

Comparative Clinical Profile and Early Response to Nebulized 3% Hypertonic Saline versus Adrenaline in Infants with Acute Bronchiolitis

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ABSTRACT

Background: Acute bronchiolitis is a common viral lower respiratory tract infection and a major cause of hospitalization in infants, most commonly caused by respiratory syncytial virus. Nebulized 3% hypertonic saline (HS) and adrenaline may improve clinical symptoms, but their comparative effectiveness remains uncertain. Evidence from Bangladesh is limited. Therefore, this study aimed to compare the clinical profile and early response to nebulized 3% HS versus adrenaline in infants with acute bronchiolitis, focusing on respiratory distress, oxygen requirement, and hospital stay. **Methods & Materials:** A prospective randomized study included 120 infants with acute bronchiolitis at Ashiyan Medical College Hospital, Dhaka, from July 2024 to December 2025. Infants were equally randomized to nebulized 3% hypertonic saline or adrenaline. Respiratory parameters were assessed at baseline, 30, 60, and 120 minutes. Early clinical response, oxygen requirement, hospital stay, respiratory support, and adverse events were compared using SPSS, with $p < 0.05$ considered significant. **Results:** Among 120 infants, baseline demographic and clinical characteristics were comparable between groups. Adrenaline produced significantly greater early improvement in respiratory distress, respiratory rate, and SpO_2 , with clinical response at 60 minutes in 71.7% vs. 56.7% ($p = 0.041$). However, these differences diminished by 120 minutes, while hospital stay, oxygen requirement, respiratory support, and adverse events remained comparable. Both treatments were generally safe and well tolerated. **Conclusion:** Nebulized adrenaline provided greater early clinical improvement than 3% hypertonic saline, particularly within the first hour of

treatment. However, both therapies demonstrated comparable short-term hospital outcomes, minimal adverse events, and favorable safety profiles in infants with acute bronchiolitis.

Keywords: Clinical Profile, Early Response, Nebulized 3% Hypertonic Saline, Nebulized Adrenaline, Infants, Acute Bronchiolitis

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INTRODUCTION

Acute bronchiolitis is a viral illness that leads to inflammation and blockage of the lower airways, primarily affecting children younger than 2 years [1]. It is a primary reason for infant hospitalization and considerable illness. It usually manifests with mild fever, nasal blockage, runny nose, cough, rapid breathing, wheezing, and heightened respiratory effort, such as grunting and chest retractions [2,3]. Respiratory syncytial virus (RSV) is responsible for more than 80% of lower respiratory tract infections (LRTIs) in infants, exhibiting a male predominance and seasonal surges primarily in winter and spring. Additional factors consist of parainfluenza virus, adenovirus, Mycoplasma, rhinovirus, human metapneumovirus (HMPV), and human bocavirus (HBoV) [4,5]. Bronchiolitis exhibits a diverse progression, from apnea to significant respiratory distress caused by airway blockage. Pulse oximetry aids in determining the requirement for additional oxygen [5,6]. The majority of children with bronchiolitis show normal chest X-rays or nonspecific results like peribronchial thickening, hyperinflation, and atelectasis. While PCR can detect respiratory viruses, regular virological testing seldom informs management or forecasts outcomes [7,8].

Nebulized hypertonic saline and epinephrine can decrease symptom intensity and length of hospitalization in infants with acute viral bronchiolitis. They are straightforward, economical, and typically possess a strong safety record [9]. Since the 1970s, nebulized epinephrine has been utilized in acute bronchiolitis, and hypertonic saline (HS) has been researched for many years, with growing evidence coming to light since the early 2000s. Epinephrine can lessen airway swelling via α - and β -adrenergic actions, while HS might hydrate airway secretions, enhance mucociliary clearance, and decrease mucus blockage and airway inflammation. Recent evidence indicates that the efficacy of HS in alleviating symptom severity, hospital duration, or admission is still unclear [10-12]. International research has shown varied results concerning nebulized epinephrine and hypertonic saline in cases of acute bronchiolitis. Certain evidence indicates enhanced respiratory distress and decreased hospital duration, while other research discovered no notable advantage. Consequently, their regular use and total clinical efficacy still remain unclear [13-15]. A study from Bangladesh revealed that nebulized 3% hypertonic saline outperformed nebulized adrenaline in managing acute bronchiolitis, notably

shortening the length of hospital stay. These results indicate that hypertonic saline could be an effective, safe, and affordable treatment alternative for children suffering from acute bronchiolitis in Bangladesh [16].

Data comparing nebulized 3% hypertonic saline and adrenaline for acute bronchiolitis is still scarce in Bangladesh. This research intends to assess their clinical characteristics and initial treatment reactions in infants, concentrating on respiratory distress, oxygen needs, and length of hospital stay.

METHODS & MATERIALS

Study design and setting

This was a prospective, randomized, comparative clinical study conducted among infants with acute bronchiolitis at Ashiyan Medical College Hospital, Bangladesh, from July 2024 to December 2025. The study aimed to compare the early clinical response and short-term hospital outcomes of nebulized 3% hypertonic saline with nebulized adrenaline in infants with acute bronchiolitis.

Study population

Infants aged 2–24 months presenting with clinical features of acute bronchiolitis during the study period were assessed for eligibility. Acute bronchiolitis was

diagnosed clinically based on a history of preceding upper respiratory tract symptoms followed by acute onset of cough, wheezing, tachypnea, and/or increased respiratory effort.

Inclusion criteria

Infants were eligible if they were aged 2–24 months, had a clinical diagnosis of acute bronchiolitis, presented within 7 days of onset of respiratory symptoms, and had wheezing with or without chest retractions or nasal flaring.

Exclusion criteria

Infants were excluded if they had a previous history of recurrent wheezing or bronchial asthma, congenital heart disease, chronic lung disease, significant congenital anomalies, neuromuscular disease, or severe pneumonia requiring immediate respiratory support. Infants requiring immediate high-flow oxygen, non-invasive ventilation, or mechanical ventilation at presentation were also excluded.

Sample size and randomization

A total of 120 eligible infants were enrolled and randomly allocated in a 1:1 ratio into two treatment groups using a computer-generated randomization sequence. Sixty infants received nebulized 3% hypertonic saline (HS group), while 60 received nebulized adrenaline (adrenaline group).

Study interventions

Infants in the HS group received nebulized 3% hypertonic saline according to the institutional treatment protocol, while infants in the adrenaline group received nebulized adrenaline according to the recommended pediatric dose and institutional protocol. Nebulization was administered using a standard nebulizer under clinical supervision.

Both groups received standard supportive management as clinically indicated, including nasal suctioning, feeding or fluid support, and supplemental oxygen when required.

Clinical assessment and outcome measures

Baseline demographic and clinical information was recorded before

administration of the study intervention. Variables included age, sex, duration of illness, respiratory rate, heart rate, oxygen saturation (SpO₂), respiratory distress score, bronchiolitis severity, wheezing, chest retraction, nasal flaring, and feeding difficulty.

Respiratory status was reassessed at 30, 60, and 120 minutes after nebulization. Respiratory distress score, respiratory rate, heart rate, and SpO₂ were recorded at each time point using the same assessment procedure.

The primary outcome was early clinical response within the first 2 hours following treatment. A clinically meaningful response was defined as a reduction of at least 2 points in the respiratory distress score together with an increase in SpO₂ of at least 2%. Complete clinical response within 2 hours was also assessed.

Secondary outcomes included changes in respiratory distress score, respiratory rate, heart rate and SpO₂; requirement and duration of supplemental oxygen; duration of hospital stay; requirement for high-flow nasal cannula or invasive mechanical ventilation; in-hospital mortality; and treatment-related adverse events.

Statistical analysis

Data were entered, cleaned, and analyzed using IBM SPSS Statistics. Continuous variables were expressed as mean $\pm$ standard deviation (SD) for normally distributed data and median with interquartile range (IQR) for non-normally distributed data. Categorical variables were presented as frequencies and percentages.

Baseline characteristics were compared between the two groups using the independent-samples *t*-test or Mann–Whitney U test for continuous variables, as appropriate. Categorical variables were compared using the chi-square test or Fisher's exact test. Changes in clinical parameters at 30, 60, and 120 minutes were compared between the treatment groups using appropriate statistical tests according to data distribution. A two-sided *p*-value <0.05 was considered statistically significant.

Ethical considerations

The study was conducted after obtaining approval from the appropriate institutional ethical review committee of Ashiyan Medical College Hospital. Written informed consent was obtained from the parents or legal guardians of all participating infants. All infants received appropriate supportive care, and confidentiality of participant information was maintained throughout the study.

RESULTS

Participant characteristics

A total of 120 infants with acute bronchiolitis were enrolled and randomly allocated equally to receive either nebulized 3% hypertonic saline (HS group, *n*=60) or nebulized adrenaline (adrenaline group, *n*=60). All enrolled infants completed the initial treatment assessment and were included in the final analysis.

Table 1 shows the mean age of the infants was 6.7 ± 3.0 months in the HS group and 6.9 ± 3.2 months in the adrenaline group, with no statistically significant difference between the groups (*p*=0.74). Male infants constituted 58.3% of the HS group and 60.0% of the adrenaline group (*p*=0.85). The mean duration of illness before presentation was also comparable between the two groups (3.2 ± 1.4 vs. 3.3 ± 1.5 days; *p*=0.71). Baseline clinical parameters were similar between the treatment groups. Mean respiratory rate was 55.8 ± 7.4 breaths/min in the HS group and 56.3 ± 7.1 breaths/min in the adrenaline group (*p*=0.69), while mean heart rate was 143.6 ± 12.8 and 145.1 ± 13.2 beats/min, respectively (*p*=0.51). Mean baseline SpO₂ on room air was $93.1 \pm 2.1\%$ in the HS group and $92.8 \pm 2.3\%$ in the adrenaline group (*p*=0.46). Moderate bronchiolitis was the most common severity category in both groups (76.7% vs. 73.3%; *p*=0.78). There were no significant between-group differences in the distribution of wheezing, chest retraction, nasal flaring, or feeding difficulty.

Table I

Baseline demographic and clinical characteristics of study participants.

Characteristics	3% Hypertonic saline (n=60), n (%)	Adrenaline (n=60), n (%)	p-value
Age, months, mean $\pm$ SD	6.7 $\pm$ 3.0	6.9 $\pm$ 3.2	0.74
Male sex	35 (58.3)	36 (60.0)	0.85
Duration of illness, days, mean $\pm$ SD	3.2 $\pm$ 1.4	3.3 $\pm$ 1.5	0.71
Respiratory rate, breaths/min, mean $\pm$ SD	55.8 $\pm$ 7.4	56.3 $\pm$ 7.1	0.69
Heart rate, beats/min, mean $\pm$ SD	143.6 $\pm$ 12.8	145.1 $\pm$ 13.2	0.51
Baseline SpO ₂ , %, mean $\pm$ SD	93.1 $\pm$ 2.1	92.8 $\pm$ 2.3	0.46
Respiratory distress score, mean $\pm$ SD	7.1 $\pm$ 1.2	7.0 $\pm$ 1.1	0.64
Bronchiolitis severity			0.78
Mild	7 (11.7)	8 (13.3)	
Moderate	46 (76.7)	44 (73.3)	
Severe	7 (11.7)	8 (13.3)	
Wheezing	55 (91.7)	54 (90.0)	0.75
Chest retraction	42 (70.0)	44 (73.3)	0.69
Nasal flaring	24 (40.0)	27 (45.0)	0.58
Feeding difficulty	31 (51.7)	34 (56.7)	0.58

SD = standard deviation; SpO₂ = peripheral oxygen saturation.**Early changes in clinical parameters**

Table II presents the changes in respiratory rate, heart rate, oxygen saturation, and respiratory distress score following nebulization. Both treatment groups showed progressive improvement in respiratory parameters during the first 2 hours after treatment.

At 30 minutes, the mean respiratory distress score decreased from 7.1 $\pm$ 1.2 to 5.8 $\pm$ 1.4 in the HS group and from 7.0 $\pm$

1.1 to 5.2 $\pm$ 1.3 in the adrenaline group. The reduction was significantly greater in the adrenaline group ($p=0.018$). At 60 minutes, the corresponding scores were 5.1 $\pm$ 1.5 and 4.5 $\pm$ 1.4, respectively ($p=0.034$). By 120 minutes, the difference between the groups was no longer statistically significant (4.6 $\pm$ 1.5 vs. 4.1 $\pm$ 1.4; $p=0.071$).

A similar pattern was observed for oxygen saturation. At 60 minutes, mean SpO₂ increased from 93.1 $\pm$ 2.1% to 95.4 $\pm$ 1.7%

in the HS group and from 92.8 $\pm$ 2.3% to 96.1 $\pm$ 1.5% in the adrenaline group. The improvement was significantly greater in the adrenaline group ($p=0.021$). Respiratory rate also decreased in both groups. At 60 minutes, the mean respiratory rate was 51.2 $\pm$ 6.8 breaths/min in the HS group compared with 48.9 $\pm$ 6.5 breaths/min in the adrenaline group ($p=0.048$).

Table II

Changes in clinical parameters following nebulization.

Parameter	Time point	3% Hypertonic saline	Adrenaline	p-value
Respiratory distress score	Baseline	7.1 $\pm$ 1.2	7.0 $\pm$ 1.1	0.64
	30 min	5.8 $\pm$ 1.4	5.2 $\pm$ 1.3	0.018
	60 min	5.1 $\pm$ 1.5	4.5 $\pm$ 1.4	0.034
	120 min	4.6 $\pm$ 1.5	4.1 $\pm$ 1.4	0.071
Respiratory rate, breaths/min	Baseline	55.8 $\pm$ 7.4	56.3 $\pm$ 7.1	0.69
	30 min	53.1 $\pm$ 7.0	51.0 $\pm$ 6.7	0.098
	60 min	51.2 $\pm$ 6.8	48.9 $\pm$ 6.5	0.048
	120 min	49.3 $\pm$ 6.5	47.8 $\pm$ 6.2	0.190
SpO ₂ , %	Baseline	93.1 $\pm$ 2.1	92.8 $\pm$ 2.3	0.46
	30 min	94.4 $\pm$ 1.9	95.2 $\pm$ 1.7	0.021
	60 min	95.4 $\pm$ 1.7	96.1 $\pm$ 1.5	0.021
	120 min	96.0 $\pm$ 1.5	96.4 $\pm$ 1.4	0.142
Heart rate, beats/min	Baseline	143.6 $\pm$ 12.8	145.1 $\pm$ 13.2	0.51
	30 min	142.0 $\pm$ 12.1	150.3 $\pm$ 13.5	0.001
	60 min	140.1 $\pm$ 11.8	147.2 $\pm$ 12.6	0.002
	120 min	138.5 $\pm$ 11.5	142.0 $\pm$ 11.9	0.094

Values are presented as mean $\pm$ SD.**Comparison of early clinical response**

Table III shows the proportion of infants achieving predefined clinical improvement at different time points. A clinically meaningful early response, defined as a reduction of at least 2 points in respiratory distress score together with an increase in SpO₂ of at least 2%, was observed in 34

(56.7%) infants in the HS group and 43 (71.7%) infants in the adrenaline group at 60 minutes. The difference was statistically significant ($p=0.041$). At 120 minutes, the proportion of infants demonstrating a clinically meaningful response increased to 42 (70.0%) in the HS group and 48 (80.0%) in the adrenaline group, although

the difference was not statistically significant ($p=0.210$). Complete clinical response within 2 hours was achieved by 17 (28.3%) infants in the HS group and 24 (40.0%) in the adrenaline group ($p=0.187$).

Table III
Comparison of early clinical response between treatment groups.

Clinical response	3% Hypertonic saline (n=60), n (%)	Adrenaline (n=60), n (%)	p-value
Clinical improvement at 30 min	27 (45.0)	37 (61.7)	0.067
Clinical improvement at 60 min	34 (56.7)	43 (71.7)	0.041
Clinical improvement at 120 min	42 (70.0)	48 (80.0)	0.210
Complete clinical response within 2 h	17 (28.3)	24 (40.0)	0.187

Clinical improvement = ≥ 2 -point reduction in respiratory distress score plus $\geq 2\%$ increase in SpO_2 .

Hospital outcomes

Table IV shows supplemental oxygen was required in 31 (51.7%) infants receiving hypertonic saline and 35 (58.3%) receiving adrenaline ($p=0.46$). The median duration of oxygen therapy was 24 hours (IQR: 12–48) in the HS group and 20 hours (IQR: 12–36) in the adrenaline group ($p=0.31$). The mean duration of hospital stay was slightly longer among infants treated with hypertonic saline than among those treated with adrenaline (3.8 ± 1.4 vs. 3.5 ± 1.3

days); however, this difference was not statistically significant ($p=0.22$). Escalation to high-flow nasal cannula was required in 5 (8.3%) infants in the HS group and 4 (6.7%) infants in the adrenaline group ($p=0.73$). No infant in either group required invasive mechanical ventilation, and there were no deaths during hospitalization.

Adverse events

Treatment-related adverse events were generally mild and transient. Coughing or increased respiratory secretions following

nebulization occurred in 7 (11.7%) infants in the HS group compared with 3 (5.0%) in the adrenaline group ($p=0.18$). Transient tachycardia was observed in 1 (1.7%) infant in the HS group and 5 (8.3%) infants in the adrenaline group ($p=0.10$). No serious treatment-related adverse events were recorded.

Table IV
Hospital outcomes and treatment-related adverse events.

Outcome	3% Hypertonic saline (n=60),n(%)	Adrenaline (n=60),n(%)	p-value
Supplemental oxygen required	31 (51.7)	35 (58.3)	0.46
Duration of oxygen therapy, hours, median (IQR)	24 (12–48)	20 (12–36)	0.31
Duration of hospital stay, days, mean $\pm$ SD	3.8 ± 1.4	3.5 ± 1.3	0.22
High-flow nasal cannula required	5 (8.3)	4 (6.7)	0.73
Mechanical ventilation	0 (0.0)	0 (0.0)	—
Death	0 (0.0)	0 (0.0)	—
Cough/increased secretions	7 (11.7)	3 (5.0)	0.18
Transient tachycardia	1 (1.7)	5 (8.3)	0.10
Serious adverse event	0 (0.0)	0 (0.0)	—

IQR = interquartile range; SD = standard deviation.

Overall, nebulized adrenaline produced a significantly greater improvement in respiratory distress score, respiratory rate, and oxygen saturation during the first hour following treatment. However, these early differences did not translate into statistically significant differences in duration of oxygen therapy, length of hospital stay, requirement for escalation of respiratory support, or complete clinical response by 2 hours.

DISCUSSION

This study observed no notable baseline variations in demographic traits, clinical metrics, or bronchiolitis severity between the 3% hypertonic saline and adrenaline groups, suggesting strong comparability. A 2020 study also found similar age, gender, and bronchiolitis severity across its treatment groups; however, adrenaline resulted in notably reduced oxygen supplementation and shorter hospital stays, in addition to better respiratory distress and oxygenation compared to 3% hypertonic saline [17]. A different randomized trial indicated comparable baseline traits in infants treated with nebulized epinephrine and hypertonic saline [9]. These results back the legitimacy of evaluating ongoing treatment responses between the two groups.

In our study demonstrated notable initial enhancement with both therapies, with adrenaline resulting in more substantial improvement in respiratory distress, respiratory rate, and SpO_2 within the first 60 minutes. Nonetheless, these variations decreased after 120 minutes, indicating a temporary advantage of adrenaline. Likewise, earlier research indicated that adrenaline led to more significant early clinical enhancements, whereas hypertonic saline demonstrated limited advantages in lessening disease severity and hospitalization duration [12,16,18].

Our current study indicated a notably greater early clinical response with adrenaline at 60 minutes (71.7% compared to 56.7%), although this variation was not significant at 120 minutes. Likewise, earlier evidence suggests that adrenaline can lead to quick clinical enhancement, whereas hypertonic saline may alleviate clinical severity and shorten hospital duration over time. Recent findings indicate that both therapies may decrease hospital length of stay, although the reliability of this benefit is still uncertain [15,19].

This study discovered no notable differences in oxygen demand, length of hospital stay, respiratory assistance, or negative events between the two therapies.

Likewise, earlier research indicated differing hospital results: adrenaline enhanced oxygen levels and decreased hospital duration in one comparison study, whereas the combination of epinephrine and hypertonic saline slightly lowered hospital length and clinical intensity without enhancing oxygen saturation. These results indicate similar safety and overall hospital results between the treatments [12,17].

In general, nebulized adrenaline results in more significant early clinical enhancement, while 3% hypertonic saline delivers similar hospital outcomes and safety in infants suffering from acute bronchiolitis.

CONCLUSION

Nebulized adrenaline resulted in more significant early enhancements in respiratory distress, respiratory rate, and oxygen saturation compared to 3% hypertonic saline, especially during the initial hour of treatment. Nonetheless, these initial advantages did not lead to meaningful variations in oxygen needs, length of hospital stay, or necessity for respiratory assistance. Both therapies were typically safe and well accepted, indicating that adrenaline could be beneficial for quick symptom alleviation, whereas 3%

hypertonic saline continues to be a viable supportive treatment choice.

REFERENCES

1. Silver AH, Nazif JM. Bronchiolitis. *Pediatrics in review*. 2019 Nov 1;40(11):568-76.
2. Angurana SK, Williams V, Takia L. Acute viral bronchiolitis: A narrative review. *Journal of Pediatric Intensive Care*. 2023 Jun;12(02):079-86.
3. Angurana SK, Takia L, Sarkar S, Jangra I, Bora I, Ratho RK, Jayashree M. Clinico-virological profile, intensive care needs, and outcome of infants with acute viral bronchiolitis: A prospective observational study. *Indian Journal of Critical Care Medicine: Peer-reviewed, Official Publication of Indian Society of Critical Care Medicine*. 2021 Nov;25(11):1301.
4. Hall CB, Weinberg GA, Blumkin AK, Edwards KM, Staat MA, Schultz AF, Poehling KA, Szilagyi PG, Griffin MR, Williams JV, Zhu Y. Respiratory syncytial virus-associated hospitalizations among children less than 24 months of age. *Pediatrics*. 2013 Aug 1;132(2):e341-8.
5. Ramagopal G, Brow E, Mannu A, Vasudevan J, Umadevi L. Demographic, clinical and hematological profile of children with bronchiolitis: a comparative study between respiratory syncytial virus [RSV] and [Non RSV] groups. *Journal of Clinical and Diagnostic Research: JCDR*. 2016 Aug 1;10(8):SC05.
6. Verma N, Lodha R, Kabra SK. Recent advances in management of bronchiolitis. *Indian pediatrics*. 2013 Oct;50(10):939-49.
7. Ecochard-Dugelay E, Beliah M, Perreaux F, de Laveaucoupet J, Bouyer J, Epaud R, Labrune P, Ducou-Lepointe H, Gajdos V. Clinical predictors of radiographic abnormalities among infants with bronchiolitis in a paediatric emergency department. *BMC pediatrics*. 2014 Jun 6;14(1):143.
8. Florin TA, Plint AC, Zorc JJ. Viral bronchiolitis. *The Lancet*. 2017 Jan 14;389(10065):211-24.
9. Pamecha P, Mandot S. A randomized controlled trial of nebulized epinephrine versus nebulized hypertonic saline in infants with acute bronchiolitis. *International Journal of Contemporary Pediatrics*. 2021 Jul;8(7):1176.
10. Brooks CG, Harrison WN, Ralston SL. Association between hypertonic saline and hospital length of stay in acute viral bronchiolitis: a reanalysis of 2 meta-analyses. *JAMA pediatrics*. 2016 Jun;170(6):577-84.
11. Zhang L. Hypertonic saline for bronchiolitis—a meta-analysis reanalysis. *Journal of Pediatrics*. 2016 Sep;176:221-2.
12. Pereira RA, Oliveira de Almeida V, Zambrano M, Zhang L, Amantéa SL. Effects of nebulized epinephrine in association with hypertonic saline for infants with acute bronchiolitis: A systematic review and meta-analysis. *Health Science Reports*. 2022 May;5(3):e598.
13. Sakulchit T, Goldman RD. Nebulized epinephrine for young children with bronchiolitis. *Canadian family physician*. 2016 Dec;62(12):991-3.
14. Sit SP, Kant M, Maiti S, Pal PS, Dey S, Kuswaha G. Comparative Efficacy of Nebulised L-Adrenaline Versus Salbutamol in Infants With Bronchiolitis. *International Journal of Scientific Study*. 2016;5(2):2025.
15. Zhang LinJie ZL, Mendoza-Sassi RA, Wainwright C, Klassen TP. Nebulised hypertonic saline solution for acute bronchiolitis in infants.
16. Ratan NH, Azhar A, Rashid MH, Ikram S, Khan N, Uddin MM. Nebulized 3% Hypertonic Saline Reduces the Duration of Hospital Stay in Comparison to Nebulized Adrenaline in the Treatment of Acute Bronchiolitis. *East West Medical College Journal*. 2026 Jan 1;14(1):36-42.
17. Elkhateeb NH, MB'El Shafiey RM, Abdel-Razik AM. Assessment of the Efficacy of Nebulized 3% Hypertonic Saline versus Nebulized Adrenaline in Infants with Acute Bronchiolitis.
18. Mellick L, Walsh P, Clanton C, Kalra S, McKinney S. Outpatient Medications Deimplemented by the AAP Bronchiolitis Guidelines: An Umbrella Review of Meta-Analyses. *Pediatric Pulmonology*. 2025 Jan;60(1):e27391.
19. Jeong H, Park D, Ha EK, Kim JH, Shin J, Baek HS, Hwang H, Shin YH, Jee HM, Han MY. Efficacies of different treatment strategies for infants hospitalized with acute bronchiolitis. *Clinical and Experimental Pediatrics*. 2024 Oct 28;67(11):608.