortality rate in females (Corica *et al.*, 2022). Immunization status indicates that 25 respondents had complete immunization, and nutritional status shows that the majority were in good nutritional status (83.4%). However, there were cases of poor nutrition, malnutrition, and overnutrition. Even though toddlers may have a normal nutritional status, there are other factors related to toddler pneumonia, such as hand hygiene and environmental cleanliness. Environmental cleanliness includes exposure to air pollution, closed windows and bedroom doors leading to poor ventilation, and exposure to cigarette smoke, all of which make toddlers highly susceptible to pneumonia (Qu *et al.*, 2023). Furthermore, the condition worsens for toddlers with malnutrition or poor nutrition, resulting in an increased risk of death due to pneumonia (Kirolos *et al.*, 2021).

Malnutrition in toddlers affects their antibodies, making them more susceptible to viral and bacterial infections, especially in the developing respiratory system (Chowdhury *et al.*, 2020). In terms of maternal respondents, the majority of mothers were in the age range of 30-40 years, with the majority having completed high school education. Most had never received information about pneumonia and had never cared for toddlers with pneumonia. This data indicates the importance of information in efforts to understand and provide care to toddlers to prevent pneumonia. Important information for mothers includes aspects related to nutrition and childcare (Kulwa, Mamiro and Kolsteren, 2023). Studies have also shown that maternal education and the healthcare system have an impact on child mortality rates (Paul *et al.*, 2022). Additionally, studies have found that toddlers with mothers who are homemakers, older in age, and do not have a separate kitchen in their homes are more likely to have a history of acute respiratory infection (ARI) in the past two weeks, which can be a contributing factor to pneumonia in the community (Bazie, Seid and Admassu, 2020)

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Distribution of Respondents Based on Oxygenation Status in the Intervention Group Pre-Test and Post-Test

Table 1. Distribution of Respondents Based on Oxygenation Status in the Intervention Group Pre-Test and Post-Test

	Oxygenation Status Component	Mean	Median	Std. Deviation	Min	Max	(CI) Lower	(CI) Upper
Pre Test	Respiratory Rate	52,9	54	6,63	44	66	49	56
	Oxygen Saturation	96,9	97	0,99	96	99	96	97
Post test	Respiratory Rate	47,1	45	6	40	60	44	50
	Oxygen Saturation	98,5	99	0,83	96	99	98	99

Based on Table 1, it shows the mean values for respiratory rate in the pre-test and post-test as 52.9 and 47.1 breaths per minute, respectively, and the median values for pre-test and post-test were 54 and 45 breaths per minute. The standard deviation values were 6.63 for the pre-test and 6 for the post-test. The minimum and maximum values for the pre-test and post-test were 44 and 66, and 40 and 60, respectively. The confidence interval indicates that we are 95% confident that the average respiratory rate in the pre-test for the intervention group in the population falls within 49-56 breaths per minute, and in the post-test, it falls within 44-50 breaths per minute.

As for oxygen saturation, the mean value in the pre-test was 96.9%, and in the post-test, it was 98.5%. The median values in the pre-test and post-test were 97 and 99, respectively. The standard deviation values for the pre-test and post-test were 0.99 and 0.83. The minimum and maximum values in the pre-test and post-test were 96 and 99, and 98 and 99, respectively. The confidence interval indicates that we are 95% confident that the average oxygen saturation in the pre-test for the intervention group in the population falls within 96-97%, and in the post-test, it falls within 98-99%.

Distribution of Respondents Based on Oxygenation Status in the Control Group Pre-Test and Post-Test

Table 2. Distribution of Respondents Based on Oxygenation Status in the Control Group Pre-Test and Post-Test

	Oxygenation Status Component	Mean	Median	Std. Deviation	Min	Max	(CI) Lower	(CI) Upper
Pre Test	Respiratory Rate	55,1	51	7,39	47	66	51	59
	Oxygen Saturation	97,3	97,0	1,04	96	99	96,7	97,9
Post test	Respiratory Rate	54,7	50,0	7,82	47	67	50,33	59,00
	Oxygen Saturation	97,2	97,0	0,77	96	99	96,77	97,63

Based on Table 2, it shows the mean values for respiratory rate in the pre-test and post-test as 55.1 and 54.7 breaths per minute, respectively. The median values for pre-test and post-test were 51 and 50 breaths per minute. The standard deviation values were 7.39 for the pre-test and 7.82 for the post-test. The minimum and maximum values for the pre-test and post-test were 47 and 66, and 47 and 67, respectively. The confidence interval indicates that we are 95% confident that the average respiratory rate in the pre-test for the control group in the population falls within 51-59 breaths per minute, and in the post-test, it falls within 50-59 breaths per minute.

As for oxygen saturation, the mean value in the pre-test was 97.3%, and in the post-test, it was 97.2%. The median values in the pre-test and post-test were both 97. The standard deviation values for the pre-test and post-test were 1.04 and 0.77, respectively. The minimum and maximum values in the pre-test and post-test were 96 and 99, and the confidence interval indicates that we are 95% confident that the average oxygen saturation in the pre-test for the control group in the population falls within 96.7-97.9%, and in the post-test, it falls within 96.7-97.63%.

The objective was to determine the effectiveness of the combination of chest physiotherapy and steam inhalation with aromatherapy on sputum production and oxygenation status. The research results indicate that concerning oxygenation status,

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including respiratory rate and oxygen saturation, the intervention given to the intervention group shows an impact with results having a p-value of less than 0.005, specifically 0.001 for respiratory rate and 0.003 for oxygen saturation. Studies show that chest physiotherapy intervention functions to remove exudate from the inflammatory process, clear secretions in the tracheobronchial area that obstruct the airway, and improve respiration while enhancing gas exchange (Chaves *et al.*, 2019). Furthermore, the research findings also demonstrate that steam inhalation using aromatherapy is effective in reducing the average respiratory rate (Amelia, Oktorina and Astuti, 2018). Studies indicate that peppermint oil contains menthol, menthone, neomenthol, and iso-menthone, which are a mixture of metabolites that play roles as anti-inflammatory, antibacterial, antiviral, immunomodulatory, antitumor, nerve protectors, antifatigue agents, and antioxidants. Additionally, peppermint oil functions to protect the respiratory, digestive, liver, kidney, nervous, brain, and skin systems (Zhao *et al.*, 2022). This research, by combining chest physiotherapy and steam inhalation with peppermint oil aromatherapy, demonstrates its effectiveness in reducing respiratory rate and increasing oxygen saturation by an average of 1%.

Distribution of Respondents Based on Additional Breath Sounds, Sputum Production, and Chest Wall Retraction in the Intervention Group Pre-Test and Post-Test

Table 3. Distribution of Respondents Based on Additional Breath Sounds, Sputum Production, and Chest Wall Retraction in the Intervention Group Pre-Test and Post-Test

Pre Test	Pre test		Post test	
	n	%	n	%
Additional Breath Sounds				
No Ronchi (Absence of Ronchi)	3	20	3	20
Ronchi Present (Ronchi Present)	12	80	12	80
Sputum Production				
None (No Sputum)	6	40	0	0
Present (Sputum Present)	9	60	15	100

Based on Table 3, it shows that the majority of respondents had rhonchi as additional breath sounds, with the same number of 12 respondents (80%) in both the pre-test and post-test. Regarding sputum production, there was an increase in the ability to produce sputum, with the initial number of 9 respondents becoming 15 (100%) in the post-test.

Distribution of Respondents Based on Additional Breath Sounds, Sputum Production, and Chest Wall Retraction in the Control Group Pre-Test and Post-Test

Table 4. Distribution of Respondents Based on Additional Breath Sounds, Sputum Production, and Chest Wall Retraction in the Control Group Pre-Test and Post-Test

Pre Test	Pre test		Post test	
	n	%	n	%
Additional Breath Sounds				
No Ronchi (Absence of Ronchi)	5	33,3	5	33,3
Ronchi Present (Ronchi Present)	10	66,7	10	66,7
Sputum Production				
None (No Sputum)	6	40	6	40
Present (Sputum Present)	9	60	9	60

Based on Table 4, it shows that the majority of respondents had rhonchi as additional breath sounds, with the same number of 10 respondents (66.7%) in both the pre-test and post-test. Regarding sputum production, there was no change in the ability to produce sputum, with 6 respondents (40%) in both the pre-test and post-test

The research results indicate that for both the control and intervention groups, the majority of additional breath sounds were identified as ronchi, and there were no significant changes observed. However, regarding sputum production, there was a notable change in the intervention group, characterized by the discharge of mucus from the nasal passages after receiving chest physiotherapy and steam inhalation with aromatherapy. The research findings

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demonstrate that the administration of chest physiotherapy and steam therapy with aromatherapy can effectively clear the airways by expelling mucus from the respiratory passages on the second day (Qurrokhmah and Rahmawati, 2023). However, in this study, breath sounds were still audible because the sputum that was discharged came from the nasal passages. This occurred because the intervention was performed only once. Therefore, there is a need to increase the frequency of intervention to allow the secretions in the throat to be expelled through coughing or to be swallowed into the digestive system. Other research results also show that aromatherapy inhalation can help remove mucus/sputum (Saepul Alamsah, Azahra and Mulyadi, 2022). References also indicate that chest physiotherapy can effectively clear secretions in infants with respiratory tract infections (DiBlasi, 2022).

Analysis of Sputum Production, Respiratory Rate, and Oxygen Saturation in the Intervention and Control Groups

Table 5. Wilcoxon Signed Ranks Test Analysis of Sputum Production, Respiratory Rate, and Oxygen Saturation in the Intervention and Control Groups

	Asymp. Sig. (2-tailed)	
	Intervention Group	**Control Group**
Sputum Production	0,014	0,157
Respiratory Rate	0,001	0,088
Oxygen Saturation	0,003	0, 480

Based on Table 5, the significance results for sputum production in the intervention group were 0.014, which is less than the p-value of 0.05, whereas in the control group, it was 0.157, which is greater than the p-value of 0.05. For respiratory rate in the intervention group, both the pre-test and post-test had a significance value of 0.001, which is less than the p-value of 0.05, while in the control group, it was 0.088, which is greater than the p-value of 0.05. Regarding oxygen saturation, in the intervention group, the significance value was 0.003, which is less than the p-value of 0.05, whereas in the control group, it was 0.480, which is greater than the p-value of 0.05.

Table 6. Mann Whitney U Test Analysis of Sputum Production, Respiratory Rate, and Oxygen Saturation in the Intervention and Control Groups. Components

Component	**Asymp. Sig. (2-tailed)**
Sputum Production	0,007
Respiratory Rate	0,037
Oxygen Saturation	0,000

Based on Table 6, the significance results for sputum production in both the intervention and control groups were 0.007, which is less than the p-value of 0.05, indicating a difference in sputum production between the intervention and control groups. For respiratory rate in both the intervention and control groups, the significance value was 0.037. As for oxygen saturation, the significance value was 0.000, which is smaller than the p-value of 0.005, indicating a difference in respiratory rate and oxygen saturation between the intervention and control groups.

The research results indicated that the application of a combination of chest physiotherapy and steam inhalation with aromatherapy is effective in reducing respiratory rate, improving oxygen saturation, and facilitating sputum production in pediatric pneumonia patients. The findings suggest that inhalation therapy using aromatherapy can reduce respiratory rate, improve oxygen saturation, and help thin mucus (Chowdhury *et al.*, 2022). Additionally, another study showed that patients with bronchopneumonia who underwent nebulization followed by chest physiotherapy experienced a significant improvement in airway clearance, which subsequently influenced respiratory rate and oxygen saturation (M, Nurhayati and Khotimah, 2023)

Conclusion and Suggestions. There was sputum production in the intervention group after receiving chest physiotherapy and

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steam inhalation with aromatherapy. There was a significant difference in sputum production, respiratory rate, and oxygen saturation between the intervention and control groups. The results of this research showed that the significance value for sputum production in the independent group is 0.007, which is less than the p-value of 0.05. Regarding oxygenation status, including respiratory rate and oxygen saturation, the intervention provided to the intervention group yielded p-values of less than 0.005, specifically 0.001 for respiratory rate and 0.003 for oxygen saturation

The results of this study can be applied in nursing care practice. In addition to collaborative actions, independent nursing interventions can be implemented by applying non-pharmacological therapies such as chest physiotherapy and steam inhalation with aromatherapy for pediatric pneumonia patients.

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