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Original Research Article

Effect of Addition of Nebulized $MgSO_4$ to Treatment of Acute Severe Asthma in Children

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Abstract:

Background: Asthma is the most common chronic respiratory disorder in children that poses a life-threatening risk. The lower airway may suddenly tighten and swell when exposed to stimuli. The well-known bronchodilator salbutamol, which is inhaled, is typically used as the first line of treatment to ease bronchospasm. The purpose of this study is to compare the results of giving children with acute, severe asthma nebulized magnesium sulphate in addition to the conventional treatment.

Method: The study was undertaken at the Department of Pediatrics, Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar from November 2022 to April 2023. The first step in treating acute, severe asthma in children aged 1 to 12 years old involved nebulizing salbutamol three times and ipratropium once. Additionally, intravenous steroids were provided to each patient. The patients who did not respond to this therapy and were still categorized as having acute severe asthma were randomly split into two groups, each consisting of 19 individuals. While each patient in Group B received 2.5 ml of isotonic saline through nebulizer, Group A patients received 2.5 ml (150 mg) of isotonic magnesium sulphate via nebulizer, three times 20 minutes apart. Salbutamol was also included in each nebulization. At the beginning of treatment, after 30 minutes, and after 60 minutes of treatment, the Yung Asthma Severity Score (ASS) was calculated.

Results: Children in group A had a mean Asthma Severity Score of 6.95± 1.29 after 60 minutes, while group B had a mean Asthma Severity Score of 7.63± 1.03 ($p < 0.05$). In group A, 10 (52.63%) children were admitted to the hospital and 9 (47.40%) children were discharged. In group B, 15 children (78.95%) were admitted to the hospital, compared to 4 (21.05%) who were discharged ($p < 0.05$).

Conclusion: It has been determined that in children with acute severe asthma, nebulized magnesium sulphate in addition to salbutamol can produce better results than salbutamol alone.

Keywords: Acute severe asthma, Nebulization, Magnesium sulphate, Salbutamol, Saline.

Introduction

Bronchospasm-induced airway blockage that is reversible and increased mucus production are the hallmarks of asthma.[1] Severe asthma in children is defined as having symptoms that persist despite receiving bronchodilator therapy.[2] Numerous hospital admissions are caused by severe asthma. In the world, it affects one out of every three children.[3] Acute severe asthma is typically treated with oxygen inhalation, nebulization with salbutamol and ipratropium, as well as intravenous steroids.[4] Epinephrine/adrenaline administered subcutaneously or inhaled, intravenous (IV) or inhaled magnesium sulfate (MgSO4), and intravenous aminophylline are further treatments.[5] Asthma care strategies recommended by the GINA (Global Initiative for Asthma) and BTS (British Thoracic Society) include the use of intravenous and nebulized magnesium sulphate6. The effectiveness of nebulized magnesium sulphate has not been shown, while intravenous magnesium sulphate is a well-established therapeutic option for acute asthma.[7]

MgSO4 prevents calcium ions from entering the smooth muscles, which limits their ability to contract. Additionally, it halts the calcium-myosin interaction that causes smooth muscle to relax. As it stabilizes mast cells and T cells, it aids in the decrease of inflammatory mediators. Additionally, it promotes the production of prostacyclin and nitric oxide, both of which can lessen the severity of asthma.[8] Although magnesium sulphate administered intravenously is useful in treating severe intractable asthma, it cannot be used on a regular basis because it needs to be monitored and has adverse effects.[9]

In contrast, the magnesium sulphate inhalation route is a non-invasive method that enables quick pharmacological action. Because of its lower toxicity and adverse effects, it also has a better safety window.[10] Although magnesium sulphate inhalation is used to treat acute asthma, its effectiveness is still up for debate.[11] According to studies, magnesium sulphate can lower the admission rate for people with severe asthma.[12,13] Due to the lack of research in our area, this study established the effectiveness of nebulized magnesium sulphate for acute asthma. We could use the information to incorporate the findings in our local setup and enhance the outcome for asthmatic kids.

Material and Methods

A Randomized Controlled trial was conducted in the Pediatrics department of Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar from November 2022 to April 2023. With 19 in each group, the total sample size estimated was 38. The test value of the population mean (mean of asthma severity score) was computed using Level of significance = 5%, Power of the test = 80%, and Expected Population Mean (mean of asthma severity score) = 0.44.12 Non-probability consecutive sampling approach was utilized. The study comprised boys and girls between the ages of 1 and 12 who had been diagnosed with severe acute asthma. The GINA/BTS definition of severe asthma was used. When a child meets all of the following criteria, who is diagnosed with severe asthma is between the ages of one and five: oxygen saturations below 92% without the use of a ventilator or additional oxygen, severe dyspnea when speaking, heart rate greater than 130 beats per minute, respiratory rate greater than 50 breaths per minute, and usage of auxiliary muscles.

Among children aged ≥ 6 years, severe asthma is diagnosed when all of the these criteria : Oxygen saturations < 92% without ventilator / oxygen supplement, severe dyspnea while talking, heart rate > 120 beats per minute, respiratory rate > 30 breaths per minute and use of accessory muscles. Co-existing diseases like pneumonia, tuberculosis, cystic fibrosis, restrictive lung diseases or any other infective etiology, renal or liver disease and patients with known adverse reaction to magnesium were excluded from the study. Parents of children provided written consent after being fully informed. To record the patient's demographic information, such as name, age, and gender, a structured proforma was employed. A patient who met the requirements for inclusion received an initial salbutamol nebulization three times and an ipratropium nebulization once. Hydrocortisone (4 mg/kg) was administered intravenously to all of the patients. The patients who did not respond to this therapy and were still categorized as having acute severe asthma were randomly split into two groups, each consisting of 38 patients. While each patient in Group B received 2.5 ml of isotonic saline through nebulizer, Group A patients received 2.5 ml (150 mg) of isotonic magnesium sulphate via nebulizer, three times 20 minutes apart. Every nebulizer also contained 2.5 mg (for children 1 to 5 years old) or 5 mg (for children 6 years and younger) of salbutamol. The Yung Asthma severity score (Table 1), which was measured prior to therapy and subsequently at 30 & 60 minutes following nebulization, served as the main outcome. After nebulization, patients who were still classified as having acute severe asthma were admitted to the pediatric ward for continued care.

Table 1: Yung asthma severity score

Score	Wheeze	Accessory muscle	Heart Rate
0	Absent	0	<80
1	Expiratory only	+	81-110
2	Inspiratory and expiratory	++	111-140
3	Audible without stethoscope/silent chest in severe asthma	+++	>141

The score from 0 - 3 was given to each of three components; the sum of this score was the ASS.
SPSS version 23 was used to enter and evaluate the data. Gender and admission rate—the percentage of children who were admitted to the ward after the first course of treatment failed—were qualitative variables that were provided as frequency and percentages. Age, weight, and the severity of the asthma at presentation, after 30 and 60 minutes of treatment, were quantitative factors that were displayed as mean and standard deviation. In order to compare the Asthma Severity Scores between the two groups, an independent sample t-test was used. To compare the outcomes of the kids in the

two groups, the chi-square test was used. P-value less than or equal to 0.05 was considered statistically significant.

Results: Patients in group A had a mean age of 3.79± 2.23 years, whereas those in group B had a mean age of 4.68 ±3.01 years. There were 10 (52.60%) female children and 9 (47.40%) male youngsters in group A. Eight (42.11%) male and eleven (57.89%) female youngsters made up group B. (Table 2)

Table 2: Demographic data of patients

	Study group	
	Group A : Magnesium sulphate	**Group B : Saline**
Age in years	3.79±2.23	4.68±3.01
Gender		
Male	9(47.40%)	8(42.11%)
Female	10(52.60%)	11(57.89%)

In group A, the mean ASS was 8.29± 0.80 at baseline, 7.24± 1.10 at the end of 30 minutes, and 6.95± 1.29 at the end of 60 minutes. Similar to group A, group B mean ASS was 8.50± 0.56 at baseline, 7.66± 0.99 at the end of 30 minutes, and 7.63±1.03 at the end of 60 minutes. After 30 minutes, the difference between the two groups was not statistically significant ($p > 0.05$), but after 60 minutes, it was ($p < 0.05$). (Table 3)

Table 3: Change in ASS score with course of treatment (n=38)

	Study group		p-value
	Group A : Magnesium sulphate	**Group B : Saline**	
ASS before treatment	8.29±0.80	8.50±0.56	0.188
ASS at 30 minutes	7.24±1.10	7.66±0.99	0.084
ASS at 60 minutes	6.95±1.29	7.63±1.03	0.013*

* = P – value < 0.05 (Significant) & ! = p – value > 0.05 (Insignificant)

In group A, 10 (52.6%) of the children were admitted to the hospital while 9 (47.4%) were discharged. In group B, 15 (78.95%) of the children were admitted to the hospital, while 4 (21.05%) were discharged. Between the two groups, there was a significant difference ($p < 0.05$). (Table 4)

Table 4: Comparison of outcome in both groups

Outcome	Study group		Total	p-value
	Group A : Magnesium sulphate	**Group B : Saline**		
Discharged	9(47.40%)	4(21.05%)	13(34.21%)	0.007*
Admitted	10(52.60%))	15(78.95%)	25(65.79%)	
Total	19(100%)	19(100%)	38(100%)	

* = P – value < 0.05 (Significant)

Discussion

When a child is diagnosed with acute asthma, over 30% of them do not respond to first-line treatment, and 84% of them need to be hospitalized.[15] The number of hospital admissions, health care costs, and the psycho-social burden of the condition can all be significantly reduced by looking for a risk-free, non-invasive, and efficient strategy to treat this stage. In our study, the magnesium sulphate nebulization group's mean ASS score was considerably lower than it would have been with just conventional care. Thus indicating that magnesium sulphate nebulization may be utilized in addition to conventional therapy. In addition to reducing hospital admissions, Schuh et al. found that adding magnesium sulfate nebulization to the treatment also resulted in a decline in PRAM (Pediatric Respiratory Assessment Measure) scores.[15] With the addition of magnesium sulphate, nine children in our study who had severe asthma were able to leave the emergency room, while ten (52.60%) required hospital admission. However, when using saline, 15 (78.95%) children required hospital admission whereas only 4 (21.05%) were released from the emergency room. Between the two groups, there was a significant difference ($p < 0.05$). This demonstrated that the addition of magnesium sulfate enhanced patient outcomes, leading to a greater number of patients being discharged from the emergency room. This resulted in fewer admissions and less strain on the hospital and the doctors.

Additionally, Mahajan P came to the conclusion that moderate asthma patients may benefit from magnesium sulphate added to albuterol nebulization.[16] Nebulized magnesium sulphate may play a moderate role in the treatment of severe asthma, according to research by Knightly et al., albeit the strength of the data was questionable.[17] Nebulized magnesium sulphate can improve ASS in acute severe asthma, according to Powell et al., however the improvement was not statistically

significant.[18] In comparison to salbutamol alone, nebulized magnesium sulfate improved PEFR (Peak Expiratory Flow Rate) in pediatric patients.[19] Nebulized magnesium sulphate has not been found to be beneficial, according to numerous research.[20,21] Additional research is required to assess the outcome. The dosage of nebulized magnesium sulphate was one of the main issues. Each dose contained 150 mg of hospital pharmacy-produced, isotonic (7.5%w/v), magnesium sulfate. The majority of pediatric research employed the same amount of isotonic magnesium sulphate.[18,19,22] However, varying study concentrations of the solution (6.3%) may have an impact on the bronchodilator effects of magnesium sulphate.16 The impact of various nebulized magnesium sulphate concentrations on the result has to be determined by additional research.

Conclusion

It has been determined that in children with acute severe asthma, magnesium sulphate combined with ventolin can produce better results than salbutamol alone. It may also lead to fewer hospital admissions and less strain on medical facilities and staff. It is now advised to carry out further studies in the future so we can promote using magnesium sulphate combined with salbutamol in local settings and practices.

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