ORIGINAL ARTICLE

A COMPARATIVE STUDY OF MAGNESIUM SULPHATE VS. HYPERTONIC SALINE IN TREATING PAEDIATRIC ACUTE BRONCHIOLITIS

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Background: Acute bronchiolitis is a common respiratory disease in children that often necessitates hospitalization. Treatments for this condition include bronchodilators and supportive care. Although magnesium sulphate and hypertonic saline have been proposed as possible therapies, it is yet unknown how successful they are in comparison. This study aimed to compare the clinical efficacy, safety, and impact on respiratory outcomes of nebulized magnesium sulphate versus hypertonic saline in treating paediatric acute bronchiolitis. **Methods**: A prospective cohort study was conducted at Bannu Medical College, MTI Bannu, from January to December 2023. A total of 120 children (ages 2 months to 2 years) diagnosed with acute bronchiolitis were randomly assigned into two groups: Group A received nebulized magnesium sulphate (0.1 cc/kg of 50% solution) every 8 hours for 24 hours, while Group B received nebulized hypertonic saline (3%, 4 cc) every 8 hours for 24 hours. Both groups received standard supportive care. Primary outcomes included improvements in respiratory distress scores, oxygen saturation, wheezing, and respiratory rate. Secondary outcomes assessed hospital stay duration, side effects, and the need for additional treatment. Data were analyzed using independent t-tests for continuous variables and chi-square tests for categorical variables, with statistical significance set at $p<0.05$. **Results**: Both treatments significantly improved respiratory distress scores and oxygenation. However, Group A (magnesium sulphate) showed greater reductions in wheezing and respiratory rate compared to Group B (hypertonic saline) ($p<0.05$). Additionally, hospital stay duration was shorter in Group A (Mean±SD: 3.2±0.9 days) compared to Group B (3.8±1.1 days, $p=0.03$). No severe side effects were observed in either group. **Conclusion**: Nebulized magnesium sulphate demonstrated superior efficacy in improving respiratory distress and reducing hospital stay duration compared to hypertonic saline, suggesting its potential as a more effective treatment option for paediatric acute bronchiolitis. These findings highlight the need for further large-scale randomized controlled trials to confirm these results and refine treatment protocols.

Keywords: Acute bronchiolitis; Magnesium sulphate; Hypertonic saline; Paediatric; Respiratory outcomes; Prospective cohort study

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INTRODUCTION

Acute bronchiolitis is one of the most prevalent respiratory conditions affecting newborns and young children, characterized by inflammation and obstruction of the lower airways.[1,2] It is primarily caused by viral infections, particularly the respiratory syncytial virus (RSV), and commonly presents with symptoms such as coughing, wheezing, and dyspnoea.[3] Acute bronchiolitis remains a major cause of hospitalization in paediatric populations, especially during seasonal epidemics, placing a significant burden on healthcare systems.[4,5]

Current management strategies primarily focus on supportive care, including oxygen therapy, hydration, and, in some cases, bronchodilators.[6] However, no universally superior treatment has been established, and optimizing therapeutic approaches remains a challenge. Emerging alternative treatments, such as magnesium sulphate and hypertonic saline, have gained interest due to their potential to alleviate respiratory distress and improve clinical outcomes.[7] Magnesium sulphate, with its anti-inflammatory and smooth muscle-relaxing properties, may reduce airway inflammation and bronchospasm.[8,9] Meanwhile, hypertonic saline enhances mucociliary clearance by drawing water into the airway lumen,

reducing airway oedema, and improving mucus clearance.[10,11]

Although previous research has explored these treatments separately, comparative studies directly evaluating their relative efficacy remain limited, and existing findings are inconsistent. For instance, while some studies have reported that nebulized magnesium sulphate improves respiratory outcomes better than hypertonic saline, others have found no significant difference between the two.[12,13] Unlike prior studies with smaller cohorts or limited clinical parameters, this study incorporates a larger sample size and a more comprehensive assessment of respiratory distress scores, oxygenation levels, and hospital stay duration. By integrating these additional variables, we aim to provide a more robust comparison of treatment efficacy and contribute evidence-based guidance on the optimal management of paediatric acute bronchiolitis.

We hypothesize that nebulized magnesium sulphate will lead to greater improvements in respiratory rate and wheezing scores compared to hypertonic saline.

This study aims to compare the clinical efficacy, safety, and impact on respiratory outcomes of magnesium sulphate versus hypertonic saline in the treatment of paediatric acute bronchiolitis.

MATERIAL AND METHODS

This study employed a prospective randomized comparative study design and was conducted at the Bannu Medical College, MTI Bannu, over one year, from January to December 2023.

Children between the ages of two months and two years who had been diagnosed with acute bronchiolitis based on clinical symptoms and verified by chest X-ray were included in the research. Patients with a history of preterm birth (defined as birth before 37 weeks), significant comorbidities such as congenital heart diseases (CHDs), pre-existing renal impairment, known allergies to magnesium sulphate, or a history of neonatal mechanical ventilation were excluded.

The study included a total of 120 participants, randomly assigned into two equal groups: Group A (60 participants receiving nebulized magnesium sulphate) and Group B (60 participants receiving nebulized hypertonic saline). The sample size was calculated using IBM SPSS Sample Power (Version 27.0), considering previous studies[12,13] and expected clinical differences. The calculation was based on an effect size (Cohen's d) of 0.5, a significance level (α) of 0.05, and a power (1-β) of 0.80 to minimize Type II errors. The analysis determined that at least 58 participants per group were required to detect a significant difference. To strengthen statistical reliability and account for potential dropouts, 60 participants per group (120 total) were included. This sample size surpasses those of similar studies (28 and 60 participants), ensuring greater generalizability and robustness of the findings.

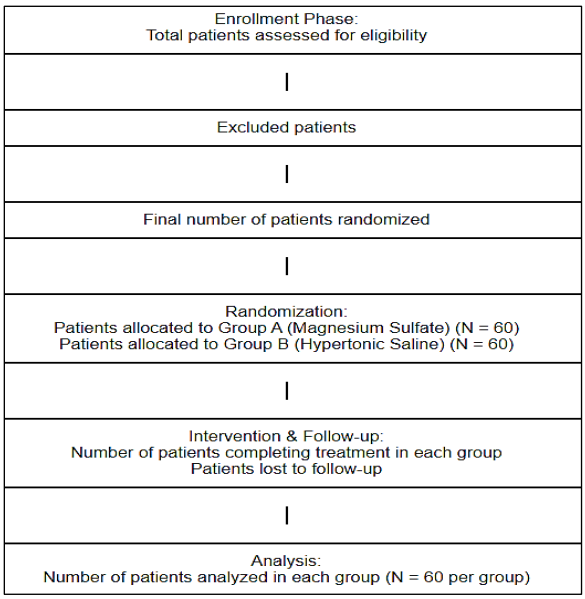

Figure-1: Flowchart

Participants were randomly assigned to one of two treatment groups. Group A received nebulized magnesium sulphate (0.1 cc/kg of 50% solution) every 8 hours for a total of three doses within 24 hours**,** while Group B received nebulized hypertonic saline (3%, 4 cc) every 8 hours for three doses within the same 24-hour period**.** Both groups received standard supportive care**,** including fluid administration, suctioning, a raised posture, oxygen therapy (if oxygen saturation dropped below 90%), and fever-reducing medications**.** By ensuring a structured dosing regimen, this study aims to evaluate the sustained therapeutic effects of each intervention over a standardized treatment window.

Information on paediatric patients with acute bronchiolitis, ages 2 months to 2 years, was gathered, including important demographics including age, gender, and weight. Improvements in clinical respiratory scores, such as oxygen saturation, wheezing, and respiratory rate, as measured before and after therapy, were the main results. The duration of hospitalization, the frequency of side effects, and the need for further treatments were examples of secondary outcomes.

Descriptive statistics (mean±SD for continuous variables and frequencies and percentages for categorical variables) were used to characterize baseline parameters, including age, gender, and

weight. Continuous outcomes, such as the duration of hospital stay and respiratory scores, were compared between the two groups using the independent t-test. Categorical factors, such as side effects and the need for further therapy, were examined using the chi-square test. Statistical significance was defined as a p-value of less than 0.05.

Ethical Approval: The Research and Ethical Committee of Bannu Medical College, MTI Bannu, provided ethical permission. The research complied with ethical standards, guaranteeing participant privacy and safety. Before enrolment, guardians provided written informed permission.

RESULTS

The research participants' baseline characteristics are summarized in Table 1. Children in Group A (Magnesium Sulphate) had a mean age of 8.21±4.53 months, while those in Group B (Hypertonic Saline) had a mean age of 8.53±4.32 months. Males comprised 58.33% of Group A and 61.67% of Group B. The mean weight was 6.87±1.24 kg in Group A and 6.98±1.17 kg in Group B. The duration of symptoms before treatment initiation was similar in both groups, with Group A averaging 3.42±1.15 days and Group B 3.57±1.21 days. These comparable baseline characteristics ensured that both groups started from an equitable clinical standpoint, reducing the likelihood of confounding factors affecting treatment outcomes.

The changes in clinical respiratory scores before and after therapy are detailed in Table 2. The respiratory rate significantly improved in both groups, decreasing from 48.52±5.61 to 34.75±4.24 breaths/min in Group A and from 48.23±5.82 to 36.17±4.63 in Group B, with a statistically significant difference favouring Group A (p=0.04). This suggests that magnesium sulphate had a stronger effect on reducing respiratory distress, which is crucial in bronchiolitis management.

The wheezing score showed a greater reduction in Group A (2.97±0.42 to 1.41±0.36) compared to Group B (3.07±0.53 to 1.76±0.48) (p=0.02). Since wheezing correlates with airway obstruction, this greater improvement suggests that magnesium sulphate was more effective in alleviating bronchospasm and airway resistance, potentially reducing the need for additional bronchodilator therapy.

Oxygen saturation levels increased in both groups, from 88.23±3.14% to 95.46±2.02% in Group A and 88.56±3.08% to 94.82±2.31% in Group B (p=0.12). While the difference was not statistically significant, the trend indicates that magnesium sulphate may provide better oxygenation support, potentially leading to earlier clinical stability.

The study's secondary results are outlined in Table 3. The average hospital stay was slightly shorter in Group A (4.32±1.27 days) compared to Group B (4.69±1.42 days) (p=0.21). Though not statistically significant, this suggests that magnesium sulphate may contribute to earlier recovery and discharge readiness, which can reduce healthcare costs and hospital congestion.

Adverse effects were reported in both groups, but Group A had fewer side effects. Mild irritation was observed in 6.67% of Group A compared to 10.00% in Group B. Similarly, coughing occurred in 5.00% of Group A versus 13.33% in Group B, while vomiting was reported in 3.33% of Group A and 5.00% of Group B. These findings suggest that magnesium sulphate had a slightly better safety profile, with fewer reported side effects.

Regarding additional treatments, Group A required fewer interventions. Nebulized bronchodilators were needed in 20.00% of Group A versus 30.00% of Group B, and supplemental oxygen was required in 16.67% of Group A compared to 23.33% of Group B. Although these differences were not statistically significant, they indicate that patients in the magnesium sulphate group achieved symptom control more effectively, reducing the need for adjunctive therapies.

A direct comparison of outcomes between the two treatment groups is shown in Table 4. Following therapy, Group A demonstrated significantly better improvements in wheezing scores (1.41±0.36 vs. 1.76±0.48, p=0.02) and respiratory rates (34.75±4.24 vs. 36.17±4.63, p=0.04). While oxygen saturation (95.46±2.02 vs. 94.82±2.31, p=0.12) and hospital stay (4.32±1.27 vs. 4.69±1.42 days, p=0.21) were also better in Group A, the differences were not statistically significant.

Although Group A had fewer side effects and required less additional treatment, these differences were not statistically significant. However, the overall trend suggests that magnesium sulphate provided greater symptom relief, improved respiratory function, and reduced the need for supportive care compared to hypertonic saline.

The findings of this study suggest that magnesium sulphate was superior to hypertonic saline in reducing respiratory distress, particularly in terms of wheezing scores and respiratory rate improvement. Although differences in oxygen saturation and hospital stay were not statistically significant, the trend favoured magnesium sulphate, suggesting potential advantages in clinical management. The fewer adverse effects and reduced reliance on additional therapies highlight the favourable safety profile and therapeutic efficacy of magnesium sulphate in paediatric bronchiolitis treatment.

Table-1: Baseline Characteristics of Study Participants

Variable		Group A (Magnesium Sulphate n=60)	Group B (Hypertonic Saline n=60)
Age in months	Mean±SD	8.21±4.53	8.53±4.32
Gender (n; %)	Male	35 (58.33%)	37 (61.67%)
	Female	25 (41.67%)	23 (38.33%)
Weight in Kg	Mean±SD	6.87±1.24	6.98±1.17
Symptom's duration in days	Mean±SD	3.42±1.15	3.57±1.21

Table-2: Pre- and post-treatment changes in clinical respiratory scores

Parameter	Time point	Group A (Mean±SD)	Group B (Mean±SD)
Respiratory Rate (breaths/min)	Pre-Treatment	48.52±5.61	48.23±5.82
	Post-Treatment	34.75±4.24	36.17±4.63
Wheezing Score	Pre-Treatment	2.97±0.42	3.07±0.53
	Post-Treatment	1.41±0.36	1.76±0.48
Oxygen Saturation	Pre-Treatment	88.23±3.14	88.56±3.08
	Post-Treatment	95.46±2.02	94.82±2.31

Table-3: Secondary outcomes: length of hospital stays, adverse effects, and additional therapies

Outcome		Group A	Group B
Length of Hospital Stay (days)	Mean±SD	4.32±1.27	4.69±1.42
Incidence of Adverse Effects (n; %)	Mild Irritation	4 (6.67%)	6 (10.00%)
	Cough	3 (5.00%)	8 (13.33%)
	Vomiting	2 (3.33%)	3 (5.00%)
Need for Additional Therapies (n; %)	Nebulized Bronchodilators	12 (20.00%)	18 (30.00%)
	Supplemental Oxygen	10 (16.67%)	14 (23.33%)

Table-4: Comparison of outcomes between magnesium sulphate and hypertonic saline groups

Outcome		Group A (Mean±SD)	Group B (Mean±SD)	95% CI	*p*-value
Length of Hospital Stay (days)		4.32±1.27	4.69±1.42	-0.9 to 0.2	0.21[a]
Respiratory Rate (Post-treatment)		34.75±4.24	36.17±4.63	-2.8 to -0.1	0.04*[a]
Wheezing Score (Post-treatment)		1.41±0.36	1.76±0.48	-0.6 to -0.1	0.02*[a]
Oxygen Saturation (Post-treatment)		95.46±2.02	94.82±2.31	-0.4 to 1.2	0.12[a]
Incidence of Adverse Effects	Mild Irritation	4 (6.67%)	6 (10.00%)	-	0.49[b]
	Cough	3 (5.00%)	8 (13.33%)	-	0.11[b]
	Vomiting	2 (3.33%)	3 (5.00%)	-	0.65[b]
Need for Additional Therapies	Nebulized Bronchodilators (%)	12 (20.00%)	18 (30.00%)	-	0.19[b]
	Supplemental Oxygen (%)	10 (16.67%)	14 (23.33%)	-	0.34[b]

a: Independent t-test, b: Chi-square test

DISCUSSION

Our study provides valuable insights into the comparative effectiveness of nebulized magnesium sulphate and hypertonic saline in treating paediatric acute bronchiolitis. In agreement with prior research suggesting the benefits of magnesium sulphate in reducing bronchospasm and airway inflammation, our findings indicate that Group A (magnesium sulphate) experienced significant improvements in respiratory rate, wheezing score, and oxygen saturation. Group A's respiratory rate decreased from 48.52±5.61 to 34.75±4.24 breaths per minute, whereas Group B (hypertonic saline) showed a decline from 48.23±5.82 to 36.17±4.63 breaths per minute (p=0.04). This aligns with studies demonstrating that magnesium sulphate enhances respiratory function in children with bronchiolitis, likely due to its smooth muscle relaxant properties, which alleviate bronchoconstriction.[12,13] While both treatments led to a notable reduction in respiratory rate, the greater improvement in Group A suggests a potentially superior role for magnesium sulphate in symptom relief. Group A demonstrated a reduction in wheezing scores, dropping from 2.97±0.42 to 1.41±0.36, compared to Group B, which improved from 3.07±0.53 to 1.76±0.48 (p=0.02). This finding supports previous studies indicating that magnesium sulphate may be more effective in reducing wheezing and airway inflammation in children with bronchiolitis.[14] The anti-inflammatory effects of magnesium sulphate, along with its ability to enhance airway muscle relaxation, may explain its superior efficacy in wheeze reduction. Conversely, hypertonic saline primarily facilitates mucociliary clearance and may have a weaker direct effect on airway inflammation, potentially explaining its lesser impact on wheezing improvement.

Both treatments significantly improved oxygen saturation, with Group A's levels rising from 88.23±3.14% to 95.46±2.02%, and Group B's increasing from 88.56±3.08% to 94.82±2.31%. This is consistent with previous studies demonstrating that both therapies enhance oxygenation.[15] However, the difference between the groups was not statistically significant (p=0.12), suggesting that both treatments are equally effective in improving oxygen levels. Interestingly, Group A required supplemental oxygen less frequently (16.67%) than Group B (23.33%), implying that magnesium sulphate may enhance oxygenation more effectively without additional interventions.

When assessing secondary outcomes, Group A exhibited a shorter hospital stay (4.32±1.27 days) compared to Group B (4.69±1.42 days), though this difference was not statistically significant (p=0.21). This is consistent with prior research indicating that magnesium sulphate may be associated with slightly reduced hospitalization duration compared to hypertonic saline.[16] Group A had fewer adverse effects, such as mild irritation (6.67%), coughing (5.00%), and vomiting (3.33%), compared to Group B (10.00%, 13.33%, and 5.00%, respectively). These findings are in line with previous studies that have shown a favourable safety profile for magnesium sulphate in paediatric bronchiolitis. However, differences in adverse effects and additional treatment requirements were not statistically significant, reinforcing the overall safety and tolerability of both interventions.

Study Strengths and Limitations

One of the study's key strengths is its prospective cohort design, which allowed for a detailed assessment of the short-term effects of nebulized magnesium sulphate versus hypertonic saline in the treatment of paediatric acute bronchiolitis. The study's rigorous inclusion criteria and comprehensive evaluation of both primary and secondary outcomes, including respiratory rate, wheezing score, oxygen saturation, and hospital stay duration, enhance the validity of the findings.

Several limitations must be acknowledged. The single-center nature of the study may introduce geographical biases, limiting the generalizability of the findings to broader populations. The short treatment duration (one day) and lack of long-term follow-up prevent an evaluation of the sustained effects of either therapy beyond the immediate hospitalization period. Moreover, if the study was not blinded, potential bias in clinical assessments could have influenced the results. To validate these findings and ensure broader applicability, future research should focus on larger, multicentre cohorts with extended follow-up periods to assess long-term clinical outcomes.

CONCLUSION

The nebulized magnesium sulphate showed greater improvements in wheezing scores and respiratory rate, but the overall treatment efficacy between the two groups was comparable. Both magnesium sulphate and hypertonic saline led to significant improvements in oxygen saturation and required similar levels of supportive care. Magnesium sulphate demonstrated some advantages, including a slightly shorter hospital stay and reduced need for additional treatments, though these differences were not statistically significant. These findings suggest that both therapies are effective, safe, and well-tolerated options for managing paediatric acute bronchiolitis. Future studies with larger sample sizes and extended follow-up periods are needed to provide more definitive treatment recommendations and assess long-term clinical outcomes.

AUTHORS' CONTRIBUTION

MRK: Data collection. AH: Analysis. MK: Data Interpret. HG: Statistics. HUR, MI: Final drafting.

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