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COMPARISON OF 3% HYPERTONIC SALINE VERSUS NORMAL SALINE NEBULIZATION IN CHILDREN WITH ACUTE BRONCHIOLITIS

Original Research

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ABSTRACT

Background: Acute bronchiolitis is a common lower respiratory tract infection in infants and young children, leading to significant morbidity and hospitalization. Effective management focuses on supportive care, but the optimal nebulization therapy remains debated. Hypertonic saline has been proposed to enhance mucociliary clearance and reduce airway edema, potentially improving clinical outcomes. This study compares the efficacy of nebulized 3% hypertonic saline versus normal saline in reducing clinical severity and hospital stay duration in children diagnosed with acute bronchiolitis.

Objective: To compare the effectiveness of 3% hypertonic saline versus normal saline nebulization in children with acute bronchiolitis.

Methods: This quasi-experimental study was conducted at the Pediatric Department, Combined Military Hospital, Lahore, from February to July 2022. Patients aged 3 months to 2 years diagnosed with acute bronchiolitis were included. Using a non-probability consecutive sampling technique, 74 patients were equally divided into two groups: Group HS received 3% hypertonic saline, and Group NS received 0.9% normal saline as a diluent for nebulization. Clinical severity score (CSS) at 0, 24, and 48 hours, along with the length of hospital stay (LOHS), were recorded and analyzed using SPSS version 23.

Results: The mean age was 8.19 ± 2.47 months in Group HS and 7.19 ± 2.62 months in Group NS. Gender distribution included 23 (62.16%) males and 14 (37.83%) females in Group HS, compared to 21 (56.75%) males and 16 (43.24%) females in Group NS. The mean CSS was significantly lower in Group HS at 24 hours (2 ± 0.57 vs. 2.3 ± 0.463, p = 0.023) and 48 hours (1.27 ± 0.65 vs. 1.62 ± 0.492, p = 0.018). The median LOHS was significantly reduced in Group HS (4 days, IQR: 4-5) compared to Group NS (5 days, IQR: 4-6) (p = 0.001).

Conclusion: Nebulized 3% hypertonic saline demonstrated superior efficacy in reducing clinical severity and hospital stay duration compared to normal saline in children with acute bronchiolitis. These findings support its inclusion as a standard treatment option to improve recovery outcomes.

Keywords: Bronchiolitis, Clinical Severity Score, Hospital Stay, Hypertonic Saline, Nebulization, Pediatric, Salbutamol.

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INTRODUCTION

Acute bronchiolitis is a common inflammatory condition of the lower respiratory tract in infants and young children, typically caused by viral infections. It primarily affects children under the age of two and presents with varying degrees of severity, ranging from mild self-limiting illness to severe respiratory distress requiring intensive care. The disease initially manifests with symptoms of upper respiratory tract infection, including rhinorrhea and cough, which can progress to wheezing, respiratory distress, and, in severe cases, apnea (1-3). The pathophysiology involves viral invasion of the lower airways, triggering an inflammatory response that leads to airway edema, mucus production, and subsequent obstruction, impairing oxygenation. Neutrophils are believed to play a central role in the immune response to bronchiolitis, as evidenced by neutrophilia in affected infants (4,5). Due to anatomical and physiological differences, airway management in pediatric patients presents unique challenges compared to adults. Features such as a proportionally larger tongue, a relatively large head, narrow nasal passages, and lower oxygen reserves contribute to the complexity of airway compromise in severe bronchiolitis. This highlights the need for timely recognition and intervention to prevent complications, particularly in cases requiring respiratory support (3). Given that bronchiolitis is a leading cause of infant hospitalization and has been associated with an increased risk of developing asthma later in life, effective treatment strategies remain a priority in pediatric medicine (1,2).

Currently, there is no universally accepted gold standard treatment for bronchiolitis. Management typically includes supportive care such as nasal suctioning, oxygen therapy, inhalational bronchodilators, corticosteroids, nebulization with hypertonic or normal saline, and, in selected cases, antibiotics (6). However, the effectiveness of these treatments remains a topic of debate, as evidence supporting the superiority of one approach over another is limited (7,8). Recent advances in pharmacology have also led to ongoing research efforts toward vaccine development to prevent bronchiolitis, although an effective vaccine has yet to be established (9). Nebulized therapy is commonly used to alleviate airway obstruction and improve respiratory function in bronchiolitis. Hypertonic saline (3%) has been proposed to enhance mucociliary clearance by reducing airway edema and loosening mucus secretions, potentially shortening hospital stays and improving clinical outcomes compared to normal saline nebulization. However, conflicting evidence exists regarding its efficacy in combination with bronchodilators such as salbutamol. This study aims to compare the effectiveness of nebulized 3% hypertonic saline versus normal saline, both administered with salbutamol, in children diagnosed with acute bronchiolitis. The primary objective is to assess clinical severity scores and hospital length of stay in both treatment groups, providing evidence-based insights for optimizing bronchiolitis management in the Pakistani pediatric population (10).

METHODS

This quasi-experimental study was conducted at the Pediatric Department, Combined Military Hospital, Lahore, from February 2022 to July 2022, after obtaining approval from the institutional review board (IRB). Written informed consent was obtained from the parents or legal guardians of all participants before enrollment. The study aimed to compare the efficacy of nebulized 3% hypertonic saline versus normal saline, both in combination with salbutamol, in children diagnosed with acute bronchiolitis (11). A total of 74 patients were included in the study, with 37 participants allocated to each group. The sample size was determined using a 5% level of significance and 90% power of the test, based on the expected mean length of hospital stay in both groups—4.98 days in the hypertonic saline group and 5.84 days in the normal saline group (10). Patients were assigned to either the hypertonic saline (HS) or normal saline (NS) group using a non-probability consecutive sampling technique. The HS group received nebulization with 3% hypertonic saline and salbutamol, while the NS group received nebulization with 0.9% normal saline and salbutamol, both administered in a total volume of 3 mL. Nebulization was given at six-hour intervals, totaling four doses within 24 hours (12).

Patients of either gender, aged between three months and two years, diagnosed with acute bronchiolitis based on clinical presentation were included in the study. Exclusion criteria comprised patients with congenital abnormalities, bacterial pneumonia, aspiration syndromes, history of wheezing episodes, cyanosis, underlying cardiac pathology, decreased level of consciousness, oxygen saturation below 92% on room air, or those requiring mechanical ventilation (13,14). Upon admission, continuous non-invasive monitoring was conducted using electrocardiographic electrodes, pulse oximetry, temperature probes, and pediatric-sized blood pressure cuffs. Baseline laboratory investigations, including complete blood count and other relevant parameters as per institutional protocol, were performed

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under aseptic conditions via peripheral venous sampling. Hemodynamic parameters and clinical conditions were continuously monitored, and supportive treatment was initiated as necessary. Clinical severity was assessed using the Clinical Severity Score (CSS) at baseline, 24 hours, and 48 hours post-admission (11). Patients were discharged upon clinical improvement, defined as the resolution of fever, respiratory distress, and maintenance of oxygen saturation above 96% on room air. Antibiotic therapy was initiated based on the attending pediatrician's discretion, considering clinical symptoms such as fever, laboratory indices indicating leukocytosis, and radiographic evidence of bacterial infiltrates (15).

All collected data, including demographic characteristics, history of allergies or exposure to smoke, CSS at different time points, and length of hospital stay, were recorded and analyzed using SPSS version 23. Categorical variables were expressed as frequencies and percentages, while continuous variables were summarized as mean and standard deviation for normally distributed data. The chi-square test was applied to compare categorical variables. For continuous variables, normality was assessed, and appropriate parametric (independent sample t-test) or non-parametric (Mann-Whitney U test) tests were used for comparisons. A p-value of ≤ 0.05 was considered statistically significant (16).

RESULTS

The mean age of patients in the hypertonic saline group was 8.19 ± 2.47 months, while in the normal saline group, it was 7.19 ± 2.62 months ($p = 0.096$). Gender distribution showed that 23 (62.16%) males and 14 (37.83%) females were in the hypertonic saline group, whereas 21 (56.75%) males and 16 (43.24%) females were in the normal saline group ($p = 0.636$). Among all participants, 37% had a history of exposure to smoke, and 6.7% had a history of atopy. The proportion of patients with smoke exposure was 24.3% in the hypertonic saline group and 29.73% in the normal saline group ($p = 0.601$). A history of allergy was noted in 8.1% of patients in the hypertonic saline group and 5.41% in the normal saline group ($p = 0.643$). The mean clinical severity score on admission was 2.73 ± 0.45 in the hypertonic saline group and 2.54 ± 0.57 in the normal saline group ($p = 0.093$). After 24 hours of hospitalization, the mean clinical severity score was significantly lower in the hypertonic saline group (2 ± 0.57) compared to the normal saline group (2.3 ± 0.463) ($p = 0.023$). At 48 hours, the mean clinical severity score further reduced to 1.27 ± 0.65 in the hypertonic saline group and 1.62 ± 0.492 in the normal saline group, showing a statistically significant difference ($p = 0.018$). The median length of hospital stay was significantly shorter in the hypertonic saline group, with a median of 4 days (IQR: 4-5), compared to 5 days (IQR: 4-6) in the normal saline group ($p = 0.001$).

Table 1: Clinical Severity Score

Score	Respiratory rate	Wheeze
0	<30	No wheeze
1	30-45	Terminal expiration or audible only with stethoscope
2	46-60	Entire expiration or audible without stethoscope during expiration
3	>60	Inspiratory and expiratory wheeze without stethoscope

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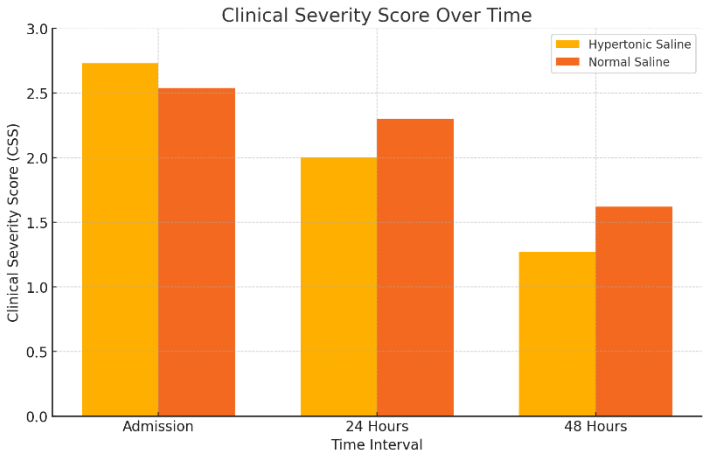
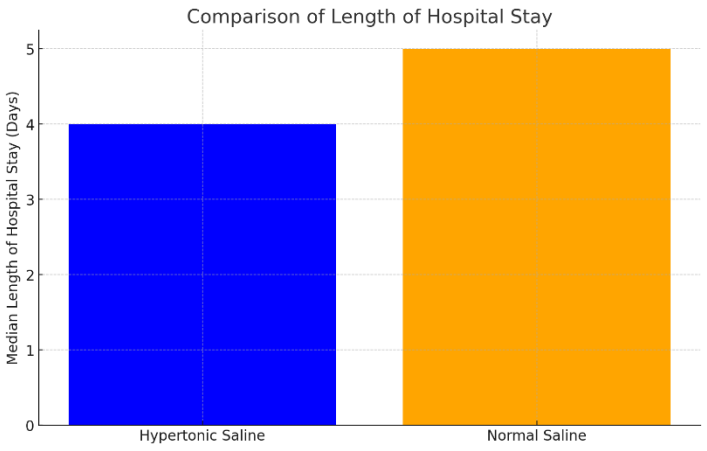
Table 2: Characteristics of patients among groups (n=74)

Variables		Group HS (n = 37)	Group NS (n = 37)	p-value
Gender	Males	23(62.16%)	21(56.75%)	0.636
	Females	14(37.83%)	16(43.24%)	
Age in months		8.19±2.47	7.19±2.62	0.096
Smoke exposure	Yes	09(24.3%)	11(29.73%)	0.601
	No	29(78.37%)	26(70.27%)	
History of allergy	Yes	03(8.1%)	02(5.41%)	0.643
	No	34(91.89%)	35(94.59%)	

Table 3: Treatment effectivity on CSS and LOHS among groups (n=74)

Variables	Group HS (n = 37)	Group NS (n = 37)	p-value
CSS on admission (Mean ± S.D)	2.73 ± 0.45	2.54 ± 0.57	0.093
CSS after 24hours (Mean ± S.D)	2 ±0.57	2.3 ± 0.463	0.023
CSS after 48hours (Mean ± S.D)	1.27 ±0.65	1.62 ±0.492	0.018
LOHS in days Median (IQR)	04 (4-5)	05 (4-6)	0.001





DISCUSSION

The study evaluated the efficacy of nebulized 3% hypertonic saline compared to normal saline in combination with salbutamol for the management of acute bronchiolitis. The findings demonstrated a significant reduction in the clinical severity score at both 24 and 48 hours in the hypertonic saline group compared to the normal saline group, with p-values of 0.023 and 0.018, respectively. Furthermore, the median length of hospital stay was notably shorter in the hypertonic saline group, with a median of 4 days (IQR: 4-5), compared to 5 days (IQR: 4-6) in the normal saline group, highlighting the therapeutic advantage of hypertonic saline nebulization. These findings align with previous trials where infants and children receiving hypertonic saline showed a greater reduction in clinical severity scores

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and a significantly decreased length of hospital stay compared to those treated with normal saline (12,16). Similar outcomes have been reported in meta-analyses of randomized controlled trials, which confirmed the superior role of 3% hypertonic saline over normal saline in improving clinical severity and reducing hospitalization duration (13). Other studies have also validated the benefits of hypertonic saline in bronchiolitis management, demonstrating its role in enhancing mucociliary clearance and reducing airway edema, which leads to improved respiratory function and faster recovery (14,15,17).

The mean age of affected patients in this study was 7.69 ± 2.58 months, with the majority being older than 7 months (63.5%). This is consistent with epidemiological studies indicating that bronchiolitis predominantly affects infants under 12 months of age, with a peak incidence in children younger than two years. A study conducted in Italy similarly reported that most cases of acute bronchiolitis occurred in children under five years, emphasizing the vulnerability of the younger age group to viral bronchiolitis (16,18-22). Exposure to environmental smoke was identified as a significant risk factor, with 27% of participants in this study having a history of passive smoking. Multivariate analyses from other research have demonstrated that prenatal and postnatal exposure to tobacco smoke increases the incidence of bronchiolitis by 28.7% and 38.5%, respectively, within the first two years of life. Smoke exposure has been identified as an independent risk factor for bronchiolitis, while breastfeeding has been shown to exert a protective effect (17). Additionally, the presence of atopy was observed in 13.51% of patients in this study, further supporting previous findings that a history of allergy predisposes infants to bronchiolitis. Other studies have reported asthma, rhinitis, and passive smoke exposure as independent risk factors that increase the likelihood of bronchiolitis episodes and hospital admissions in children (23-26).

Despite advancements in preventive strategies, acute bronchiolitis remains a significant health concern. Several preventive and therapeutic measures are under investigation to reduce its burden, particularly in regions where exposure to allergens, environmental pollutants, and climate variations contribute to disease prevalence (19). In the local context, a high prevalence of smoking, rising rates of atopic disorders, and environmental factors necessitate urgent strategies for prevention, early diagnosis, and prompt intervention. The findings of this study provide valuable clinical evidence supporting the use of nebulized 3% hypertonic saline as a superior treatment option compared to normal saline in improving clinical severity and reducing hospitalization duration in the pediatric population (27-29). While the study provides important insights, certain limitations should be acknowledged. The non-randomized design may introduce selection bias, and the relatively small sample size limits the generalizability of the findings. Additionally, the study did not assess potential adverse effects of hypertonic saline nebulization, such as bronchospasm or increased coughing, which have been reported in some studies. Future research with larger randomized controlled trials, long-term follow-up, and consideration of adverse effects would further strengthen the evidence and guide clinical decision-making in bronchiolitis management (30).

CONCLUSION

Nebulized 3% hypertonic saline demonstrated a superior therapeutic role compared to normal saline in the management of acute bronchiolitis, effectively reducing clinical severity and shortening the duration of hospitalization. These findings highlight its potential as a beneficial treatment option for improving patient outcomes in pediatric bronchiolitis. The study reinforces the importance of evidence-based interventions in optimizing care and suggests that incorporating hypertonic saline nebulization into standard treatment protocols may enhance recovery and reduce healthcare burden.

Author Contribution

Author	Contribution
Khadija Salman*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Talal Waqar	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published

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