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Impact of an asthma management program on hospitalizations and emergency department visits

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Abstract

Objectives: To assess the frequency of hospitalizations and emergency department visits of children and adolescents before and after the enrolment in an asthma program.

Methods: Medical records of 608 asthmatics younger than 15 years were assessed retrospectively. The frequency of hospitalizations and emergency department visits caused by exacerbations were evaluated before and after enrolment in an asthma program. Patients were treated with medications and a wide prophylactic management program based on the Global Initiative for Asthma (GINA). The before asthma program (BAP) period included 12 months before enrollment, whereas the after asthma program (AAP) period ranged from 12 to 56 months after enrollment.

Results: In the BAP period, there were 895 hospitalizations and 5,375 emergency department visits, whereas in the AAP period, there were 180 and 713, respectively. This decrease was significant in all statistical analyses ($p = 0.000$).

Conclusions: Compliance with the GINA recommendations led to a significant decrease in the frequency of hospitalizations and emergency department visits in children and adolescents with asthma.

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Introduction

Asthma is a major public health problem, and its prevalence has been increasing in recent decades in some parts of the world, despite advances in the pathophysiology and treatment of this condition.[1,2]

In Brazil, asthma is the third largest hospitalization-related expense in the Brazilian public Unified Health System.[3] International agreements aiming to promote the treatment and control of a large number of patients in primary health care[1,4-6] and also to minimize the problems of 235 million people worldwide who suffer from asthma (it is the most common chronic disease in childhood)[7] are not always incorporated into the routine of several health services, especially in developing countries.[8]

In Belo Horizonte, state of Minas Gerais, Brazil, a city with over 2.2 million people, the treatment of asthma patients, like in other Brazilian cities, was restricted to

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exacerbations, with people being treated in emergency departments and hospitals instead of in primary health care facilities.[9] In 1994, a study conducted in a pilot outpatient clinic, called Campos Sales, established in the West Belo Horizonte Sanitary District (Distrito Sanitário Oeste de Belo Horizonte, DISAO), showed that 89.9% of asthma patients visited the emergency department regularly and 64.0% of them had already been hospitalized. These data supported the implementation of an asthma program in Belo Horizonte.[9]

The reorganization of public assistance regarding asthma care took place through the Wheezing Child program, a partnership between the Municipal Department of Health and Welfare (Secretaria Municipal de Saúde e Assistência, SMSA), the service provider, and the School of Medicine at Universidade Federal de Minas Gerais (UFMG).[9,10]

The program was progressively implemented in the primary health care system in 1995. At DISAO and in all other sanitary districts, it began to be implemented in 1996, the year when acute asthma episodes led to 6,924 hospitalizations of children in the city, accounting for 20.1% of all hospitalizations.[3,9,10]

The Wheezing Child program was developed based on the recommendations of the Global Initiative for Asthma (GINA, 1995).[11] Children younger than 5 years were initially prioritized due to high morbidity in this age group.[3,9] Guided by a holistic approach to health, the program has established a link between the patient and the health unit and has promoted interactions between different levels of the health care system, health education for patients and families, and asthma training for health care providers. The program has also provided medications, including inhaled corticosteroids, beclomethasone dipropionate (BDP), and valved spacers.[9,10]

This study aims to assess the impact of the Wheezing Child program on hospitalizations and emergency department visits in a group of children and adolescents assisted by the program for at least 12 months.

Methods

The frequency of hospitalization and emergency department visits of patients aged between 1 and 15 years enrolled in the program was calculated. Children under 1 year were excluded from the study because of the difficulty in differentiating between asthma and wheezing.[12,13] Data collection was based on medical records and covered the periods before and after program enrollment, and patients were their own controls.[14] The study included the period from January 1997 to August 2001 and it was the first systematic assessment of the program.[10]

The inclusion criteria were: being enrolled in the program for at least 12 months, being followed up at the same health care unit, and having an updated medical record.

Before enrolling in the program, children were carefully assessed in order to differentiate the diagnosis of persistent asthma from wheezing.[12] The criteria for the initial prescription of BDP were hospitalization for acute asthma and/or exacerbations in the previous 12 months with periods shorter than 6 weeks between episodes and/or symptomatic periods between episodes with response to bronchodilators. BDP was only prescribed by a pediatrician after completing training in asthma and it was based on the GINA, administered by the Department of Pediatric Pulmonology, Hospital das Clínicas of UFMG and by pediatric pulmonologists from secondary health care centers.[9]

The research protocol investigated the patients' medical history covering the 12 months prior to enrollment in the program and a follow-up period of 12 months or longer. Data were collected by a team consisting of four pediatric pulmonologists assisted by 10 medical students trained in data collection. The protocol was completed by consulting the medical records, which included a specific form of the Wheezing Child program updated at each medical visit.[10] The team responsible for data collection was assisted by the pediatrician and other health professionals in charge of the patients' care. In addition, whenever deemed necessary, family members where interviewed.[10]

The exclusion criteria were: impaired adherence to treatment due to maternal disease and presence of concomitant diseases, namely Down syndrome, cleft lip, cleft palate, heart disease, bronchiectasis, pulmonary tuberculosis, cystic fibrosis.[10]

Operational definitions

Definition of asthma, severity classification criteria, and treatment were defined according to the GINA.[11] The date of enrollment in the program was the date of BPD initial prescription. Based on the date of enrollment in the program and considering this as the reference date, two times of observation of the clinical course, before asthma program (BAP) and after asthma program (AAP).

In the BAP period, the treatment was restricted to the control of the episode, and the data from this period were related to the 12 months preceding the first BDP prescription. When the interval between the first asthma episode and the start of prophylaxis was shorter than 12 months, the investigation of the patient was restricted to this interval. In the AAP period, the treatment was not limited to the asthma episodes, but it included the BDP prescription, as well as full assessment of the patient, including social, environmental, nutritional, and emotional factors and counseling on the disease. Patients underwent a multidisciplinary follow-up with the purpose of improving their health status. AAP data are related to the clinical course between the first BDP prescription and August 2001. The minimum duration of this period was 12 months.

The sample was stratified by the number of hospitalizations and emergency department visits in the BAP and AAP periods, as these events are related to the morbidity and severity of asthma.[13]

Statistical analysis

Descriptive analysis of all variables was performed using tables of frequency distribution.

We compared the frequency of hospitalization and the frequency of emergency department visits in the BAP and AAP periods using the monthly means of these events and the Student's *t* test for paired samples in both periods. The McNemar test was used to compare the frequency of hospitalizations and the frequency of emergency department visits in the BAP and AAP periods for different groups.

The calculation of sample size based on the comparison of the mean number of hospitalizations and the mean number of emergency department visits before and after the event, considering an alpha error of 0.05 and a beta error of 0.05, suggested that the sample should include 30 cases.

In order to investigate the association between the measures of interest (monthly mean number of emergency department visits and monthly mean number of hospitalizations) and the covariates sex and age, we used the linear regression model for dependent observations.[14]

Ethical aspects

The present study was approved by the Research Ethics Committee at the UFMG and had the permission of the SMSA to be conducted.

Results

Among the children and adolescents younger than 15 years enrolled in the program, 2,925 had updated medical records. Of these, 1,065 were being followed up for at least 12 months. There were 146 losses due to loss of medical records, unknown or difficult to access place of residence, which made it impossible to interview the patients. Therefore, 919 protocols were completed.[10] Finally, 98 cases were excluded because of impaired adherence to treatment caused by maternal disease and presence of concomitant diseases, which resulted in 821 patients.[10] Of these, 213 patients younger than 1 year old were excluded.[12,13] Thus, the final sample comprised 608 patients. The characteristics of these patients are described in Table 1.

The age distribution of the 608 patients upon program enrollment ranged from 1.1 to 12.8 years (mean of 4.1 years). We grouped the patients according to age groups because the clinical manifestations of asthma are different at each age.[10,12,13]

We could determine the duration of the BAP period for 582 patients (95.7%). Those patients whose interval between the first episode of wheezing and the first BDP prescription was shorter than 12 months had a BAP with the same duration of this interval and were divided into groups. In 74.8% of the sample, the BAP period was 12 months; in 83.6%, it was at least 9 months. Whereas the AAP period ranged from 12 to 56 months. No patient was followed up for a period shorter than 12 months.

Regarding the proportion of emergency department visits and hospitalizations, 89.8% of the sample had emergency department visits and 58.8% were hospitalized before the program (Table 2). In the BAP period, 11.9% were hospitalized from 4 to 15 times, whereas 53% had emergency department visits between 5 to 24 times, and 0.8% from 25 to 40 times. In the AAP period, 79.2% of patients were not hospitalized, and the maximum number of hospitalizations was four, accounting for only 0.8% of the sample; 49.2% did not need to go to the emergency department, and only 5.3% had more than five visits.

Table 1 - Characteristics of the sample (n = 608)

Variables	n	%
Age group		
1 to 2 years	162	26.6
> 2 to 3 years	118	19.4
> 3 to 5 years	148	24.3
> 5 to 10 years	145	23.8
> 10 to 15 years	35	5.8
Sex		
Male	364	59.9
Female	244	40.1
Data prior to the program enrollment		
Last 12 months	455	74.8
9 to 11 months	62	10.2
6 to 8 months	38	6.3
4 to 5 months	16	2.6
≤ 3 months	11	1.8
No data	26	4.3
Follow-up period after program enrollment		
12 to 18 months	179	29.4
19 to 24 months	93	15.3
25 to 36 months	191	31.4
37 to 56 months	145	23.8
Period before the program		
Emergency department visits		
Yes	475	78.1
No	54	8.9
No data	79	13
Hospitalization		
Yes	340	55.9
No	238	39.1
No data	30	4.9

Table 2 - Number and proportion of emergency department visits and hospitalizations before and after the program

	Before the program		After the program		
	Number	%	Number	%	p*
Number of emergency department visits					p = 0.000
None	54	10.2	269	49.2	
1	47	8.9	99	18.1	
2-4	128	24.2	150	27.5	
5-24§	306	53	29	5.3	
25-40§	4	0.8	0	0	
Subtotal	529	100	547	100	
No data	79	–	61	–	
Total	608	–	608	–	
Number of hospitalizations					p = 0.000
None	238	41.2	473	79.2	
1	138	23.9	82	13.7	
2	78	13.5	33	5.5	
3	55	9.5	4	0.7	
4-15‖	69	11.9	5	0.8	
Subtotal	578	100	597	100	
No data	30	–	11	–	
Total	608	–	608	–	

* McNemar test. p value was calculated using the McNemar test for the relationship of the number of visits before and after and the relationship of the number of hospitalizations before and after the program.
† For the number of visits before the program/Number of visits after the program.
‡ For the number of hospitalizations before the program/Number of hospitalizations after the program.
§ The group of patients who have had from 5-40 visits is divided into groups of 5-24 and 25-40 in the table because the clinical value of this information. However, to calculate the p value, we considered a single group of 5-40 because the McNemar test cannot be used when there is zero in any category.
‖ The maximum number of hospitalizations after the program was four.

The frequencies of emergency department visits and hospitalizations were calculated for each patient and compared in the BAP and AAP periods. In terms of emergency care, there was a reduction of 86.7% of the emergency department visits: 529 patients were involved in 5,375 BAP visits, and 547 patients were involved in only 713 AAP visits. As for the frequency of hospitalizations, there was a reduction of 80%: 578 patients were involved in 895 BAP hospitalizations, and 597 patients were involved in only 180 AAP hospitalizations.

Since the BAP and AAP periods had different durations (Table 1), we calculated the monthly mean (ratio between the number of episodes recorded during that period and the months of observation) for each variable (emergency department visit and hospitalization) in both study periods (Table 3).

The monthly means of emergency department visits and hospitalizations were calculated for patients who had these variables recorded in the BAP and AAP periods and whose data enabled the calculation of such periods. The mean number of BAP and AAP emergency department visits was 0.946 and 0.051, respectively, considering 491 patients (p = 0.000). And the monthly mean of BAP and AAP hospitalizations was 0.150 and 0.012, respectively, involving 551 patients (p = 0.000).

The linear regression model for dependent observations was used to demonstrate the influence of the program, age and sex on the monthly means of emergency department visits and hospitalizations[15] (Table 4). This model showed a significant effect of the intervention on the mean number of emergency department visits (p = 0.000) and hospitalizations (p = 0.000). Therefore, after enrollment in the program, there was a mean reduction of almost one emergency department visit per month and a mean reduction of 0.13 hospitalizations per month: there was a reduction of approximately one hospitalization every 10 months.

In addition, there was no significant effect of age on the monthly mean number of emergency department visits (p = 0.171) and hospitalizations (p = 0.296). Hence, age group was not a determinant for the number of emergency department visits or hospitalizations (both per month) in our sample. Finally, there was no significant effect of sex

Table 3 - Monthly mean of emergency department visits and hospitalizations before and after the program

Variable	n	Monthly mean	Standard deviation	t	p
Emergency department visits					
Before the program	491	0.946	1.107	18.067	0.000
After the program	–	0.051	0.081	–	–
Hospitalization					
Before the program	551	0.150	0.227	14.816	0.000
After the program	–	0.012	0.029	–	–

t = Student's *t* test.

Table 4 - Result of the linear regression model for dependent observations regarding the association between the variables (number of emergency department visits per month and number of hospitalizations per month) and the factors: program, age, and sex

	Effect	Coefficient	Standard error	Z statistic	p Value
Mean number of emergency department visits per month	Program	-0.903	0.049	-18.635	0.000
	Age	0.024	0.017	1.371	0.171
	Sex	0.018	0.048	0.383	0.702
Mean number of hospitalizations per month	Program	-0.133	0.009	-14.301	0.000
	Age	-0.004	0.004	-1.046	0.296
	Sex	0.008	0.010	0.745	0.456

on the mean number of emergency department visits or hospitalizations per month (p = 0.702 and p = 0.456, respectively).

Discussion

Because of the high prevalence of asthma and the limited establishment of consensus, especially in developing countries, demonstrate the impact of the Wheezing Child program implies a great social importance. In spite of its limitations, the choice of the study design, history control, was necessary to overcome the difficulties of conducting an evaluation study in a city with complex characteristics such as Belo Horizonte. Furthermore, this design is suggested as a valid option by Gordis.[14] Nevertheless, previous studies have used the frequency of hospitalizations and emergency department visits as parameters to evaluate preventive treatments in asthma.[6,16-24] In addition, these variables can be counted and are milestones in the patient's life, thus reducing memory bias.[25,26]

However, it is relevant to consider whether this non-randomized sample is significant to assess the impact of the program. Based on the data about the sample size calculation, we found that our sample was larger than the size necessary to investigate the objective of the study. It should be noted that in relation to sex and age distribution, results were similar to other evaluations of the program conducted by the SMSA. Thus, our results can be considered significant for evaluating the program since they show internal validity.

The high-quality data used in the present study was carefully selected, mainly those related to the period preceding the intervention. Our investigation on symptoms, treatment, and complications related to the 12 months prior to enrollment in the program was conducted by the pediatrician of the health care unit at the time of the first BDP prescription and was recorded in a specific form attached to the medical record (a routine procedure in the program) which reduced the memory bias. In addition, the disease course was described in the research protocols, which were often assisted by the pediatrician responsible for the patient. In this process, the pediatrician was helped by the local health care team, which remained relatively stable during the study period, since the team members are employees of the institution. All protocols were reviewed and, whenever there were doubts, the patients' family members were interviewed.[10]

Because of the model used in the present study, it was not possible to quantify the reduction in the events caused by the natural course of the disease or by other factors, such

as social and nutritional changes, which may be possible biases in our study. However, a sudden improvement in the course of persistent asthma is very uncommon when there is no prophylactic intervention, particularly in large samples.[5,19,20,25] Conversely, the reductions of 80 and 86.7% in the frequency of hospitalizations and emergency department visits, respectively, are in agreement with other studies. The prophylactic intervention in the study by Cabral et al. led to 100% reduction in hospitalizations and 87.5% in emergency department visits, in addition to decreasing asthma severity ($p < 0.0001$).[19] Blais et al. found 80% decrease in hospitalizations of patients using inhaled prophylactic therapy when compared to regular treatment with any derivative of theophylline [odds ratio (OR) 0.2, 95% CI 0.1-0.5].[20] Greineder et al. obtained a reduction of 79% ($p < 0.0001$) in emergency department visits and 86% ($p < 0.001$) in hospitalizations.[5]

A retrospective study involving all hospitalizations for asthma in children aged 2 to 12 years living in Rochester and Boston (United States, n = 614) showed that the children from Boston received less preventive therapy, inhaled corticosteroids or cromolyn sodium, [OR 0.4 (0.2, 0.9)] and were hospitalized three times more often than the children from Rochester.[4] Donahue et al., in a retrospective cohort study conducted from 1991 to 1994, found that children with asthma treated with inhaled corticosteroids were hospitalized 50% less often [relative risk (RR) 0.5; 95% CI 0.4-0.6] when compared with children who did not receive this treatment.[18]

In the BAP period, asthma had greater severity and morbidity (Table 2). In the AAP period, there was a statistically significant reduction in both the number of hospitalizations ($p = 0.000$) and emergency department visits ($p = 0.000$). The number of children who did not need to be hospitalized nearly doubled, and there was approximately a fivefold increase in the number of children who did not have emergency department visits from the BAP period to the AAP period, which shows the impact of the program.

The decrease in hospitalizations for respiratory diseases in children under 5 years living in Belo Horizonte (9,826 cases in 1998 and 5,832 cases in 2008) is relevant.[3] Concomitantly, there was significant reduction in the three-year mean mortality rate due to respiratory diseases. In the period between 1996 and 1998, this rate was approximately 2.3 per 1,000 live births, and in the period from 2002 to 2004, the rate dropped to 0.8 per 1,000 live births.[3] The implementation of the Wheezing Child program at the primary health care units after 1995 may have greatly contributed to these results.

Further analyses have shown a statistically significant effect of the program on the variables of interest during both periods studied. Since the observation and follow-up periods did not have the same duration, the monthly mean of each variable of interest was calculated for the BAP/AAP periods and compared using the Student *t* test for paired samples. As for hospitalizations, the monthly mean of 551 patients in the BAP period was 0.150 and it dropped to 0.012 in the AAP period ($p = 0.000$); the monthly mean of emergency department visits, involving 491 patients, was 0.946 before enrollment in the program and 0.051 after the program ($p = 0.000$).

The regression model for dependent observations also showed significant effect of the program on the monthly mean number of emergency department visits ($p = 0.000$) and the monthly mean number of hospitalizations ($p = 0.000$). It is expected that older patients need to be hospitalized less often and have fewer emergency department visits than younger patients,[27] however, this was not the case in the present study. It is important to stress that children under 1 year old (the age group most likely to be hospitalized) were not included in the sample, which may have interfered with the result.[12,13]

The decrease in frequencies of hospitalization and emergency department visits also depends on the type of health care offered to patients in the period between the episodes.[9,28] The Wheezing Child program, in addition to widely providing inhaled corticosteroids, invests in the training of teams and promotes clinical follow-up and discussion groups, focusing on education about the disease.[9,10,25-30] Asthma education programs improve the quality of life of patients and reduce the number of hospitalizations and emergency department visits, which are costly to the health system and often preventable if asthma is properly managed.[25-30]

In conclusion, the Wheezing Child program led to reduction in the frequencies of hospitalizations and emergency department visits. Taking into consideration that this program was the result of a partnership between UFMG and the municipal administration of Belo Horizonte, we also demonstrated the importance of the association between the institutions responsible for education and health care in order to find solutions for the population's problems. This shows that the recommendations of the guidelines are feasible, even in large cities of developing countries.[10]

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