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The Role of Hypertonic Saline in the Management of Bronchiolitis at Raparin Hospital

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Abstract

Background and objectives: Bronchiolitis is the prevailing acute respiratory ailment of significant severity among newborns and young children. The objective of the study was to assess the effectiveness of hypertonic saline 3% in treating acute bronchiolitis and its impact on the severity of cases admitted to the emergency department, in comparison to Salbutamol nebulization.

Methods: A comparative, experimental, longitudinal study was conducted on 150 infants aged 1–24 months who were admitted to Raparin pediatric teaching hospital at emergency department with moderate to severe respiratory distress from November 2022 to May 2023. Two groups of patients were formed by age and severity. Using a nebulizer device, the two medication combinations (Salbutamol and hypertonic saline) were given to the patients in each of the two groups every six hours. Initial assessment was executed through taking vital signs on admission. Moreover, additional assessments were conducted before and following each nebulization for four times each day until the recovery and discharge. The length of recovery, hospital stay, duration of oxygen therapy, wheezing and oxygen saturation was compared between the two groups.

Results: The study found that 32% of the Salbutamol group stayed 4 days and 18.7% of same group stayed ≥ 5 days in the hospital respectively, compared with 14.7% of the hypertonic group stayed in hospital for 4 days and 0% stayed ≥ 5 days in the hospital ($p < 0.001$). Furthermore, one day after treatment, around half (44%) of children treated with hypertonic saline had no wheeze, compared with 24% of children of the Salbutamol group ($p < 0.001$).

Conclusion: The present study concluded that the role of Nebulized 3% Hypertonic Saline is significant in management of bronchiolitis.

Keywords: Bronchiolitis, Hypertonic saline, Nebulization, Salbutamol

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Introduction

Bronchiolitis is the most prevalent disease affecting the lower respiratory tract in infants particularly during the first two years of life.[1,2] It is a significant contributor to hospital admissions among children within their first two years of life.[3] Bronchiolitis is mostly attributed to respiratory syncytial virus (RSV), accounting for an estimated 50-80% of cases. Consequently, the use of antibiotics is often unsuccessful in treating this condition.[4] The duration of the infection typically spans a period of about 2 to 3 weeks, during which mucosal congestion and sputum production are seen.[5,6] The condition is defined by the presence of acute inflammation, edema, and necrosis of the epithelial cells that lining the tiny airways. Additionally, there is an observed increase in mucus production and bronchospasm.[7] The often-seen manifestations include rhinitis, tachypnea, nasal flaring, cough, wheezing, crackles, and the use of accessory muscles.[8] Infection with (RSV) does not provide enduring or sustained immunity. Inhalation treatment with hypertonic saline (HS) has been studied in several clinical trials with varying outcomes. There exists a divergence of opinions among professionals about the efficacy of HS, Furthermore, babies who are admitted to the hospital due to bronchiolitis not only experience morbidity and death during the acute phase of the illness, but they also exhibit a higher propensity for respiratory complications in later childhood, particularly recurrent wheezing, in comparison to those who did not encounter severe manifestations of the disease.[9,10] Severe sickness is characterized by consistently increased respiratory effort, periods of apnea, or the requirement for intravenous fluid administration, supplemental oxygen, or mechanical respiratory support such as epinephrine or beta 2 -agonists in the treatment of bronchiolitis caused by respiratory syncytial virus (RSV). This lets the bronchial mucosa or submucosal layers receive water molecules and lowers the risk of airway swelling.[11,12] When Zhang et al. did a thorough literature review and meta-analysis, they found that using HS 3% can decrease hospital stays by a lot.[13] However, the study didn't explain why the results were so different. The 2014 AAP (American Academy of Pediatrics) bronchiolitis recommendation says that supporting care, like rest, keeping up with diet, and drinking extra fluids, is the best way to treat bronchiolitis.[14] As of late, several studies have shown that HS (3%) is helpful for getting water molecules into the lung mucosa, this lets the bronchial mucosa or submucosal layers receive water molecules and lowers the risk of airway swelling.[11,12] The length of stay in the hospital and the clinical bronchiolitis severity score (CBSS) were looked at to see how well 3% HS worked compared to Salbutamol nebulization which is the objective of this study.

Patients and methods

This research was comparative, experimental, longitudinal study conducted in Raparin teaching hospital for pediatrics, Iraq, Erbil, from November 2022 to May 2023. Non-randomized sampling was utilized for a total of 150 inpatients with age range of 1-24 months with moderate to severe bronchiolitis and were divided into two groups, each group 75 patients. Inclusion criteria include patients aged 1-24 months, as were inpatients with moderate to severe respiratory distress and wheezing. Patients with congenital heart disorders, chronic lung diseases (such as cystic fibrosis and asthma), and immunodeficiency were excluded. To determine the severity of the disease a modified Tal score which is a validated score for prediction of bronchiolitis severity was used. Based on age and severity the patients were divided into two groups. Group one underwent treatment with hypertonic saline

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3% nebulizer of 5 ml per time. Group two, meanwhile, received a salbutamol nebulizer at a dose of 0.1 mg/kg, and distilled water was used to achieve the necessary concentration. Using a nebulizer device, the two medication combinations were given to the patients in each of the two groups every six hours. Assessments were conducted before and following each nebulization four times each day until the recovery and discharge. Informed consent was obtained from the patient's guardians, and after the consent patients were assigned into two groups, salbutamol group and HS group. The Ethical approval code is 560 from the scientific committee of the higher council of medical specialties. The data was analyzed using the Statistical package for social sciences (SPSS), specifically version 25. The proportions of the two study groups were compared using the Chi square test of association. Fisher's exact test was used when the anticipated frequency (value) of more than 20% of the cells in the table was less than 5. To compare the proportions of the same sample taken at two distinct times, the McNemar or McNemar-Bowker tests were employed. The means of the two study groups were compared using the unpaired t test. A statistically significant result was defined as a p value of less than 0.05.

Results

The total number of children was 150. Their mean age (SD) was 8.7 (5.8) months, the median was 7 months, and the age range was 1-24 months. They were divided into two groups, the Salbutamol group (n = 75), and the hypertonic saline group (n = 75). The largest proportion of the whole sample (38.7%) were aged 6-11.9 months, and 36.7% were aged less than six months, but there were no significant differences in the age distribution and mean age of the two groups (p = 0.576, and p = 0.140 respectively). More than half of the sample (53.3%) was of male gender, and the gender distribution was exactly the same of both groups (p = 1.000). No significant differences were detected between the two study groups regarding the following variables: SpO_2 (p = 0.351), respiratory rate (p = 0.351), wheeze (p = 0.617), cyanosis (p = 1.000), modified Tal score (p = 0.070) as presented in Table (1).

Table (1): Demographic and clinical data

	Salbutamol	Hypertonic	Total	
	No. (%)	No. (%)	No. (%)	p
Age Mean (SD)	9.4 (6.4)	8.0 (5.1)		0.140**
Gender				
Male	40 (53.3)	40 (53.3)	80 (53.3)	
Female	35 (46.7)	35 (46.7)	70 (46.7)	1.000*
Socioeconomic status				
Good	9 (12.0)	20 (26.7)	29 (19.3)	
Intermediate	38 (50.7)	42 (56.0)	80 (53.3)	
Poor	28 (37.3)	13 (17.3)	41 (27.3)	0.007*
SpO_2				
31-45	13 (17.3)	7 (9.3)	20 (13.3)	
46-60	39 (52.0)	42 (56.0)	81 (54.0)	
> 60	23 (30.7)	26 (34.7)	49 (32.7)	0.351*
Respiratory rate				
31-45	13 (17.3)	7 (9.3)	20 (13.3)	
46-60	39 (52.0)	42 (56.0)	81 (54.0)	

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> 60	23 (30.7)	26 (34.7)	49 (32.7)	0.351*
Cyanosis				
None	40 (53.3)	40 (53.3)	80 (53.3)	
Perioral with cry	35 (46.7)	34 (45.3)	69 (46.0)	
Perioral at rest	0 (0.0)	1 (1.3)	1 (0.7)	1.000**
Modified Tal score				
Moderate	38 (50.7)	27 (36.0)	65 (43.3)	
Severe	37 (49.3)	48 (64.0)	85 (56.7)	0.070*
Total	75 (100.0)	75 (100.0)	150 (100.0)	

*By Chi square test. **By unpaired t test.

It is evident in Table (2) that 32% and 18.7% of children of the Salbutamol group stayed 4 and ≥ 5 days in the hospital respectively, compared with 14.7% and 0% respectively of the hypertonic group ($p < 0.001$) as shown in Table (2).

Table (2): Duration of hospitalization by type of management

Duration of hospitalization (days)	Salbutamol	Hypertonic saline	Total	
	No. (%)	No. (%)	No. (%)	P*
1	0 (0.0)	3 (4.0)	3 (2.0)	
2	7 (9.3)	26 (34.7)	33 (22.0)	
3	30 (40.0)	35 (46.7)	65 (43.3)	
4	24 (32.0)	11 (14.7)	35 (23.3)	
≥ 5	14 (18.7)	0 (0.0)	14 (9.30	< 0.001
Total	75 (100.0)	75 (100.0)	150 (100.0)	

*By Chi square test.

It is evident in Table (3) that none of the children in the hypertonic group had SpO_2 of more than 93%, but one day after treatment, 45.3% had an SpO_2 of > 93%. Regarding respiratory rate (RR), none of the children had RR of ≤ 30 / minute, this percentage increased to 17.3% after treatment. The table shows also that 34.7% had RR of > 60 / minute before treatment, while none had it after treatment. The tables show that all the children had wheeze before treatment, but after treatment, 44% improved and had no wheeze. More than half (53.3%) had no cyanosis before treatment, but for the group which had cyanosis there was improvement after treatment and 81.3% of this group had no cyanosis. The proportion of children using accessory muscles before treatment was 14.7%, which improved to 6.7% after treatment ($p = 0.031$) as presented in Table (3).

Table (3): Respiratory progress indicators, before and one day after treatment with hypertonic saline.

	Before	After	p
	No. (%)	No. (%)	
SpO_2			
< 85%	15 (20.0)	0 (0.0)	
85-90%	53 (70.7)	5 (6.7)	
91-93%	7 (9.3)	36 (48.0)	

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> 93%	0 (0.0)	34 (45.3)	NA
Respiratory rate / minute			
≤ 30	0 (0.0)	13 (17.3)	
31-45	7 (9.3)	46 (61.3)	
46-60	42 (56.0)	16 (21.3)	
> 60	26 (34.7)	0 (0.0)	NA
Wheeze			
None	0 (0.0)	33 (44.0)	
End expiratory with stethoscope	10 (13.3)	39 (52.0)	
Insp. and exp. with stethoscope	43 (57.3)	3 (4.0)	
Audible	22 (29.3)	0 (0.0)	NA
Cyanosis			
None	40 (53.3)	61 (81.3)	
Perioral with cry	34 (45.3)	14 (18.7)	
Perioral at rest	1 (1.3)	0 (0.0)	NA
Accessory muscle use			
No	64 (85.3)	70 (93.3)	
Yes	11 (14.7)	5 (6.7)	0.031*
Total	75 (100.0)	75 (100.0)	150 (100.0)

*By McNemar test. **By McNemar-Bowker test.

One day after treatment, around half (44%) of children treated with hypertonic saline had no wheeze, compared with 24% of children of the Salbutamol group ($p < 0.001$). No significant differences were detected between the two study groups regarding the other progress indicators as shown in Table (4).

Table (4): Respiratory progress indicators, one day after treatment with salbutamol and hypertonic saline

	Salbutamol	Hypertonic	Total	p
	No. (%)	No. (%)	No. (%)	
SpO_2				
85-90%	5 (6.7)	5 (6.7)	10 (6.7)	
91-93%	42 (56.0)	36 (48.0)	78 (52.0)	
> 93%	28 (37.3)	34 (45.3)	62 (41.3)	0.594*
Respiratory rate				
≤ 30	15 (20.0)	13 (17.3)	28 (18.7)	
31-45	45 (60.0)	46 (61.3)	91 (60.7)	
46-60	15 (20.0)	16 (21.3)	31 (20.7)	0.911*
Wheeze				
None	18 (24.0)	33 (44.0)	51 (34.0)	
End expiratory with stethoscope	36 (48.0)	39 (52.0)	75 (50.0)	
Insp. and exp. with stethoscope	21 (28.0)	3 (4.0)	24 (16.0)	< 0.001*
Cyanosis				
None	64 (85.3)	61 (81.3)	125 (83.3)	
Perioral with cry	11 (14.7)	14 (18.7)	25 (16.7)	0.511*
Accessory muscle use				
No	70 (93.3)	70 (93.3)	140 (93.3)	
Yes	5 (6.7)	5 (6.7)	10 (6.7)	1.000*
Total	75 (100.0)	75 (100.0)	150 (100.0)	

*By Chi square test.

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Discussion

Acute viral bronchiolitis is characterized by airway edema and mucus clogging rather than bronchospasm; hence the indicated treatment choices are restricted.[15] As per the outcomes of our study, nebulized salbutamol and 3% HS can both effectively lower the clinical bronchiolitis severity score (CBSS) during a moderate bronchiolitis patient's initial episode in the emergency room. But there was significant difference in length of hospital stay between two groups, as it is evident in the result that 32% and 18.7% of children of the Salbutamol group stayed 4 and ≥ 5 days in the hospital respectively, compared with 14.7% and 0% respectively of the hypertonic group ($p < 0.001$). The results of our study aligned with those of a study conducted by Zhang et al., regarding the use of nebulized hypertonic saline solution for acute bronchiolitis in infants. Another study's findings support those of our study that demonstrate that hospitalized infants treated with nebulized HS had a statistically significant shorter length of stay.[13] Further evidence show that nebulized 3% hypertonic saline solution is more effective than 0.9% saline solution and epinephrine in reducing hospitalized infant's symptoms and length of stay comes from Giudice et al.'s study on the effectiveness of nebulized hypertonic saline and epinephrine in infants with bronchiolitis. Both treatments have a favorable safety profile.[16] Additionally, the findings of our study were in line with a study conducted by Wang et al., which found that infants treated with HS nebulizers spent less time in the hospital than those treated with normal saline nebulizers (weighted mean difference = −0.43; 95% CI = −0.70, −0.15).[17] The current study's findings support the findings of and indicate that nebulized salbutamol and 3% HS are effective in reducing the CBSS in the emergency department during the first attack of moderate bronchiolitis.[18] Furthermore, our results were consistent with findings of a study by Wang et al., regarding the effects of HS use on the CSS score, showing that HS treatment significantly reduced the CSS score on the first, second, and third days (SMD=−0.58; 95% CI=−0.85, −0.32).[17] The current study's findings aligned with a study by Hsieh et al., which demonstrates that the HS group significantly reduced the severity of respiratory distress when compared to the control group. The studies used the Respiratory Distress Assessment Instrument (n = 5; MD, − 0.60; 95% CI, − 0.95 to − 0.26; I2 = 0%) and the Clinical Severity Score (n = 8; MD, 0.71; 95% CI, − 1.15 to − 0.27; I2 = 73%) for evaluation, respectively. The HS group also reduced the duration of hospital stay.[19]

Conclusion

This study makes a significant contribution to the existing knowledge base in the Kurdistan Region of Iraq, being the inaugural investigation into the efficacy of Hypertonic Saline 3% in managing bronchiolitis. Infants who are admitted to the hospital and receive treatment with nebulized 3% hypertonic saline may have a somewhat shorter average hospitalization period compared to those who are treated with nebulized Salbutamol or normal methods.

Conflicts of Interest

There are no conflicts of interest.

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