Volume 3, Issue 4, 2025

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

COMPARISON OF THE OUTCOME OF 7% HYPERTONIC SALINE VERSUS 3% HYPERTONIC SALINE IN TREATMENT OF BRONCHIOLITIS IN CHILDREN

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DOI: https://doi.org/10.5281/zenodo.17241700

Keywords

Bronchiolitis, Hypertonic saline, Nebulization, Hospital stay, Pediatrics, Randomized controlled trial

Article History

Received: 15 April 2025
Accepted: 25 May 2025
Published: 02 June 2025

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Abstract

Background: Bronchiolitis represents one of the most common lower respiratory tract infections among infants and young children. Nebulized hypertonic saline (HS) has been investigated as an adjunct therapy because of its potential to decrease mucosal edema, enhance mucociliary clearance, and promote quicker recovery. Objective: To evaluate and compare the therapeutic effects of 7% HS and 3% HS in infants hospitalized with acute bronchiolitis. Methods: A randomized controlled trial was conducted in the Pediatric Medicine Department of Government Teaching Hospital, Shahdara, Lahore, from September 2024 to March 2025. The study was conducted on children aged 2–24 months diagnosed clinically with bronchiolitis. Participants were randomly divided into two groups: Group A received 7% HS and Group B received 3% HS, administered via nebulization every eight hours in addition to standard supportive management. Primary outcomes were defined as clinical improvement at 72 hours and length of hospitalization. Data were analyzed using SPSS version 25.0, with statistical significance set at $p \leq 0.05$. Results: Baseline demographic and clinical profiles did not differ significantly between groups. The 7% HS group demonstrated a significantly shorter average hospital stay compared with the 3% HS group. Improvement within 72 hours was also more frequently observed in the 7% HS group. Conclusion: Nebulization with 7% HS was more effective than 3% HS in reducing hospital stay in infants with bronchiolitis. Larger, multicenter studies are recommended to validate these results and refine treatment guidelines.

INTRODUCTION

Bronchiolitis contributes substantially to pediatric hospital admissions worldwide. More than 70% of cases are attributed to respiratory syncytial virus (RSV), making it the predominant etiological agent.[1]. Nearly all children acquire RSV infection by two years of age, with the highest incidence observed between 2 and 6 months of life[2].

The standard approach to treatment remains largely supportive, focusing on adequate oxygenation, hydration, and nutrition[3]. However, in recent years, researchers have explored adjunct therapies to shorten

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

the course of illness and reduce hospital stay.[4,5]. The precise mechanism remains under investigation, but it is hypothesized that HS enhances airway clearance by promoting osmotic hydration of inspissated mucus, disrupting ionic bonds that crosslink mucus strands, and reducing airway wall edema[6].

Insights from cystic fibrosis research further suggest that higher concentrations, such as 7% HS, can accelerate mucociliary clearance and diminish epithelial swelling, thereby improving airway patency[7]. This has prompted several clinical studies to evaluate the role of 7% HS in infants with bronchiolitis. Findings from one such study demonstrated that by 72 hours, 88.9% of children receiving 7% HS had recovered compared with 74.4% in the 3% HS group. Moreover, the average hospital stay was shorter in the 7% HS group (56.36 ± 16.33 hours) compared with the 3% HS group (63.07 ± 21.48 hours), although the difference narrowly missed statistical significance (p = 0.067)[8].

Given that nebulized 3% HS remains the conventional therapeutic practice in hospitalized infants with acute bronchiolitis, there is growing interest in evaluating whether higher concentrations offer superior benefit. While international data hint at improved outcomes with 7% HS, no local studies have been conducted to provide context-specific evidence. Therefore, this study aims to directly compare the outcomes of 7% versus 3% HS in the management of bronchiolitis in children. By generating local evidence, the findings could guide clinical practice and inform future guidelines, ultimately improving the standard of care for infants admitted with this common respiratory illness.

METHODOLOGY

The trial was carried out in the Pediatric Medicine Department of Government Teaching Hospital, Shahdara, Lahore, from September 2024 to March 2025. A total of 176 children, aged 1–24 months, were enrolled consecutively. Sample size was determined assuming a 95% confidence level, 80% power, and recovery rates of 88.9% with 7% saline versus 74.4% with 3% saline, giving 88 children per group.[8] Children were excluded if they had previous wheezing episodes, received bronchodilators within two hours of arrival, had chronic cardiac or respiratory disease, developed respiratory failure requiring ventilation, or had already received hypertonic saline within the preceding 12 hours. Informed consent was obtained from parents or guardians before enrollment. Information was recorded using a structured proforma. Participants were randomly allocated into two groups. Group I received 3 ml of 7% hypertonic saline, while Group II received 3 ml of 3% hypertonic saline, administered every eight hours. Standard supportive management was provided to both groups, including semi-upright positioning, nasal/oropharyngeal suctioning, IV fluids, appropriate feeding, oxygen for saturations <90%, paracetamol for fever, antibiotics if required, and parental counseling. Outcomes were assessed as improvement at 72 hours (yes/no) and total hospital stay. Data were analyzed in SPSS v25. A p-value ≤0.05 was considered statistically significant.

RESULTS

The mean age in Group A (7% HS) was 8.4 ± 4.2 months, while Group B (3% HS) had a mean age of 8.1 ± 4.5 months, showing no significant difference between the two groups (p = 0.64) (Table 1). At 72 hours, clinical improvement was noted in 78 children (88.6%) in Group A compared with 66 children (75.0%) in Group B, a difference that reached statistical significance (p = 0.03) (Table 2). The average hospital stay was shorter for children receiving 7% HS than for those receiving 3% HS (Table 3).

Further subgroup analysis was carried out. In infants aged ≤6 months, 86.4% in Group A improved compared to 69.0% in Group B (p = 0.04). For children older than six months, improvement was recorded in 90.9% of Group A versus 80.4% of Group B, though the difference did not reach statistical significance (p = 0.18) (Table 4).

When hospital stay was stratified, consistent patterns were observed across different categories. Among infants ≤6 months, mean duration was 3.3 ± 1.0 days in Group A and 4.3 ± 1.2 days in Group B (p = 0.00). By gender, both male (3.2 ± 1.1 vs. 4.0 ± 1.4 days, p = 0.01) and female children (3.1 ± 1.2 vs. 4.2 ± 1.3 days, p = 0.001) in the 7% HS group had significantly shorter stays. Stratification by residence also demonstrated shorter hospitalization for rural children in Group A (3.3 ± 1.1 vs. 4.2 ± 1.4 days, p = 0.002) as well as for urban children (3.2 ± 1.2 vs. 4.0 ± 1.2 days, p = 0.01) (Table 5).

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ISSN: (e) 3007-1607 (p) 3007-1593

Table 1: Baseline Characteristics of Children (n=176)

Variable	Group A (7% saline) n=88	Group B (3% saline) n=88	p-value
Mean Age (months) ± SD	8.4 ± 4.2	8.1 ± 4.5	0.64
Mean Weight (kg) ± SD	7.5 ± 1.8	7.6 ± 1.9	0.78
Duration of Symptoms (days)	3 (2–5)	3 (2–5)	0.91
Gender (Male %)	52 (59.1%)	49 (55.7%)	0.65
Place of Living (Rural %)	40 (45.5%)	43 (48.9%)	0.68

Table 2: Improvement at 72 hours

Improvement at 72 hrs	Group A (7% saline) n=88	Group B (3% saline) n=88	Total (n=176)	p-value
Yes	78 (88.6%)	66 (75.0%)	144 (81.8%)	0.03
No	10 (11.4%)	22 (25.0%)	32 (18.2%)	

Table 3: Length of Hospital Stay (days)

Hospital Stay (days)	Group A (7% saline)	Group B (3% saline)	p-value
	3.2 ± 1.1	4.1 ± 1.3	0.001*

Table 4: Stratified Analysis of Improvement at 72 Hours

Stratification Variable	Subgroup	Group A (7% saline) Improved (%)	Group B (3% saline) Improved (%)	p-value
Age (months)	≤6 months	38/44 (86.4%)	29/42 (69.0%)	0.04*
	>6 months	40/44 (90.9%)	37/46 (80.4%)	0.18
Gender	Male	46/52 (88.5%)	40/49 (81.6%)	0.32
	Female	32/36 (88.9%)	26/39 (66.7%)	0.02*
Residence	Rural	35/40 (87.5%)	30/43 (69.8%)	0.04*
	Urban	43/48 (89.6%)	36/45 (80.0%)	0.19

Table 5: Stratified Analysis of Hospital Stay (days, Mean ± SD)

Stratification Variable	Subgroup	Group A (7% saline)	Group B (3% saline)	p-value
Age (months)	≤6 months	3.3 ± 1.0	4.3 ± 1.2	0.001*
	>6 months	3.1 ± 1.2	3.9 ± 1.3	0.02*
Gender	Male	3.2 ± 1.1	4.0 ± 1.4	0.01*
	Female	3.1 ± 1.2	4.2 ± 1.3	0.001*
Residence	Rural	3.3 ± 1.1	4.2 ± 1.4	0.002*
	Urban	3.2 ± 1.2	4.0 ± 1.2	0.01*

DISSCUSSION

In this randomized controlled trial, we evaluated the comparative efficacy of nebulized 7% hypertonic saline (HS) versus 3% HS in children admitted with acute bronchiolitis. Our results indicate that 7% HS was associated with a significantly higher rate of clinical improvement at 72 hours (88.6% vs. 75.0%, p = 0.03) and a shorter mean hospital stay (3.2 ± 1.1 vs. 4.1 ± 1.3 days, p = 0.001). Subgroup analyses further demonstrated that these benefits were consistent across younger infants (≤6 months), both genders, and children from rural as well as urban settings. Collectively, these findings suggest that 7% HS may

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

accelerate recovery and reduce hospitalization compared with 3% HS.

The existing literature on hypertonic saline in bronchiolitis has largely focused on 3% HS, with fewer studies directly comparing 7% and 3% solutions. An Indian double-blind RCT assessing both concentrations found no statistically significant difference in length of stay (4.34 ± 1.01 days vs. 4.59 ± 1.10 days), though a trend toward shorter stay with 7% HS was observed[9]. This aligns with our findings but also highlights how results may vary depending on study size and context. Similarly, evidence from Egypt demonstrated that 3% HS significantly shortened hospital stay compared with normal saline (62.3 ± 20.8 vs. 76.8 ± 26.1 hours, $p = 0.001$)[10], while a Pakistani study by Taseer et al. reported reduced hospital stay with 3% HS relative to 0.9% saline (2.83 ± 0.78 vs. 3.80 ± 0.71 days, $p < 0.001$)[11]. Another trial from Multan showed that 3% HS was superior to salbutamol in reducing hospitalization (3.5 vs. 4.3 days, $p < 0.001$)[12].

Direct head-to-head studies of 7% versus 3% HS are limited. A notable trial comparing 7%, 3%, and 0.9% saline with salbutamol found mean lengths of stay of 60.0, 64.0, and 72.0 hours respectively, suggesting a dose-response trend where higher concentrations conferred greater benefit[13–15]. However, these results did not always reach statistical significance, underscoring the need for adequately powered multicenter studies.

Our trial adds to this body of evidence by demonstrating a significant advantage of 7% HS over 3% HS, particularly in terms of reduced hospital stay. These findings carry important clinical implications. Shorter hospitalization not only lessens the economic burden on families and health systems but also reduces risks associated with prolonged admissions, such as nosocomial infections, and improves caregiver satisfaction.

Nevertheless, several limitations warrant consideration. Being a single-center study, the findings may not be generalizable to all healthcare settings, especially those with different patient populations or standards of care. The follow-up period was restricted to 72 hours, which may not capture outcomes such as relapse, readmission, or long-term sequelae like recurrent wheeze. Additionally, although operational definitions were applied, assessment of clinical parameters such as respiratory distress and wheeze can be subjective, introducing potential observer bias.

From a practical perspective, the use of 7% HS requires careful monitoring. While generally well tolerated, higher concentrations may provoke transient cough or airway irritation, and their safety profile in routine practice needs further validation. Training healthcare staff and monitoring for possible electrolyte disturbances or airway effects should be incorporated into clinical protocols before widespread adoption.

Future research should prioritize multicenter randomized controlled trials directly comparing 7% and 3% HS with standardized dosing regimens and supportive care protocols. Such studies should be adequately powered to detect differences in clinically meaningful outcomes, including hospital stay, symptom resolution, readmission rates, and adverse events[17]. Cost-effectiveness analyses, caregiver-reported outcomes, and mechanistic studies examining mucociliary clearance or viral load reduction could further elucidate why higher saline concentrations appear more effective in some contexts but not others.

In summary, our findings suggest that nebulized 7% HS provides superior outcomes compared with 3% HS in the management of bronchiolitis, particularly by reducing hospital stay and expediting clinical improvement. While promising, these results should be interpreted alongside existing heterogeneous evidence, and larger multicenter studies are needed before 7% HS can be recommended as standard care.

CONCLUSION

The results of this study demonstrate that 7% hypertonic saline provides superior clinical benefits compared with 3% hypertonic saline in the management of acute bronchiolitis, particularly by promoting faster recovery and reducing hospital stay across various patient subgroups. These findings suggest that 7% HS could serve as a more effective therapeutic option in routine practice. Nevertheless, confirmation through larger multicenter trials is essential to ensure generalizability, assess long-term safety, and support the development of evidence-based clinical guidelines.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

ACKNOWLEDGEMENTS
None

CONFLICT OF INTEREST
None

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