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ORIGINAL ARTICLE

Efficacy of magnesium sulphate treatment in children with acute asthma.

Hina Rashid[1], Muhammad Ashfaq[2], Khatidja Ally[3], Bader u Nisa[4], Muhammad Hanif[5]

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ABSTRACT… Objective: To determine the effectiveness of magnesium sulphate ($MgSO_4$) in improving lung function parameters in children presented with acute asthma (AA). **Study Design:** Quasi-experimental study. **Setting:** Department of Emergency, National Institute of Child Health, Karachi, Pakistan. **Period:** October 2023 to March 2024. **Methods:** Children of either gender, aged between 6-13 years, presenting with respiratory complaints due to AA were included. Demographic and clinical details of each child were obtained. Presenting complaints including wheezing, short ness of breath, cough chest tightness was asked from children and their parents/guardians. Dose of $MgSO_4$ was calculated according to body weight of child and infusion was prepared in 100 mL normal saline by on duty senior nurse. Spirometry of each child was performed by trained experienced spirometry technician before and after 15 minutes of $MgSO_4$ infusion. **Results:** In a total of 82 children with AA, 47 (57.3%) were boys. The mean age was 9.87±1.72 years. The most frequent associated conditions were dust allergy, and fragrance allergy, noted in 34 (41.5%), and 32 (39.0%) children, respectively. Wheezing, and cough were the most frequently noted symptoms, observed in 65 (79.3%) children each. Significant improvement in FEV1 ($p<0.001$), FVC ($p<0.001$), PEF ($p<0.001$), and FEF 25-75 ($p<0.001$) were observed after treatment with $MgSO_4$. **Conclusion:** These findings suggest that IV $MgSO_4$ may serve as an effective adjunct therapy for acute pediatric asthma exacerbations, leading to improved clinical outcomes.

Key words: Asthma, Forced Expiratory Volume, Forced Vital Capacity, Magnesium Sulphate, Spirometry.

INTRODUCTION

Asthma is a chronic, heterogeneous and non-communicable disease that affects all age groups. Asthma is marked by recurrent episodes of airflow obstruction and is related with significant morbidity and mortality.[1,2] Asthma is defined as "the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness and cough that vary over time and in intensity, together with variable expiratory airflow limitation".[3] As per the Global Asthma Report, asthma ranks 16th as the major cause behind years lived with disability.[4] About 300 million people globally are currently afflicted by asthma, with projections suggesting further rise in the next few years.[5] According to World Health Organization (WHO), in year 2019 0.8% of total deaths were reported due to asthma, out of which 2.54% were reported in children having age ≤ 14 years.[6]

In children, multiple triggers including respiratory viruses, allergens, tobacco smoke, air pollution, and exposure to cold or dry air, can provoke asthma symptoms. Such acute asthma (AA) episodes significantly increase clinic or emergency department visits, hospitalizations, and school absenteeism among pediatric patients.[7,8] Therefore, adjunct therapies should be used in treatment of AA attack along with standard therapy such as intravenous administration of Magnesium sulphate ($MgSO_4$).[8,9] $MgSO_4$ is known to be a bronchodilator that relaxes the bronchial muscles, further resulting in expanding the airways and improving the pulmonary functioning.[10,11] Özdemir et al. evaluated the effectiveness of $MgSO_4$ in AA and founded significant improvements in pulmonary function parameters following treatment, particularly among those with mild to moderate asthma severity.[12] Similar beneficial outcomes from $MgSO_4$ treatment in AA have also

1. MBBS, Post-graduate Trainee Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.
2. MBBS, MCPS, FCPS, CHPE, Professor Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.
3. MBBS, FCPS, Senior Registrar Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.
4. MBBS, DCH, FCPS, Associate Professor Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.
5. MBBS, FCPS, Assistant Professor Pediatric Medicine, National Institute of Child Health, Karachi, Pakistan.

Correspondence Address:
Dr. Muhammad Ashfaq
Department of Pediatric Medicine
National Institute of Child Health, Karachi, Pakistan.
drishi_sindhu@yahoo.com

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been documented by other researchers.[13,14]

Internationally, little work has been done on the role of $MgSO_4$ in improving lung function in AA children, while not much local data exists. Therefore, this study is designed in local population of Karachi, Sindh for find the effectiveness of $MgSO_4$ and its role in improving lung function in AA children. This study aimed to determine the effectiveness of $MgSO_4$ in improving lung function parameters in children presented with AA.

METHODS

This quasi-experimental study was conducted in the emergency department of National Institute of Child Health, Karachi, Pakistan from October 2023 to March 2024. Online OpenEpi sample size software was used taking the mean of FEV1 as 48.50±6.81 before treatment and 53.78±9.81 after treatment with $MgSO_4$ in asthma patients[12], by taking confidential interval 95%, power 80%. Sample size was calculated to be 82. Inclusion criteria were children aged between 6-13 years, presenting with respiratory complaints due to AA. Children with mild to moderate AA were included. Children were enrolled if they had no history of using beta 2 agonist in past 3 hours, and no history of using oral/IV steroids in past 12 hours. Exclusion criteria were children who were unable to undergo spirometry evaluation, or those who had oxygen saturation below 92%. Children showing clinical deterioration or with immunodeficiency and chronic diseases having impact on respiratory symptoms were also excluded. Non-probability, consecutive sampling technique was used. AA was labeled if the child presented with any of the following; wheezing, shortness of breath, coughing bouts or dyspnea with forced expiratory volume in 1 sec (FEV1) between 40-75% on spirometry at the time of presentation. AA was categorized as mild if FEV1 ranged from 60% to 75%, or moderate if FEV1 ranged from 40% to 59%.

Approval from "Institutional Ethical Review Board" were obtained prior to the commencement of this research (IERB-44/2021, dated: 15-08-2023). For the purpose of this study, informed and written consents were sought from parents/guardians. Demographic details of each child were obtained. Weight and height of the child were measured using standard weighing machine and standard stadiometer, respectively. Asthma related history including duration of asthma, allergic rhinitis, atopic dermatitis, allergic to dust, smoke and fragrance and current treatment were noted. Presenting complaints including wheezing, short ness of breath, cough chest tightness was asked from children and their parents/guardians.

Dose of $MgSO_4$ was calculated according to body weight of child and infusion was prepared in 100 mL normal saline by on duty senior nurse. Dose of $MgSO_4$ was 40-50 mg/Kg or maximum 1500 mg in children having weight > 30 Kg, diluted in 100 mL of normal saline and administered through intravenous route over 60 minutes. Spirometry of each child was performed by trained experienced spirometry technician before and after 15 minutes of $MgSO_4$ infusion. During spirometry, child was seated at upright position and at least three maneuvers were obtained. Spirometry findings were interpreted by on-duty consultant. Forced vital capacity (FVC), FEV1, peak expiratory flow (PEF), and forced expiratory flow between 25-75% of the FVC (FEF_{25-75}) were measured. On the basis of spirometric findings, children were distributed into mild and moderate asthma. Oxygen saturation, along with heart rate and blood pressure of each child was monitored continuously during spirometry and recorded before and after treatment with $MgSO_4$. Children were treated according to standard protocols. A special proforma was designed to record all study related data.

After collection of data, the analysis was conducted using "IBM-SPSS Statistics, version 26.0". Mean and standard deviation were calculated for quantitative variable. Frequency and percentages were calculated for qualitative variables. Paired sample t test was applied to make comparisons between pre and post-treatment pulmonary function parameters taking $p<0.05$ as significant.

RESULTS

In a total of 82 children with AA, 47 (57.3%)

were boys. The mean age was 9.87±1.72 years, ranging between 6-13 years. The mean duration of disease was 3.26±1.21 years. The most frequent associated conditions were dust allergy, and fragrance allergy, noted in 34 (41.5%), and 32 (39.0%) children, respectively. Wheezing, and cough were the most frequently noted symptoms, observed in 65 (79.3%) children each (table-1).

Characteristics		Frequency (%)
Gender	Boys	47 (57.3%)
	Girls	35 (42.7%)
Age	6-10	48 (58.5%)
	11-13	34 (41.5%)
Frequency of Associated conditions	Allergic rhinitis	20 (24.4%)
	Atopic dermatitis	8 (9.8%)
	Dust Allergy	34 (41.5%)
	Smoke allergy	30 (36.6%)
	Fragrance allergy	32 (39.0%)
Current treatment	None	31 (37.8%)
	Montelukast	2 (29.3%)
	Montelukast+ Inhalaer+Steroids	21 (25.6%)
	LABA	6 (7.3%)
Frequency of Symptoms	Wheezing	65 (79.3%)
	Shortness of breath	12 (14.6%)
	Cough	65 (79.3%)
	Chest tightness	11 (13.4%)
Acute asthma type	Mild	35 (42.7%)
	Moderate	47 (57.3%)

Table-I. Characteristics of children with acute asthma (n=82)

The mean $MgSO_4$ dose was 1356.10±211.17 mg. Significant improvement in FEV1 ($p<0.001$), FVC ($p<0.001$), PEF ($p<0.001$), and FEF 25-75 ($p<0.001$) were observed after treatment with $MgSO_4$. No significant differences were observed with respect to saturation ($p=0.198$), and heart rate ($p=0.443$). Significant decrease in systolic blood pressure ($p=0.006$), and diastolic blood pressure ($p=0.018$) were documented (Table-II). The details about various pulmonary and related parameters with respect to pre-treatment and post-treatment are shown in Table-II.

Parameters	Pre-Treatment (n=82)	Post-Treatment (n=82)	P- Value
Forced expiratory volume in 1 second (%)	57.84 ± 10.73	64.93 ± 10.81	<0.001
Forced vital capacity (l)	70.52 ± 16.83	74.43 ± 17.37	<0.001
FEV1/FVC (%)	72.85 ± 5.41	77.93 ± 4.87	<0.001
Peak expiratory flow (L/min)	48.63 ± 9.94	53.46 ± 9.91	<0.001
Forced expiratory flow 25-75 (%)	39.26 ± 10.59	45.88 ± 10.07	<0.001
Saturation (%)	95.29 ± 1.16	95.13 ± 0.87	0.198
Heart Rate (beats/ minute)	102.77 ± 6.00	102.45 ± 4.41	0.443
Systolic blood pressure (mmHG)	111.52 ± 8.18	108.24 ± 6.71	0.006
Diastolic blood pressure (mmHg)	76.82 ± 6.71	74.48 ± 5.81	0.018

Table-II. Comparison of Pulmonary and related parameters pre and post $MgSO_4$ treatment (N=82)

Paired sample t-test applied

DISCUSSION

Asthma poses a significant medical concern in pediatric patients, often carrying a risk of high morbidity and mortality. Effective management is crucial to mitigate its impact. Experts have endorsed a step-wise approach towards the management of severe AA, and may initiate with standard 1st line therapy, while progress in treatment is made by adding other options if necessary. While many studies have investigated the efficacy of IV $MgSO_4$ in adults, its role in pediatric asthma management remains to be fully elucidated.[15,16] The present study exhibited the effectiveness of IV $MgSO_4$ in improving all pulmonary functions including FEV1, FVC, PEF, and FEF 25-75. Ehsan et al demonstrated that the acute exacerbation of pediatric asthma can be effectively managed by IV $MgSO_4$ when used in conjunction with standard treatment protocols.[17] A meta-analysis evaluating the effectiveness of $MgSO_4$ infusion in children, based on five trials, found promising results with adjuctive use of $MgSO_4$ with β2-agonists and systemic steroids. This analysis demonstrated a reduction in

hospital admission rates and an 85% decrease in symptoms when $MgSO_4$ was used as an adjunct therapy alongside conventional treatments.[18] Our results are also similar to another local study where notable improvements in clinical asthma score was reported in 82% of children aged 2-12 years following a single dose of IV $MgSO_4$.[17]

Mathew and colleagues assessed the efficacy of both IV and nebulized $MgSO_4$ for AA exacerbations. Their findings indicated significant improvements in clinical parameters along with decrease in admission rates.[19] Ciarallo et al reported that more pediatric patients who received IV $MgSO_4$ in the emergency department were able to return home and did not require admission.[20] We only noted immediate outcomes among children with AA and the results exhibited that all patients improved their pulmonary parameters following IV $MgSO_4$. Griffiths et al. also evaluated intravenous $MgSO_4$ effectiveness in children with AA symptoms, noting minimal side effects and a substantial 68% reduction in admission rates.[21] Contrary to these findings, Rodrigo et al in a meta-analysis revealed that $MgSO_4$ did not reduce admission rates among adults with AA.[22] Our findings are in contrast with Khaskheli et al where they observed that IV $MgSO_4$ was ineffective in managing AA among adults. Khaskheli et al did not report the severity of asthma patients which might have been different to us as we only considered mild to moderate AA children.[23]

The present findings exhibited that IV $MgSO_4$ is effective improving pulmonary spirometry parameters among children with mild to moderate AA. Clinical implications of this study highlight the potential benefits of IV $MgSO_4$ as an adjunct therapy in managing AA exacerbations in pediatric patients. The significant improvements observed in lung function parameters such as FEV1, FVC, PEF, and FEF 25-75 post-treatment suggest that MgSO4 could enhance respiratory function and alleviate symptoms like wheezing and cough effectively. Incorporating MgSO4 into acute asthma management protocols in emergency settings, alongside standard therapies, may lead to better clinical outcomes, reduced hospital admissions, and improved overall quality of care for children experiencing AA episodes. Further studies could explore optimal dosing regimens and long-term benefits to refine its clinical application in pediatric asthma management.

This study evaluated children with mild to moderate AA so further local trials should inquire the effectiveness of IV $MgSO_4$ in severe AA cases. This study was absent of any direct comparison in terms of treatment options so randomized controlled trials should be planned in the future.

CONCLUSION

These findings suggest that IV $MgSO_4$ may serve as an effective adjunct therapy for acute pediatric asthma exacerbations, leading to improved clinical outcomes.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Hina Rashid:** Data collection, data analysis, drafting, responsible for data's integrity, approved for publication.
2	**Muhammad Ashfaq:** Conception, design, proof reading, critical revisions, approved for publication.
3	**Khatidja Ally:** Data analysis, methodology, proof reading, critical revision, approved for publication.
4	**Bader u Nisa:** Data collection, literature review, proof reading, approved for publication.
5	**Muhammad Hanif:** Data collection, literature review, proof reading, approved for publication.