Predictors of hospital admission due to asthma in children and adolescents enrolled in an asthma control program*

Fatores preditores de hospitalização por asma em crianças e adolescentes participantes de um programa de controle da asma

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Abstract

Objective: To determine the clinical characteristics and the predictors of hospital admission due to asthma among children and adolescents with asthma under treatment at a referral center. **Methods:** A retrospective cohort study comprising 151 children and adolescents with asthma, referred from the Unified Health Care System and enrolled in the Asthma and Allergic Rhinitis Control Program in the city of Feira de Santana, Brazil, followed for a period of 12 months and receiving asthma medication at no cost. The chi-square test was used in order to determine the associations between the studied variables and the occurrence of hospital admissions, whereas the Mann-Whitney test was used for the comparison between the groups of hospitalized patients and nonhospitalized patients. The level of significance was set at $p < 0.05$. Univariate analysis with logistic regression was performed in order to determine the predictors of hospital admission. **Results:** Of the 151 patients evaluated, 8 (5.2%) were hospitalized, in a total of 12 hospital admissions. In the univariate analysis, the only variable found to be a predictive factor was greater asthma severity (OR = 13.3; 95% CI: 2.55-70.1). **Conclusions:** The fact that, in our study sample, the principal predictor of hospital admission was greater asthma severity, calls for special attention being given to the care of these patients.

Keywords: Asthma; Hospitalization; Health services.

Resumo

Objetivo: Determinar as características clínicas e os fatores preditores para hospitalizações por asma em crianças e adolescentes sob tratamento em um centro de referência para asma. **Métodos:** Estudo de coorte retrospectiva com 151 crianças e adolescentes com asma, provenientes do Sistema Único de Saúde, recebendo tratamento gratuito e acompanhados durante 12 meses no centro de referência do Programa de Controle da Asma e Rinite Alérgica de Feira de Santana, em Feira de Santana (BA) Brasil. O teste do qui-quadrado foi utilizado para determinar a associação entre as variáveis estudadas e a ocorrência de hospitalizações, enquanto o teste de Mann-Whitney foi utilizado para a comparação entre os grupos de pacientes hospitalizados e não hospitalizados. O nível de significância adotado foi de $p < 0,05$. A análise univariada com regressão logística foi realizada para determinar os fatores preditores de hospitalização. **Resultados:** Dos 151 pacientes do estudo, 8 (5,2%) foram hospitalizados com um total de 12 internações. O único fator preditor encontrado na análise univariada foi maior gravidade da asma (OR = 13,3; IC95%: 2,55-70,1). **Conclusões:** Devido ao fato de que, em nossa amostra, o principal fator preditor de hospitalização foi a maior gravidade da asma, essa condição requer atenção especial no cuidado a esses pacientes.

Descritores: Asma; Hospitalização; Serviços de saúde.

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* Study carried out at the Bahia School of Medicine and Public Health, under the auspices of the Graduate Course in Medicine and Health, and at the Federal University of Bahia School of Medicine, Salvador, Brazil.
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Financial support: None.
Submitted: 7 June 2010. Accepted, after review: 24 August 2010.

Introduction

Asthma is a highly prevalent chronic disease and one of the leading causes of hospital admission among children in various parts of the world. Wheezing and asthma, which are associated with respiratory infection, account for half of hospital admissions among children aged 1-4 years and for one third of hospital admissions among those aged 5-9 years.[1-3] Emergency room visits and hospital admissions account for the use of health care services at rates ranging from 30.0% to 92.7% per child/year.[2,3] The frequency of hospital admissions for wheezing or asthma among children increases by 30% after the first hospital admission, by 46% after the second, and by 59% after the third.[1]

National and international guidelines on asthma recommend the use of inhaled corticosteroids as anti-inflammatory medication since they benefit most patients and allow asthma to be controlled, avoiding the use of health care services for readmissions attributed to a lack of asthma control.[4] There is a subpopulation of patients, classified as having severe asthma, who, despite appropriate treatment, have impaired quality of life due to frequent exacerbations and to the high risk of hospital admission.[5]

The risk factors for hospital admission among children who are not enrolled in specific programs for asthma care have been as follows: inappropriate treatment; lack of appropriate monitoring during the treatment period; low socioeconomic status; age under 5 years; and recent exacerbations.[6-9] We found no studies addressing the clinical characteristics and the predictors of hospital admission among children using anti-inflammatory medication for the treatment of asthma and under regular monitoring at a referral outpatient clinic. The characterization of these children, as well as the identification of predictors of emergency room visits and hospital admission during monitoring, can contribute to better disease control, reducing the risk of hospital admission for asthma during the treatment period and the consequent use of health resources.[10,11]

The proportion of hospital admissions for asthma among children under 5 years of age ranges from 50% to 60% of the total number of hospital admissions for asthma in the city of Feira de Santana, Brazil, as well as in other regions in Brazil.[12] The *Programa de Controle da Asma e Rinite Alérgica de Feira de Santana* (ProAR-FS, Program for the Control of Asthma and Allergic Rhinitis in the city of Feira de Santana) offers multidisciplinary care to patients with asthma and allergic rhinitis at primary care centers and at the referral center of the program, as well as providing secondary prevention through the dispensation of inhaled corticoids, asthma education, and rehabilitation. Five years after the implementation of the program, there was a 74.4% reduction in the rate of hospital admission for asthma in the city of Feira de Santana,[13] a result similar to that found in the city of Salvador, Brazil, after interventions for the control of severe asthma.[14]

The objective of the present study was to characterize two groups of children enrolled in the ProAR-FS—those who were hospitalized for asthma and those who were not—as well as to identify the predictors of hospital admission during a 12-month monitoring period at the ProAR-FS referral center.

Methods

This was a retrospective, observational cohort study comprising 151 patients with asthma, referred from the Unified Health Care System and enrolled in the ProAR-FS, Brazil, followed for a period of 12 months (from January to December of 2007).

The inclusion criteria were as follows: consecutive male and female patients clinically diagnosed with asthma, in accordance with the Global Initiative for Asthma (GINA) guidelines,[15] ranging from 4 to 19 years of age, with at least one hospital admission for asthma in the 12 months before admission to the program.

Patients with severe comorbidities, such as heart diseases, neuropathies, nephropathies, gastroesophageal reflux disease, and chronic lung diseases, were excluded.

The information was obtained from the standard outpatient form through a specific questionnaire of the study, with questions related to the following aspects: demographic data (gender, age at admission to the program, place of birth, and place of residence); socioeconomic status (family income and level of maternal education); anthropometric data (height and weight); nutritional status; asthma history (age at first attack, asthma severity, and frequency of emergency room visits in the 12 months before

and after admission to the program); medical care (use of prophylactic medication, number of follow-up visits during monitoring, and pulmonary rehabilitation); and overall health status (including comorbidities, with special attention to chronic rhinitis).

At the first ProAR-FS patient visit, asthma severity was diagnosed and classified by a pulmonologist, in accordance with the GINA criteria.[15] In patients who were able to perform the measurement maneuvers, PEF was measured at admission to the program and at each follow-up visit. The diagnosis of allergic rhinitis was based on the criteria established in the World Health Organization "Allergic Rhinitis and its Impact on Asthma" workshop.[16]

The nutritional status of the children and adolescents was classified in accordance with the World Health Organization 2007 guidelines, based on Z scores for anthropometric indices (weight for height and height for age). Children with a body mass index (BMI) less than –2 Z scores below the reference median were considered underweight, whereas those with a BMI ≥ the 85th percentile and ≥ the 95th percentile for their age and gender were considered overweight and obese, respectively.[17]

The patients and their family members were included in an asthma education program, which provides information on the disease, its triggering factors, the appropriate use of medications, the identification of attacks, and the use of an action

Table 1 - Demographic and clinical characteristics of the study sample of children and adolescents with asthma.[a]

Variable	Children (n = 107)	Adolescents (n = 44)	Total (n = 151)
Age, years[b]	6 (3.0)	11.5 (3.0)	8 (3.5)
Age at first attack, years[b]	1.42 (1.2)	2.80 (3.8)	1.85 (2.4)
Gender			
Female	37 (34.6)	18 (40.9)	55 (36.4)
Male	70 (65.4)	26 (59.1)	96 (63.6)
Place of residence			
Urban area	99 (92.5)	43 (97.7)	142 (94.0)
Rural area	8 (7.5)	1 (3.2)	9 (6.0)
Level of maternal education			
≤ 8 years of schooling	68 (63.2)	30 (68.2)	98 (65.7)
> 8 years of schooling	39 (36.4)	14 (31.8)	53 (35.3)
Family income			
≤ the national minimum wage	75 (70.1)	27 (61.3)	98 (66.7)
> the national minimum wage	32 (29.9)	17 (38.7)	49 (33.3)
Nutritional status			
Underweight	17 (15.9)	9 (20.5)	26 (17.3)
Normal-weight	71 (66.4)	24 (54.5)	95 (62.9)
Overweight	12 (11.2)	9 (20.5)	21 (13.9)
Obese	7 (6.5)	2 (4.5)	9 (5.9)
Asthma severity			
Intermittent	2 (1.4)	0 (0.0)	2 (1.3)
Mild persistent	25 (23.5)	8 (18.2)	33 (21.8)
Moderate persistent	55 (51.6)	14 (31.8)	69 (45.6)
Severe persistent	25 (23.5)	22 (50.0)	47 (31.1)
Baseline PEF, % of predicted[c]	71.9	64.5	69.5
Symptoms of chronic rhinitis	93 (86.9)	37 (84.1)	130 (86.0)
Pulmonary rehabilitation	29 (27.1)	12 (27.3)	41 (27.1)
Parental history of asthma or rhinitis	85 (81.0)	35 (79.5)	120(79.4)

[a]Data expressed as n (%), except where otherwise indicated. [b]Data expressed as median (SD). [c]Data expressed as mean.

plan for asthma exacerbations. Medications for asthma and allergic rhinitis were dispensed at the treatment facility and consisted of inhaled corticosteroids (beclomethasone or budesonide), bronchodilators (albuterol or formoterol), topical nasal corticosteroids (beclomethasone or budesonide), antihistamines, and oral corticosteroids, in the doses recommended by the attending physician. The medications were dispensed via the pharmacy, after the completion of a form containing patient identification, type of medication, medication delivery date, quantity dispensed, and the subsequent units dispensed (upon the return of the empty medicine bottle).

Pulmonary rehabilitation was offered to patients with moderate or severe asthma. It was performed by physical therapists and was aimed at promoting the appropriate use of the respiratory muscles and reinforcing the correct technique for using inhaled medications.

The project was approved by the Research Ethics Committee of the Bahia Foundation for Science Development (ruling no. 18/2007).

Descriptive statistics were performed in order to calculate the frequency of hospital admissions after admission to the program. The Mann-Whitney test was used in order to compare the groups of hospitalized and nonhospitalized patients in terms of the means of the quantitative independent variables, whereas Pearson's chi-square test and Fisher's exact test were used in order to compare qualitative independent variables and hospital admission variables in terms of proportions. Values of $p < 0.05$ were considered statistically significant. Univariate logistic regression analysis was used in order to determine the association between the independent variables and the occurrence of hospital admissions. Statistical analyses were performed with the Statistical Package for the Social Sciences, version 14.0 (SPSS Inc., Chicago, IL, USA).

Results

We studied 151 asthma patients, of whom 107 (70.9%) were children with a median age of 6 years and 44 (29.1%) were adolescents with a median age of 11 years. Although there was a preponderance of boys (n = 70, 65.4%; $p < 0.001$) among the children, no such difference was found among the adolescents. The majority of the children (92.5%) and adolescents (97.7%) resided in the urban area of the city of Feira de Santana, Brazil. In most cases, the level of maternal education was ≤ 8 years of schooling (65.7%; $p < 0.001$) and the family income was ≤ the national minimum wage (66.7%; $p < 0.001$; Table 1).

Regarding clinical characteristics, 17 children (15.9%) and 9 adolescents (20.9%) were found to be underweight, whereas 19 children (17.7%) and 11 adolescents (25.0%) were found to be overweight or obese. Severe persistent asthma was significantly more common among the adolescents than among the children (50.0% vs. 23.4%; $p = 0.049$). Symptoms of chronic rhinitis were quite common, affecting 93 adolescents

Table 2 - Comparison of the children and adolescents hospitalized for asthma during the 12-month monitoring period with those who were not in terms of clinical characteristics (n = 151).[a]

Variable	Hospitalized (n = 8)	Not hospitalized (n = 143)	p*
Age, years[b]	7 (5.00)	8.01 (3.61)	0.69
Age at first attack, years[b]	1 (2.50)	1.90 (2.47)	0.20
Male gender	7 (87.5)	89 (62.7)	0.15
Urban area	8 (100)	133 (93.7)	0.46
Level of maternal education ≤ 8 years of schooling	7 (87.5)	95 (67.4)	0.23
Income ≤ the national minimum wage	7 (87.5)	90 (65.2)	0.20
Overweight/obesity	1 (12.5)	29 (20.4)	0.58
Severe asthma	6 (75.0)	27 (18.9)	0.00
PEF, % of predicted[c]	66	73	0.45
Symptoms of rhinitis	6 (75.0)	113 (80.7)	0.32
Parental history of asthma or rhinitis	7 (87.5)	119 (80.7)	0.61

[a]Data expressed as n (%), except where otherwise indicated. [b]Data expressed as median (SD). [c]Data expressed as mean. *Mann-Whitney test.

Table 3 - Univariate analysis of the factors associated with hospital admission among 151 children and adolescents followed for a period of 12 months.

Factor	Hospital admission, OR (95% CI)*
Female gender	2.98 (0.47-18.9)
Level of maternal education ≤ 8 years of schooling	2.06 (0.33-12.5)
Income ≤ the national minimum wage	1.54 (0.23- 9.95)
Overweight/obesity	1.64 (0.25-10.5)
Severe asthma	13.3 (2.55-70.1)
Chronic rhinitis	1.16 (0.77-1.74)

*Chi-square test.

(86.9%) and 37 children (84.1%; Table 1). Treatment for chronic rhinitis was given to 61.3% of the sample as a whole, to 53.3% of those with asthma exacerbations, and to 50% of those who were hospitalized.

The mean PEF (expressed as a percentage of the predicted value) was 73% among the children, compared with 64% among the adolescents. The PEF values were determined during regular outpatient visits. The mean PEF among the patients with exacerbations and among those hospitalized for asthma was 68.0% and 52.2% of predicted, respectively.

The frequency of hospital admissions was significantly associated with asthma severity (Table 2).

In the study period, there were 12 hospital admissions, involving 8 patients (5.2%)—6 children and 2 adolescents—6 of whom had severe asthma. Among the tested covariates, asthma severity showed a high odds ratio for hospital admission (OR = 13.3; 95% CI: 2.55-70.1; Table 3).

Discussion

In the present study, greater asthma severity at admission to the ProAR-FS was found to be the only predictor of hospital admission among the children and adolescents, who were followed for a period of 12 months. The patients with severe asthma were thirteen times more likely to be hospitalized than were those with mild or moderate asthma (Table 3).

The study was carried out at a referral asthma outpatient clinic, where the frequency of patients with moderate or severe asthma is higher than is that of other populations. The use of inhaled corticosteroids, combined with asthma education during the monitoring of these patients at the outpatient clinic of the referral center, results in a marked reduction in hospital admissions for asthma, as has been reported in studies evaluating asthma/rhinitis control programs[18,19] and in health care facilities that are not affiliated with an asthma/rhinitis control program but take an educational approach. The proportion of hospitalized children is high when appropriate disease control measures are not taken.[7-9]

In the present study, as well as in other studies,[20] severe asthma was strongly associated with the occurrence of hospital admissions. Studies have shown that more aggressive treatment is needed in order to control severe asthma and that the use of inhaled corticosteroids alone as maintenance treatment is sometimes insufficient.[21] In such patients, hospital admissions could be prevented if an inhaled corticosteroid were used in combination with a long-acting bronchodilator or a leukotriene receptor antagonist, which has been shown to be highly efficacious in moderate and severe asthma.[22] Unfortunately, patients enrolled in the ProAR-FS must pay for these medications, although they are available at no cost to patients residing in other cities.[23] The possibility of poor adherence to the prescribed treatment, which was provided at no cost, or of the inappropriate use of the inhaled medication cannot be ruled out, despite the fact that all of the patients and their legal guardians were duly instructed and supervised during monitoring. Although hospital admissions were more common among children,[6] being in this age group did not translate to a significantly higher risk of hospital admission.

Chronic rhinitis was not associated with hospital admission among these patients. This finding can be explained by the low power of the sample to detect significant associations, due to the small number of hospitalized patients.[8] It is possible that, although patients under treatment for asthma and rhinitis seek emergency room treatment because of breathing difficulties caused by nasal symptoms such as nasal obstruction, they are not hospitalized for having the symptom.

In this study, the frequency of overweight was 13.9% and the frequency of obesity was

5.9%, values that are higher than those found in a study on the prevalence of overweight and obesity among schoolchildren that was conducted in the city of Feira de Santana, Brazil (4.4% and 9.3%, respectively).[24] Studies have shown a relationship between asthma and obesity among adolescents.[25] In the present study, there was a higher frequency of obesity and overweight among the children and adolescents, respectively. Overweight and obesity were not found to be associated with asthma severity, nor were they found to lead to a higher risk of hospital admission for asthma among the children and adolescents.

Among the asthma patients receiving suboptimal treatment at a municipal referral center, greater asthma severity (severe persistent asthma) was associated with a higher risk of hospital admission for asthma. Necessary measures for changing this scenario include the dispensation of medications, including long-acting bronchodilators combined with an inhaled corticosteroid, at no cost by the government, patient education in order to promote higher adherence, continuous monitoring of patients (in all visits), evaluation of the quality of the inhalation technique, guidance on following an action plan for symptom control, and guidance on the appropriate use of medications.

Acknowledgments

The authors would like to thank the Feira de Santana Municipal Department of Health.

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