Magnesium sulfate as a bronchodilator in asthma attacks in pediatric patients. A single-center observational study.

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Abstract

Introduction: The objective of this study was to determine the effectiveness of magnesium sulfate as a bronchodilator for asthma attacks in pediatric patients at a regional referral pediatric hospital in Guayas, Ecuador.

Methodology: This observational study was conducted at Francisco Icaza Bustamante Hospital (Ecuador) from 2019--2021. Records of pediatric patients admitted with a diagnosis of status asthmaticus were included. The variables used were age, sex, clinical manifestations, magnesium sulfate dose, and length of hospital stay. The sample was probabilistic.

Results: Ninety-two patients were in the group that received magnesium sulfate, and 38 were in the group that did not. There were no differences according to age. Compared with those who did not use magnesium sulfate, those who received it within the first 2 hours of admission had a shorter hospital stay of 2.7 days, whereas those who did not use it had a shorter stay of 5 days ($P<0.05$).

Conclusions: The use of magnesium sulfate as a bronchodilator in moderate and severe pediatric asthma exacerbations is highly significant when appropriate; hospital stays are significantly shorter when the drug is administered within the first 4 hours. Since there was no significant improvement in pediatric patients who received magnesium sulfate compared with those who received conventional therapy, its efficacy remains under investigation, considering various parameters and arguments arising from the decision to use it, such as the crucial step of asthma exacerbation.

Keywords:

Asthma, Asthmatic crisis, Magnesium sulfate, Children.

Abbreviations

MgSO4: magnesium sulfate.

Supplementary information

No supplementary materials are declared.

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Authors' contributions

Mary Belén Bohórquez Calva: Conceptualization, Research, Writing – original draft, Resources, Software, Supervision .

Nathalie Domenica Borbor Leon: Conceptualization, research, writing—original draft, resources, software, supervision.

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Availability of data and materials

The datasets used and analyzed during this study are available to the corresponding author upon reasonable request.

Introduction

Asthma is one of the most common chronic noncommunicable diseases worldwide in pediatric patients. The World Health Organization estimates, based on the Global Burden of Disease Study and the Global Asthma Report, that this disease affects an average of 300 million people worldwide [1]. Asthma attacks are among the main reasons why pediatric patients visit emergency departments and require hospitalization. Furthermore, it is crucial to recognize that any exacerbation of asthma, whether acute or severe, that does not respond to repeated administration of inhaled beta-agonists can be fatal if not treated promptly and effectively. According to the World Health Organization, in 2019, it affected 262 million people, including adults and children, and caused 461,000 deaths [1, 2].

This condition is characterized by chronic inflammation, thickened bronchial walls, and increased mucus production, leading to airway obstruction and bronchial hyperreactivity. This triggers symptoms such as shortness of breath and a persistent cough, which may or may not be accompanied by expectoration at night, along with a characteristic wheezing sound during breathing as air passes through the smaller airways in the lungs. Various triggers can worsen symptoms, which differ from person to person [3].

The recommended first-line treatment includes inhaled β2-agonists, ipratropium bromide, systemic corticosteroids, and controlled oxygen therapy. Most children with mild to moderate asthma attacks respond well to first-line medications; in more severe cases, second-line therapy becomes necessary. Second-line asthma medications usually involve intravenous drugs such as salbutamol, magnesium sulfate, and aminophylline [4].

Intravenous magnesium, administered as magnesium sulfate, is approved for treating seizure disorders, tachycardia, vertigo, preeclampsia, ischemic heart disease, and asthma. It is recommended in many clinical practice guidelines as a first-line treatment for children with severe asthma who do not respond to initial medications. Its potential mechanisms of action include serving as a cofactor in several smooth muscle enzymatic reactions that promote relaxation [5].

Given the high prevalence of asthma in children, this study aimed to evaluate the benefits of using magnesium sulfate as a bronchodilator during pediatric asthma crises. It involved an objective assessment of the treatment administered to patients diagnosed with an asthma attack and their subsequent progress. The goal was to determine the effectiveness of magnesium sulfate as a bronchodilator for asthma episodes in pediatric patients at a regional referral pediatric hospital in Guayas, Ecuador.

Materials and methods

Studio design

This study is observational. The source is retrospective.

Scenery

The study was conducted at the Statistics Department of Francisco Icaza Bustamante Hospital, part of the Ministry of Public Health of Ecuador, located in Guayaquil, Guayas Province. The research period spanned from January 1, 2019, to December 31, 2021.

Participants

Records of pediatric patients admitted with diagnoses of status asthmaticus, unspecified asthma, and predominantly allergic asthma were included. Incomplete case records were excluded; additionally, patients with a history of chronic diseases that may alter the natural course of asthma, and those with mild asthma attacks that did not require magnesium sulfate for clinical management, were also excluded.

Variables

The variables used were age, sex, clinical manifestations, magnesium sulfate dose, and length of hospital stay.

Data sources/measurements

The source was indirect; an electronic form was completed using data from the institutional medical records. For the case search, multiple searches were conducted for patients diagnosed with respiratory distress syndrome, with the following diagnoses:

J45.9 Asthma, asthmatic (bronchial) (catarrhal) (spasmodic)
J46 Acute, severe asthma
J62.8 Masons for asthma
J45.0 Extrinsic allergic asthma
J62.8 Potters' Asthma
J45.9 Late-onset asthma
J62.8 Sandman's Asthma
J45.0 Atopic asthma
I50.1 Cardiac asthma (see also failure, left ventricle)
J67.8 Red cedar asthma
J45.9 Late-onset asthma
J45.0 Hay fever asthma
J45.0 Asthma with allergic rhinitis
I50.1 Heart asthma
J45.9 Asthma with croup
J69.8 Detergent-induced asthma
J82 Eosinophilic asthma

J46 Asthmatic state of malaise
J45.0 Extrinsic asthma, allergic
J45.1 Idiosyncratic asthma
J45.0 Childhood Asthma
J45.1 Intrinsic asthma, nonallergic
J 62.8 Marblers' asthma
J38.5 Millar's Asthma
J60 Asthma of the miners (coal miners)
J45.8 Mixed asthma
J62.8 Millers' Asthma
J45.1 Nervous asthma
J64 Pneumoconiosis Asthma NCOP
J45.0 Childhood Asthma
J45.1 Nonallergic asthma
J44 Chronic obstructive asthma
J45.0 Platinum Asthma
J45.0 Predominantly allergic asthma
J82 Eosinophilic pulmonary asthma
I50.1 Rostan Asthma
J67.8 Asthmatic syndrome
J46 Severe, acute asthma.

Biases

Observation and selection bias were minimized by applying participant selection criteria. To prevent potential interviewer, information, and memory biases, the principal investigator collected data following a set of guidelines with records approved in the research protocol. Two researchers independently analyzed each record twice, and variables were entered into the database after verifying their consistency.

Study size

The sample was probabilistic. In 2024, Guayaquil's estimated pediatric population consisted of 662,168 children aged 0–12 years. With an asthma incidence rate of 10.1%, there were roughly 66,216 potential asthma cases, of which 18% required one or more emergency room visits, totaling approximately 11,918 cases. With a hospitalization rate of 225 per 100,000 cases, the population experienced about 149 hospitalizations per year (447 cases overall). Using a 95% confidence level, a 5% margin of error, and an expected frequency of 13.2%, the calculated sample size was 126 cases. Epi Info™ version 7.2 (CDC, Atlanta, March 9, 2025) was used.

Quantitative variables

The variables were treated as continuous, using their full original distribution. No mathematical transformations, such as logarithms or square roots, were applied. Outliers were identified using a Tukey diagram, and extreme values were verified against primary sources for correction. Missing data were dealt with by exclusion. No dichotomization or categorization groups were created for the continuous variables.

Statistical analysis

Qualitative variables were analyzed using frequencies and percentages. The statistical package used was IBM Corp. (released in 2018). IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.

Results

Participants

A total of 130 patients who met the inclusion criteria were analyzed, allowing us to reach 100% of the sample.

Characteristics of the study group

There were 92 patients in the magnesium sulfate group and 38 in the non-magnesium sulfate group (Table 1).

Board 1. Description general of patients.

	Magnesium sulphate N=92	Magnesium sulfate free N=38	*P*
Moderate Asthma Attack	36 (39.1%)	28 (73.7%)	0.000338
Severe Asthma Attack	56 (60.9%)	10 (26.3%)	
Male sex	45 (48.9%)	19 (50.0%)	0.9102
Female	47 (51.1%)	19 (50.0%)	
Heart rate on admission	110 ± 11	115 ± 9	0.867
Heart rate after MgSO4 administration	95 ± 9	110 ± 12	0.892
Respiratory rate on admission	28 ± 4	29 ± 4	0.967
Respiratory rate after MgSO4 administration	24 ± 6	26 ± 5	0.987

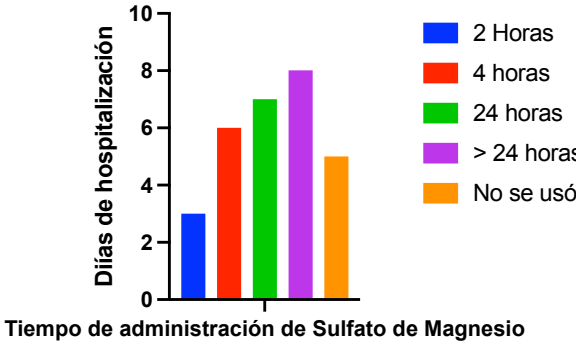
Clinic

According to data collected from a sample of 130 pediatric patients, 64 were admitted with moderate asthma, of whom 36 were male, and 28 were female. A total of 66 patients were admitted with severe asthma attacks: 44 males and 22 females (Table 2). Magnesium sulfate was administered during 71% of all asthma attacks. It was used in 56% of moderate attacks and 85% of severe attacks. Conventional therapy was used in 29% of the total patients. A decrease in heart rate was observed after magnesium sulfate administration; however, this decrease was not statistically significant (P = 0.16). Similarly, a decrease in respiratory rate was observed following magnesium sulfate administration, but this change was also not statistically significant (P = 0.20).

During moderate asthma attacks, magnesium sulfate was used more frequently within 24 hours, with notable variation in its use within the first 2 hours, compared with severe asthma attacks, where it is clear that the drug is used within 4 hours and rarely within the first 2 hours. Therefore, we can standardize the timing of its use to demonstrate that if magnesium sulfate is effective at 24 hours, the length of hospital stay increases even when the drug is not administered (Figure 1).

The timing of magnesium sulfate initiation is linked to the average number of hospital days in pediatric patients, with earlier initiation leading to a significant reduction in hospitalization days. After 24 hours, the drug no longer results in a greater decrease in hospital stay, so, statistically, it does not align with the study's proposed goal.

Figure 1. Days of hospitalization according to the time at which Magnesium Sulfate was administered.



Board 2. Clinical description of patients with asthma.

	Magnesium sulphate N=92	Magnesium sulfate free N=38	*P*
Days of stay in moderate asthma	6 ± 2.4	5 ± 1.2	0.689
Days of stay in severe asthma	6.8 ± 2 .5.	5 ± 1.4	0.678

X^2, P =0.69

Discussion

The use of magnesium sulfate as a bronchodilator in pediatric patients with asthma offers multiple benefits when administered correctly. Although its use is not routine, it is established in treatment guidelines for moderate and severe crises that do not respond to usual therapy [6].

This study examined 130 pediatric patients aged 1 to 15, with an average age of 6 years. The studied asthma attacks occurred mainly in males; however, no data were available on this parameter. The severity of asthma attacks was analyzed using bibliographic criteria, with inclusion of moderate asthma attacks (56% of cases) and severe asthma attacks (44% of cases) [7].

Evaluating the effectiveness of a drug in a specific population is a major challenge in any observational and descriptive study. This study compared clinical data before and after administering magnesium sulfate as a bronchodilator during asthma attacks. Moderate and severe classifications are based on heart rate, which, although it decreases by 15 bpm after drug use, is not statistically significant. In cases where conventional therapy is used, the reduction is 5 beats per minute. A respiratory rate analysis was also conducted. Compared with patients who used the drug, those who received conventional therapy showed a decrease of 3 rpm.

When examining the data, which were not within a statistically significant and valid range, parameters for drug initiation were analyzed, and the average hospital stay concerning the timing of drug administration was calculated. This approach is important for understanding and studying, as various guidelines suggest that earlier initiation of bronchodilator therapy increases its effectiveness. These data are valuable; however, among the 92 patients who received magnesium sulfate as part of their treatment, more than 50% received it within 24 hours or later. Therefore, the study's results are limited and inconclusive.

Conclusions

The use of magnesium sulfate as a bronchodilator in moderate-to-severe pediatric crises is essential when appropriate; hospital stays are significantly shorter when the drug is administered within the first 4 hours. Since there was no significant improvement in pediatric patients who received magnesium sulfate compared with those who received conventional therapy, its efficacy remains under investigation based on various parameters and arguments arising from the decision, such as the importance of asthma exacerbation.

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Statements

Ethics committee approval and consent to participate

The study was approved by the bioethics committee of the Faculty of Medical Sciences, University of Guayaquil.

Publication consent

This information was not needed, as the present study did not publish images, radiographs, or specific patient studies.

Conflicts of interest

The research has no financial interests or conflicts of interest.

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