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Article

Comparison Between Nebulized 0.9% Normal Saline and 3% Hypertonic Saline in the Management of Acute Bronchiolitis in the Emergency Department

[1]Rand Majid Abd -Almahdi, [2]Ali Mahdi Al-Thabhawi
[1,2]College of medicine, University of Babylon

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Abstract: Background: Acute bronchiolitis is an acute viral infection of the lower respiratory tract that primarily affects infants and young children, usually under two years of age. It is characterized by inflammation, edema, and necrosis of the epithelial cells lining the small airways, resulting in increased mucus production, airway obstruction, wheezing, and respiratory distress. Respiratory syncytial virus is the most common causative agent. Nebulized 3% hypertonic saline is a sterile sodium chloride solution administered as a fine mist directly into the airways. It functions as a mucolytic and airway-hydrating agent by drawing water into the mucus and airway surface, thereby thinning secretions, improving mucus rheology, and enhancing mucociliary clearance through osmotic mechanisms. Nebulized 0.9% normal saline is an isotonic sterile sodium chloride solution commonly used to hydrate the airways, facilitate mucus clearance, and dilute inhaled medications. Although normal saline provides a gentle and soothing effect in respiratory infections, some studies suggest that 3% hypertonic saline may be more effective in reducing the duration of hospitalization among infants with bronchiolitis. Aim of the Study: This study aimed to compare the clinical effectiveness of nebulized 0.9% normal saline and nebulized 3% hypertonic saline in the management of acute bronchiolitis in the emergency department. Patients and Methods: This prospective comparative study was conducted at Babil Teaching Hospital for Maternity and Children, Babil City, Iraq, from November 1, 2025, to March 15, 2026. A total of 200 consecutive infants diagnosed with acute bronchiolitis were included. The participants were divided into two groups. Group H consisted of 100 infants who received 4 mL of nebulized 3% hypertonic saline at each treatment session, whereas Group N consisted of 100 infants who received 4 mL of nebulized 0.9% normal saline. Clinical responses were assessed using the Modified Tal Score. Statistical significance was set at $p < 0.05$. Results: The mean age was 5.095 ± 4.13 months in Group H and 6.03 ± 3.90 months in Group N, with no statistically significant difference between the groups ($p = 0.1181$). A statistically significant difference was observed in body weight between Group H (6.16 ± 2.12 kg) and Group N (6.86 ± 2.28 kg; $p < 0.001$). The initial Modified Tal Score was slightly higher in Group N (5.12 ± 1.49) than in Group H (4.98 ± 1.64), although the difference was not statistically significant ($p = 0.110$). One hour after nebulization, Group H had a lower mean Modified Tal Score (3.91 ± 0.99) than Group N (4.14 ± 0.99), but the difference remained statistically non-significant ($p = 0.149$). After the second nebulization session, Group H continued to demonstrate a lower mean score (3.20 ± 1.23) than

Group N (3.50 ± 1.26), with no statistically significant difference (p = 0.103). Following the third nebulization session, the mean Modified Tal Score was 2.70 ± 1.09 in Group H and 2.95 ± 1.16 in Group N, with no statistically significant difference between the groups (p = 0.976). Conclusion: Nebulized 3% hypertonic saline produced slightly greater clinical improvement than nebulized 0.9% normal saline in infants with acute bronchiolitis. However, the differences in Modified Tal Scores between the two treatment groups were not statistically significant.

Keywords: Acute Bronchiolitis, Hypertonic 3% Saline, Normal saline 0.9%, Modified tall score

Introduction

Acute bronchiolitis is one of the most common acute viral infections of the lower respiratory tract in infants and young children, particularly those younger than two years of age. It is characterized by inflammation, edema, epithelial cell injury, and necrosis of the small airways, resulting in increased mucus production, bronchiolar obstruction, wheezing, and respiratory distress. Respiratory syncytial virus (RSV) is considered the most common causative agent of acute bronchiolitis [1]. The disease process begins when the virus invades and replicates within the bronchiolar epithelial cells, leading to epithelial cell damage, necrosis, and sloughing of the airway lining [2]. This epithelial injury triggers an inflammatory response with infiltration of immune cells, mainly lymphocytes and neutrophils, causing bronchiolar wall edema and increased vascular permeability [3]. In addition, stimulation of goblet cells leads to mucus hypersecretion, which combines with cellular debris and contributes to airway narrowing and obstruction [3].

The clinical manifestations of bronchiolitis are mainly related to partial or complete obstruction of the small airways. Edema, mucus plugs, and sloughed epithelial cells may cause air trapping, hyperinflation, atelectasis, ventilation–perfusion mismatch, hypoxemia, and increased work of breathing [4],[5]. These pathophysiological changes explain the typical clinical features of the disease, including wheezing, tachypnea, chest retractions, nasal flaring, crackles, poor feeding, and respiratory distress, which may be more severe in young infants because of their small airway diameter [5],[6]. Acute bronchiolitis usually starts with prodromal upper respiratory tract symptoms such as rhinorrhea, nasal congestion, low-grade fever, and irritability, which are often followed within one to three days by lower respiratory tract symptoms, including persistent cough, wheezing, rapid breathing, and increased respiratory effort [7],[8]. In severe cases, infants may develop cyanosis, lethargy, apnea, dehydration, or signs of impending respiratory failure [9]. Symptoms commonly peak between the third and fifth day of illness, while cough and wheezing may persist for two to three weeks after the acute phase has resolved [10].

The diagnosis of acute bronchiolitis is mainly clinical and depends on careful history taking and physical examination. Routine laboratory investigations, chest radiography, and viral polymerase chain reaction testing are not recommended in uncomplicated cases, as they are usually unnecessary for confirming the diagnosis [11]. However, assessment of disease severity is essential and should include evaluation of respiratory rate, work of breathing, oxygen saturation, feeding ability, and hydration status [12]. Viral testing, including testing for RSV, may be considered in selected cases, particularly for hospitalized infants, infection control purposes, research, or public health surveillance, but identification of the specific virus is not required for routine clinical diagnosis [13]. In general, acute bronchiolitis is diagnosed in an infant or young child below two years of age who presents with a recent viral upper respiratory prodrome followed by progressive lower respiratory tract signs such as persistent cough, tachypnea, increased respiratory effort, wheezing, and/or crackles on auscultation [14].

Management of acute bronchiolitis is primarily supportive and focuses on maintaining adequate oxygenation, hydration, and respiratory comfort. Nebulized therapies have been used in clinical

practice to improve airway hydration, reduce mucus viscosity, and support mucus clearance. Normal saline 0.9% is commonly used as a nebulized solution, while 3% hypertonic saline has been suggested to improve mucociliary clearance and reduce airway edema by drawing water into the airway lumen. However, the comparative clinical effectiveness of nebulized 0.9% normal saline and nebulized 3% hypertonic saline in the emergency department setting remains an important clinical question, particularly in infants presenting with acute bronchiolitis.

Aim of the Study

The aim of this study is to compare the clinical effectiveness of nebulized 0.9% normal saline and nebulized 3% hypertonic saline in the management of acute bronchiolitis among infants and young children attending the emergency department.

Materials and Methods

2.1. Settings: This is a prospective cross-sectional comparative study which was conducted at the Babil Teaching Hospital for Maternity and Children / Babil City /Iraq during the period from the 1st of November 2025 to the 15th of March 2026. The study included a total of 200 consecutive infants with bronchiolitis.

2.2. Scientific Considerations A written permission from hospital and each patient was obtained before data collection after explaining the aim of the study. The confidentiality of data throughout the research was guaranteed and the patients were assured that data would be used for research purposes only.

2.3.1. Inclusion criteria :

1- Age 1 – 24 months who are diagnosed with bronchiolitis

2.3.2. Exclusion criteria :

1 – Patients with congenital anomalies, (ex : Congenital heart diseases)

2 – Patients with chronic lung diseases

3 – Severe cases

2.4. Study deign

Eligible patients (200 in total) were divided into two groups:

The first group (group H): included 100 infants with bronchiolitis , in this group patients receive hypertonic saline 3% nebulizer 4 ml each time .

The second group (group N): included 100 infants with bronchiolitis , in this group patients receive normal saline 0.9 % nebulizer 4 ml each time .

2.5. Intervention

- Group H (Hyper tonic saline Group)

Nebulization with 4 ml of 3% hypertonic saline , Administered using a jet nebulizer with oxygen flow of 6–8 L/min given every 6 hours for 24 hours .

- Group N (Normal Saline Group)

Nebulization with 4 ml of 0.9% normal saline , Administered using a jet nebulizer with oxygen flow of 6–8 L/min given every 6 hours during emergency department observation .

- Standard supportive treatment will be provided for both groups, including (Oxygen therapy if SpO_2 < 92% , Adequate hydration and Nasal suction when required) .

- No bronchodilators or corticosteroids will be routinely administered unless clinically indicated.

2.6. Outcome measurement: In each two groups monitor SpO2 , respiratory rate m respiratory sounds and use of accessory muscles and calculate modified tall score at different times (before , after 1st nebulizer , after 2nd nebulizer and after 3rd nebulizer) .

2.7. Demographic and Baseline data

Demographic data, including (sex , mode of delivery , term and preterm , history of mother smoking , exposure to tobacco , family history of flu and family history of atopy) were collected from all patients.

2.8. Statistical Analysis:

the collected data were statistically analyzed using frequency and SPSS version 29, to detect the effect of different factors in the study parameters. Mean, SD and variance (T test) were used to significantly compare between means in this study. Considering a p-value less than 0.05 which is considered statically significant.

Results and Discussion

Results

3.1. Baseline and clinical characteristics data

The baseline characteristics including sex , mode of delivery , term status , presence of congenital diseases , smoking history of mother and exposure to tobacco are comparable and not significant difference between groups in each of them except family history of flu and family history of atopy were difference between groups is significant as in (table 3-1) .

Table 3-1 : Comparison between 3% hypertonic saline group and 0.9% normal saline group in baseline and clinical characteristics data .

Variables		3% Hypertonic group	0.9% Normal Saline group	P- Value
Number		100	100	
Sex	**Male**	60	53	0.3201
	Female	40	47	
Vaginal Delivery		38	44	0.39
Caesarian Delivery		62	56	
Term		99	96	0.17
Preterm		1	4	
Mother Smoker	**Yes**	0	0	1.00
	No	100	100	
Tobacco Exposure	**Yes**	61	57	0.56
	No	39	43	
Family Hx of Flu	**Yes**	95	86	**0.017**
	No	5	14	
Family Hx of Atopy	**Yes**	21	48	**< 0.001**
	No	79	52	

3.2. Demographic data

The Mean +/- SD age of 3% group was (5.095 +/- 4.13 months) and (6.03 +/- 3.9 months) in 0.9% group with non-significant difference (P-value = 0.1181) ., as illustrate in (Table 3-1) .

Table 3-2 : Comparison between 3% hypertonic saline group and 0.9% normal saline group in demographic data .

Variable	3% Hypertonic group Mean ± SD) (	0.9% Normal Saline group (Mean ± SD)	P-Value
Number	100	100	
Age (month)	5.095 +/- 4.13	6.03 +/- 3.9	0.1181

3.3. Initial Modified Tal Score

There is non-significant difference between two groups in modified tal score before treatment , as illustrate in table 3-3 .

Table 3-3 : Modified Tal Score Before Treatment

Variable	3% Hypertonic group	0.9% Normal Saline group	P-Value
Number	100	100	
Mild	37	43	0.38
Moderate	63	57	0.27

3.4. Modified Tal Score after 1 hour of first treatment

There is non-significant difference between two groups in modified tal score after 1 hour of first treatment , as illustrate in table 3-4 .

Table 3-4 : Modified Tal Score 1 hour of first nebulizer

Variable	3% Hypertonic group	0.9% Normal Saline group	P-Value
Number	100	100	
Mild	45	46	0.89
Moderate	55	54	0.62

3.5. Modified Tal Score after 6 hour of first treatment

There is non-significant difference between two groups in modified tal score after 6 hours (2nd nebulizer) , as illustrate in table 3-5 .

Table 3-5 : Modified Tal Score after 6 hours (2nd nebulizer)

Variable	3% Hypertonic group	0.9% Normal Saline group	P-Value
Number	100	100	
Mild	56	51	0.48
Moderate	44	49	0.32

3.6. Modified Tal Score after 12 hours (3rd nebulizer)

There is non-significant difference between two groups in modified tal score after 12 hours (3rd nebulizer) , as illustrate in table 3-6 .

Table 3-6 : Modified Tal Score after 12 hours (3rd nebulizer)

Variable	3% Hypertonic group	0.9% Normal Saline group	P-Value
Number	100	100	
Mild	67	59	0.24
Moderate	33	41	0.18

3.7. There is significant difference between two groups in number of patients improved after 1 hours of therapy but there is no significant difference between two groups in patient improvement after 6 and 12 hours , as illustrate in table 3-7

Table 3-7 : Comparison between two groups in patient improvement in different time of therapy .

Time	No. of patients improved 3%	No. of patients improved 0.9%	P - Value
After 1 hour	**11**	**3**	**0.049**
After 6 hours	**11**	**5**	0,191
After 12 hours	**8**	**8**	0.999
Total	**30**	**16**	**0.019**

3.8. Comparison Modified Tal Score Between both groups in different times

Initial modified tall score was higher in group N (normal saline 0.9%) (5.12 +/- 1.49) than group H (hypertonic 3%) (4.98 +/- 1.64) the difference was statistically non-significant (P= 0.110) . After 1 hour ,

group H (hypertonic 3%) had non significantly lower modified tal score (3.91 +/- 0.99) compare to group N (normal saline 0.9%) (4.14 +/- 0.99) with (P = 0.149) .After 2nd nebulizer, group H (hypertonic 3%) had non-significant lower modified tall score (3.20 +/- 1.23) compare to group N (normal saline 0.9%) (3.50 +/- 1.26) with (P = 0.103) . After 3rd nebulizer, group H (hypertonic 3%) had non-significant lower modified tall score (2.70 +/- 1.09) compare to group N (normal saline 0.9%) (2.95 +/- 1.16) with (P = 0.976) , as illustrate in tables (3-8).

Table 3-8 : Comparison Modified Tal Score Between both groups in different times

Parameter	3% Hypertonic group Mean ± SD) (	0.9% Normal Saline group (Mean ± SD)	P-Value
Number	100	100	
Before	4.98 +/- 1.64	5.12 +/- 1.49	0.110
After 1 hour	3.91 +/- 0.99	4.14 +/- 0.99	0.149
After 2nd Neb	3.20 +/- 1.23	3.50 +/- 1.26	0.103
After 3rd Neb	2.70 +/- 1.09	2.95 +/- 1.16	0.976

3.9. Comparison of patient fate in ER

There is non-significant difference between two groups in deposition out of emergency department , as illustrate in table 3-10 .

Table 3-9 : Comparison of patient fate in ER

Variable	3% Hypertonic group	0.9% Normal Saline group	P-Value
Number	100	100	
Discharge (home)	63	54	0.20
Admitted (ward)	37	46	0.11

3.10. Length of hospital stay

There is significant difference between two groups in length of hospital stay (P-value = 0.0015) , as illustrate in table 3-11 .

Table 3-10 : Length of hospital stay distribution

Variable	3% Hypertonic group	0.9% Normal Saline group	P-Value
1 -2 days	24	12	**0.0015**
3 – 4 days	10	22	
≥ 5 days	3	12	

3.11. Mean Length of hospital stay

There is significant difference between two groups in mean length of hospital stay (2.61 +/- 0.7) in hypertonic 3% group and (4.23 +/- 1.15) in normal saline 0.9% group , (P-value < 0.001) , as illustrate in table 3-12 .

Table 3-11 : Mean length of hospital stay

Variable	3% Hypertonic group	0.9% Normal Saline group	P-Value
Length of hospital stay (mean ± SD) days	2.61 +/- 0.74	4.23 +/- 1.15	**< 0.001**

Discussion

Acute bronchiolitis is one of the most common causes of emergency department visits and hospital admissions among infants worldwide. The present study was conducted to compare the efficacy of

nebulized 3% hypertonic saline and 0.9% normal saline in the management of acute bronchiolitis. Before evaluating treatment outcomes, baseline demographic and clinical characteristics were assessed to ensure comparability between the study groups.

The baseline demographic and clinical characteristics were generally comparable between the 3% hypertonic saline group and the 0.9% normal saline group. No statistically significant differences were observed regarding sex distribution, mode of delivery, gestational age, maternal smoking status, or tobacco smoke exposure. This similarity indicates that both groups were adequately matched at baseline, minimizing the potential influence of confounding factors on treatment outcomes.

Male infants constituted the majority of participants in both groups. This finding is consistent with previous studies reporting a higher incidence of bronchiolitis among male infants, which may be attributed to sex-related differences in airway size, pulmonary maturation, and immune responses [15][16]

Regarding the mode of delivery, cesarean section was more common than vaginal delivery in both groups. Previous evidence suggests that cesarean delivery may alter neonatal microbial colonization and early immune development, potentially increasing susceptibility to respiratory tract infections during infancy [17][18]

Most participants were born at term, while only a small proportion were preterm. Prematurity is a well-established risk factor for severe bronchiolitis and RSV-associated hospitalization due to immature lung development, reduced airway caliber, and lower levels of maternally acquired antibodies [19][20][21]

Although no maternal smoking was reported in either group, exposure to environmental tobacco smoke was relatively common. Passive smoke exposure has been associated with increased severity of bronchiolitis, enhanced airway inflammation, impaired mucociliary clearance, and a greater risk of hospitalization among affected infants [22][23]

A statistically significant difference was observed between the two groups regarding family history of influenza and family history of atopy. Previous studies have shown that atopy may contribute to increased airway hyperresponsiveness and recurrent wheezing following bronchiolitis episodes [24][25]. Nevertheless, the majority of baseline characteristics were comparable between groups, supporting the validity of subsequent comparisons of treatment outcomes .

The present study demonstrated no statistically significant differences in Modified Tal Scores between the 3% hypertonic saline and 0.9% normal saline groups at individual assessment points after 1, 6, and 12 hours of treatment. However, cumulative clinical improvement was significantly greater in the hypertonic saline group, where 30 patients showed improvement compared with 16 patients in the normal saline group (P=0.019) .

The significant cumulative improvement observed in the present study suggests that repeated nebulization with 3% hypertonic saline may provide additional clinical benefit in the management of acute bronchiolitis. These findings are consistent with the updated Cochrane review by Zhang et al. (2023)[26], which reported that nebulized hypertonic saline may improve clinical outcomes in infants with acute bronchiolitis, particularly when administered repeatedly over time. The observed cumulative improvement in our study further supports the potential role of hypertonic saline as an adjunctive therapy in acute bronchiolitis .

Similarly, Yu et al. [(35)] conducted a systematic review and meta-analysis of randomized controlled trials and reported that nebulized 3% hypertonic saline was associated with improved clinical outcomes compared with normal saline in infants with acute bronchiolitis. Their findings support the hypothesis that repeated nebulization with hypertonic saline may provide additional clinical benefits beyond those achieved with isotonic saline alone.

Regarding the length of hospital stay (LOS), the present study demonstrated a statistically significant difference between the two groups. The mean hospital stay was shorter in the 3% hypertonic saline group (2.61 ± 0.74 days) compared to the 0.9% normal saline group (4.23 ± 1.15 days), with a P-value < 0.001.

This clinical reduction in hospitalization time is strongly supported by the updated Cochrane review by Zhang et al. [8], which concluded that nebulized hypertonic saline leads to a consistent reduction in the length of hospital stay among infants. Furthermore, our findings closely align with those reported by

Awang et al. [27], who similarly demonstrated that the use of nebulized 3% hypertonic saline significantly shortens the duration of hospitalization in children managed for acute bronchiolitis .

In contrast to our findings, recent evidence has questioned the clinical benefit of nebulized hypertonic saline in acute bronchiolitis. A multicentre randomized controlled trial by Szupieńko-Bujak et al. [28] found no significant difference in either length of hospital stay or clinical severity scores between infants treated with 3% hypertonic saline and those receiving 0.9% normal saline. The authors concluded that hypertonic saline did not provide a measurable clinical advantage over normal saline in hospitalized children with bronchiolitis [29][30][31][32].

The discrepancy between these findings may be explained by several factors, including differences in study design, patient age, disease severity, frequency of nebulization, and healthcare settings (emergency department versus inpatient care) [33][34][35]

In conclusion, nebulized 3% hypertonic saline was associated with better clinical outcomes and a shorter hospital stay compared with 0.9% normal saline in infants with acute bronchiolitis. These findings support its use as an effective treatment option, although further multicentre studies are needed to confirm its benefit [36][37].

Conclusion

5.1. Conclusions

1. The study demonstrate that the nebulized 3% hypertonic saline is slightly more effective than 0.9% normal saline in the management of acute bronchiolitis with non-significant difference .

2. The use of hypertonic saline was associated with greater lightly clinical improvement , as evidenced by better symptoms relieve , shorter hospital stay and overall patient outcome .

5.2. Recommendations

1. Nebulizes 3% hypertonic saline is recommended as preferred treatment option for children with acute bronchiolitis due to superior clinical outcomes and its ability to reduce the duration of hospital stay .

2. Further multicenter , randomized controlled trials with longer sample sizes are recommended to confirm these findings and to standardizes dosing regimens and frequency of administration .

3. Further researches should also evaluate the long term outcome , safety profile and cost effectiveness of hypertonic saline compared to normal saline .

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