Original Article

Risk factors for multiple hospital admissions among children and adolescents with asthma*

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ABSTRACT

Objective: To determine the influence that hospital admission of suckling infants with asthma has on their risk for future admissions for the same cause. **Methods:** A retrospective study was conducted, in which the charts of 202 patients, all less than fifteen years of age, were evaluated. All of the patients had been treated as outpatients in a pediatric pulmonology clinic and had been admitted to the hospital on one or more occasions. A multivariate analysis was conducted in order to evaluate the risk factors associated with multiple hospitalizations. **Results:** Virtually all of the patients evaluated were hospitalized a second time within 18 months of the first hospitalization. Among the patients first hospitalized at = 12 months of age, the second admission occurred sooner than did that recorded for those first hospitalized at > 12 months of age (p = 0.001). The risk factors found to be associated with multiple hospital admissions were as follows: age at first admission = 12 months (odds ratio: 2.55; 95% confidence interval: 1.18-5.48); age at first admission between 13 and 24 months (odds ratio: 3.54; 95% confidence interval: 1.31-9.63); and severity of asthma symptoms (odds ratio: 3.86; 95% confidence interval: 2.02-7.40). **Conclusion:** After the first hospitalization, children with asthma should be closely monitored, since the risk of subsequent admissions is elevated in the first months following discharge, especially among those of less than two years of age. Health care facilities should be organized to confront this problem appropriately and should dispense prophylactic medication more freely.

Keywords: Asthma; Child, hospitalized; Patient readmission; Risk factors

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Submitted: 20 March 2005. Accepted, after review: 10 February 2006.

INTRODUCTION

Hospital admissions for asthma among patients previously hospitalized for asthma constitute a public health problem, accounting for 41.2% of all hospital admissions due to asthma, which demonstrates the need to implement strategies to reduce the number of such hospitalizations.[1-2] In the last decade, asthma was the second leading cause of hospitalization among children from one to nine years of age in Belo Horizonte, Brazil, 60% of such hospital admissions being of children younger than four years of age.[3]

Financial resources spent on hospitalizations represent the largest share of all expenditures for asthma in developed countries.[1] In Brazil, it is estimated that hospital admissions, disregarding emergency room visits, accounted for 44% of all Sistema Único de Saúde (SUS, Unified Health Care System) expenditures for asthma in 1996.[4]

Despite the fact that asthma is a potentially avoidable cause of re-admission,[2] as well as that consensuses have been established and disseminated at the national[4-5] and international[6-7] levels, patient re-admission rates remain high. Diagnostic and therapeutic recommendations for the clinical approach to treating patients, which have been published especially within the past ten years, have not been incorporated into the clinical practices used in treating most patients.[8-10]

The principal risk factors for multiple hospital admissions include the following: age bracket, especially the younger than five years of age bracket;[8,11-12] the number of previous admissions;[1-2,11] low socioeconomic level;[1,8-9] and the lack of regular follow-up treatment of the disease.[2,8] However, the younger than five years of age bracket is very broad, which might mask the epidemiologic importance of suckling infants.

The objective of the present study was to determine the influence that hospital admission of children and adolescents with asthma has on their risk for future admissions for the same cause.

METHOD

The study was conducted at the Campos Sales Pediatric Pulmonology Outpatient Clinic as a pilot project, initiated in 1996, for the treatment of children with asthma in Belo Horizonte.

The charts of 202 patients with asthma, all less than fifteen years of age, selected from 325 charts of patients diagnosed with asthma from October 1994 to December 1995, were evaluated. This group comprised the total number of patients with asthma who, prior to being treated at the clinic, had been hospitalized at least once. The charts of the remaining 123 patients with asthma were excluded, since those patients had no history of previous hospitalization. A prior evaluation of the risk factors associated with at least one hospitalization was conducted using the same group of 325 patients.[13]

The data necessary for the analysis were collected in 1997 using a retrospective verification of a standardized protocol that was developed when the outpatient clinic was created in 1994. All patients were referred to the clinic by physicians practicing in Belo Horizonte (including the greater metropolitan area) and in other cities in the state of Minas Gerais.

Inclusion criteria were as follows: a diagnosis of asthma reported in the referral document (signed by the physician responsible for the referral); discharge summary (signed by the physician responsible for the patient during hospitalization) for the confirmation of the diagnosis during hospitalization; history of recurrent episodes (three or more) of wheezing or dyspnea that were responsive to bronchodilators or systemic corticosteroids and were aggravated by temperature changes, viral infections, exposure to allergens or physical exercises; family history of asthma;[7,14] and asthma diagnosis confirmed by the pediatric pulmonologist in the reference outpatient clinic.

Patients referred to the outpatient clinic after being diagnosed with asthma and who, after having been submitted to clinical evaluation and laboratory tests, were diagnosed with other diseases, such as cardiopathy, congenital or acquired immunodeficiency, cystic fibrosis, gastroesophageal reflux, suspicion of foreign bodies, mediastinal masses, vascular abnormalities, pulmonary malformations, pulmonary tuberculosis, tracheomalacia, brain paralysis, or bronchopulmonary dysplasia, were excluded.

Gastroesophageal reflux was diagnosed using clinical criteria. When necessary, such patients were submitted to contrast-enhanced radiological examination of the esophagus and duodenum, as well as to pH-metry.

Sociodemographic variables related to asthma and to the quality of health care in health care

birth, educational level of the mother, family income, and age bracket at the first visit to the outpatient clinic. The clinical variables studied were the frequency of exacerbations within the twelve months preceding the first visit to the outpatient clinic, as well as the class and severity of the asthma.[6] Hospitalizations were not considered a criterion for severity, since many occurred without a precise clinical recommendation.[9] The studied variables related to health care were as follows: frequency of visits to the emergency room (number of visits per month within the twelve months preceding the first visit to the outpatient clinic); age; principal and secondary diagnoses at hospitalization (in accordance with the data in the discharge summary); immunization schedule; type of follow-up evaluation (presence/absence of periodic control for the re-evaluation of asthma in health clinics); and type of prophylactic drug treatment employed. The diagnoses of bronchitis and asthmatic bronchitis reported in some of the discharge summaries were interpreted as asthma.

The determination of peak expiratory flow and spirometry were carried out in children who were able to perform the necessary maneuvers for such determinations.

For the evaluation of the risk factors, we conducted a univariate analysis of the associations between the independent variables and the incidence of multiple hospital admissions (dependent variable) by calculating the odds ratios (OR) and the respective 95% confidence intervals (95% CIs), as well as by applying Pearson's chi-square test, the linear trend test, and Fisher's exact test. Subsequently, risk factors associated with multiple admissions were evaluated using ORs, calculated by adjusting logistic regression models. Initially, the model contained all of the variables that presented statistical significance in the univariate analysis. The exclusion of each variable was determined using the Wald test, and the models were compared using likelihood ratios. The level of significance was set at 5%. Cumulative probabilities of multiple admissions were also studied - according to the interval (up to twenty-four months) between the first and second admissions - and were graphically represented by Kaplan-Meier survival curves and compared, using the log-rank test, to the age at first hospitalization.

The study design was approved by the Ethics Research Committee of the Federal University of Minas Gerais and by the Belo Horizonte Municipal Secretary of Health.

TABLE 1

Characteristics of hospital admissions according to discharge summaries

Variable	n	%
Number of admissions*		
Once	70	34.7
Two to four times	83	41.1
Five to twelve times	49	24.2
Principal diagnosis from 1st to 4th admission**		
Pneumonia	83	54.3
Asthma	62	40.5
Bronchiolitis	3	1.9
No data	5	3.3
Principal diagnosis from 5th to 12th admission***		
Pneumonia	8	16.3
Asthma	36	73.5
Other	3	6.1
No data	2	4.1

* median, number of hospitalizations: two
** median, age at 1st-4th admission: 18 months
***median, age at 5th-12th admission: 26 months (n = 49).

RESULTS

Table 1 shows the characteristics of hospital admissions, according to the discharge summary, prior to patient admission to the referral outpatient clinic. Of the 202 patients evaluated, 132 (65.3%) were re-admitted while having an attack, and patients were predominantly diagnosed with pneumonia during their first hospitalization and with asthma during subsequent hospitalizations.

Among the sociodemographic factors (Table 2), low educational level of the mother increased the risk of multiple admissions (OR = 2.55, 95% CI: 1.26-5.20).

Regarding the factors related to asthma, children who were diagnosed with persistent forms of moderate or severe asthma presented a risk of multiple admissions (OR = 6.28, 95% CI: 2.92-13.48) six times greater than did those diagnosed with mild or intermittent forms of asthma. The incidence of four or more exacerbations was also associated with multiple admissions (OR = 2.19, 95% CI: 1.03-4.71). Only 80 (39.6%) of the children were able to perform the functional tests. Forced expiratory volume in one second lower than 80% of the predicted value was not associated with multiple admissions.

TABLE 2

Univariate analysis of sociodemographic and asthma-related risk factors (n = 202)

Factors	Multiple hospital admissions Yes (n %)	No (n %)	p value	OR (95% CI)
Gender				
Male	91 (68,9)	45 (64,3)	0,608	1,23(0,63-2,37)
Female	41 (31,1)	25 (35,7)		
Body weight at birth				
≤ 2500 g	20 (15,2)	13 (18,6)	0,624	0,76(0,33-1,77)
> 2500 g	107 (81,1)	53 (75,7)		
No data	5 (3,7)	4 (5,7)		
Educational level of the mother				
0 - 3 anos	56 (42,4)	16 (22,9)	0,007	2,55(1,26-5,20)
> 3 anos	74 (56,1)	54 (77,1)		
No data	2 (1,5)	0 (0,0)		
Family income*				
≤ 3× the minimum wage	110 (84,0)	55 (78,0)	0,521	1,36(0,62-3,01)
> 3× the minimum wage	22 (16,0)	15 (22,0)		
Age at 1st visit to outpatient clinic**				
< 12 months	23 (17,4)	12 (17,1)	0,884	1,02(0,45-2,36)
>12 months	109 (82,6)	58 (82,9)		
Classification of asthma				
Moderate persistent	120 (90,9)	43 (61,4)	<0,001	6,28(2,92-13,48)
Mild intermittent	12 (9,1)	27 (38,6)		
Number of attacks/month				
> 4	44 (33,0)	13 (18,6)	0,030	2,19(1,03-4,71)
< 4	88 (67,0)	57 (81,1)		
Functional evaluation				
FEV_1 (% of predicted)				
≤ 60-79	42 (31,8)	22 (31,4)	0,187	2,45(0,71-8,63)
> 80	7 (5,3)	9 (12,8)		
Unable to perform maneuvers	83 (62,9)	39 (55,8)		

* median family income = 2× the minimum wage; **median of 47.5 months
OR: odds ratio; 95% CI: 95% confidence interval; FEV_1: forced expiratory volume in one second

Table 3 shows that, in the first year of life, 61.8% of the children had been hospitalized at least once; at the age of two years, almost all children had already been hospitalized at least once. When patients were first hospitalized between thirteen and twenty-four months of age (OR = 3.52, 95% CI: 1.22-10.38) or at twelve months of age or younger (OR = 3.14, 95% CI: 1.42-7.02), the risk of multiple admissions was approximately three times greater than that observed for patients who were first hospitalized when they were older than two years of age.

Visits to emergency rooms (Table 3) were associated with multiple admissions (OR = 2.13, 95% CI: 1.10-4.18), and 91% of the patients had visited the emergency room at least twice per month. None of the patients were submitted to regular follow-up evaluation or prophylactic treatment for asthma at any of the basic health care clinics. Noncompliance with the immunization schedule was associated with multiple admissions. In children who were diagnosed with pneumonia during their first hospitalization, the risk of multiple admissions was approximately three and a half times greater (OR = 3.50, 95% CI: 1.69-7.32).

Figure 1 shows that 56% of the children were re-admitted three months after the first admission, and that 94% of the children were also re-admitted eighteen months after the first admission. Figure 2 shows that, for patients at the age of twelve months, the median interval between the first and the second hospital admissions was two months, compared with eight months for those older than twelve months of age.

TABELA 3

Univariate analysis of factors related to the health care provided by the Unified Health Care System (n = 202)

Factors	Readmission Yes(n %)	No(n %)	p value	OR (95% CI)
Age at 1st hospitalization*			0.005	
> 24 months	17(12.9)	23(32.9)		1.00
> 12 ≤ 24 months	26(19.7)	10(14.3)		3.52 (1.22-10.38)
≤ 12 months	86(65.2)	37(52.9)		3.14 (1.42-7.02)
No data	3 (2.2)	0 (0.0)		
Number of emergency visits**				
> 2 /month	61(46.2)	20(28.6)	0.024	2.13 (1.10-4.18)
Maximum 1/month	70(53.0)	49(70.0)		
No data	1 (0.8)	1 (1.4)		
Principal diagnosis at 1st hospitalization				
Pneumonia	109(82.6)	42(60.5)	<0.001	3.50 (1.69-7.32)
Asthma	20(15.2)	27(38.5)		
No data/Bronchiolitis	3 (2.2)	1 (1.0)		
Regular prophylactic treatment (inhaler) at health clinic	-	-		
Immunization schedule				
Not updated	9 (6.8)	-	0.028	
Updated	118(89.4)	70(100.0)		
No data	5 (3.8)	-		

*median = 9 months; **9% no emergency visits; OR: odds ratio; 95% CI: 95% confidence interval

Cumulative probabilities of multiple admissions differed: three months after the first admission, 61% of the children twelve months of age had been re-admitted, compared with 40% of those older than twelve months of age (p = 0.001). In the group of patients first hospitalized prior to twelve months of age, 34% were re-admitted in less than one month.

In the final model, the educational level of the mother and the number of exacerbations lost their statistical significance after adjustment. However, persistent forms of moderate and severe asthma remained in the model as predictors of multiple admissions (OR = 6.23, 95% CI: 2.82-13.76). Among the factors related to health care, being first hospitalized at between one and two years of age increased the risk of multiple admissions by four times (OR = 3.54, 95% CI: 1.31-9.63), compared with a three-times greater risk for being first hospitalized at one year of age or less (OR = 2.55, 95% CI: 1.18-5.48), in comparison to being first hospitalized at the age of twenty-five months or older. The frequency of visits to the emergency room lost its significance when adjusted for asthma severity. Similarly, being diagnosed with pneumonia during the first hospitalization lost its significance when adjusted for the age at first admission, since the latter variable behaved as a confounding factor.

The most significant risk factors for multiple admissions were severity of the disease and age at the first hospitalization.

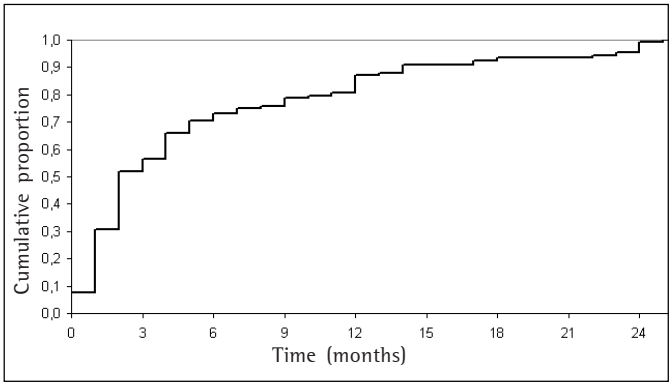

Figure 1 - Interval between the first and second hospitalization

DISCUSSION

The present study was carried out at a referral outpatient clinic, reflecting the characteristics of

patients with moderate or severe asthma. In order to minimize memory bias, the number of hospitalizations, as well as age and diagnosis at the first and subsequent hospital admissions were validated using the discharge summary, a document signed by the physician who had treated the patient during their stay in the hospital.

Studies conducted in specialized outpatient clinics have shown higher asthma severity rates than those seen in the general population of patients with asthma. However, such studies are important for the identification of risk factors and formulation of intervention strategies. These types of studies also contribute to the understanding of children with asthma as a whole, since 58.7% of such children are hospitalized, and 41.2% of those hospitalizations are subsequent admissions.[1]

In the present study, 65.3% of the children had been admitted to the hospital more than once, a finding that is in agreement with that of a study conducted by Brazilian researchers, who reported a rate of 64%.[16] Internationally, the reported rates of multiple hospital admissions range from 41.2% to 47%.[1,11,17]

The data used in the present study were collected from 1994 to 1995 but remain consistent with the analysis of hospital morbidity in the southeastern part of the country. In 1995, pneumonia and asthma accounted for 73% and 20%, respectively, of the total number of hospitalizations due to respiratory diseases. In 2004, these values were 69% and 23%, respectively.[18] These data reveal that more managerial efforts need to be made in order to lower the rate at which children with asthma are hospitalized. In addition, it has been shown that effective implementation of the National Asthma Program, which will provide adequate treatment for the population of patients who are dependent on the SUS, is necessary.[5]

The health care network in Belo Horizonte underwent various modifications between 1996 and 2005. The project for the treatment of children with asthma was implemented, and, for those patients diagnosed with intermittent asthma, as well as for those diagnosed with persistent mild or moderate asthma, beclomethasone was made available in health care centers. However, the profile of the patients treated at the Campos Sales Pediatric Pulmonology Outpatient Clinic remained similar: patients with severe asthma - most under four years of age - referred by basic health clinics in Belo Horizonte (including the greater metropolitan area) and in other cities in the state of Minas Gerais having a history of previous hospitalizations due to pneumonia or asthma. Consequently, the profile of the sample population of the Campos Sales Pediatric Pulmonology Outpatient Clinic was consistent at both time points: when the study was conducted (in 1994) and currently. Furthermore, the physician who examined the children in 1994 was the pediatric pulmonologist in 2005.

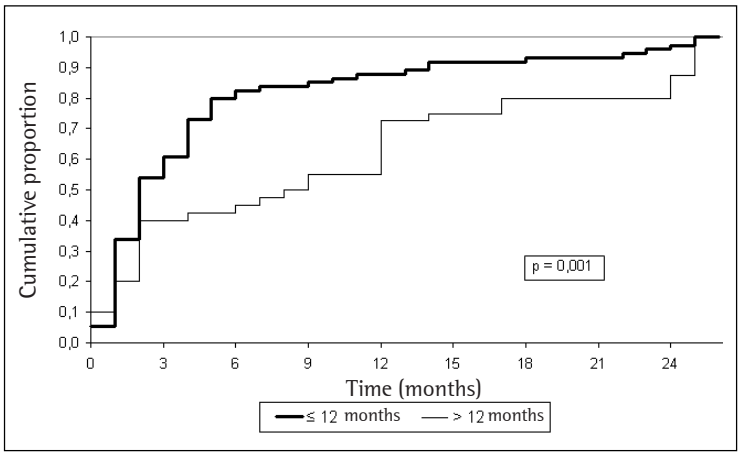

Figure 2 - Probability of multiple hospital admission in patients younger or older than 12 months of age at first hospital admission

In the present study, the probability curves for multiple admissions demonstrated that this event occurred earlier than what has been reported in the international literature. By twelve months after the first hospital admission, 87% of the patients had already been re-admitted. Internationally, various probability of re-admission within the twelve months immediately following the first hospitalization have been reported: 25.9%,[12] 26%,[19] 35%,[20] 43%,[11] and 47%.[17] Some studies have shown a tendency toward lower rates of multiple hospital admission after the use of prophylactic medication.[17,19] Others found no association between prophylaxis and lower indices of multiple hospital admission.[11,20]

The data on multiple hospital admissions are influenced not only by medical indications, but also by the characteristics of health care systems, number of beds offered, and professional practices. There is a great variation among the various social groups under similar clinical conditions.[9] Children who are underprivileged from a socio-economic point of view are more frequently hospitalized.[1]

The health care system in Belo Horizonte is composed of public health care clinics and hospitals, for emergencies and hospitalizations, as well as private hospitals contracted by the SUS for hospitalizations.

In the present study, the children were hospitalized very early (65.2% had their first hospitalization at less than twelve months of age), and age at the first hospitalization was a risk factor for subsequent re-admission. These data are consistent with those obtained in another investigation demonstrating that children presenting early onset of symptoms were more frequently hospitalized more than once.[21-22] Brazilian authors have reported that from 50% to 65% of children with asthma presented their first symptoms within the first year of life.[23-24] Another study found that children in Brazil become sensitized to mite antigens at an early age (< twelve months).[25]

The results obtained in this investigation reveal the greater vulnerability of those younger than two years of age, which is in agreement with the findings of other studies.[14,19] However, such results do not explain the multiple admissions probability curves, which revealed that almost all of the children had been re-admitted within eighteen months after the first hospitalization, as well as the early re-admissions among those who were first hospitalized before the age of twelve months.

Of the children studied, 61.8% were hospitalized before the age of one year, and almost all of the children had been hospitalized before the age of two. However, when they were arrived at the referral pediatric pulmonology outpatient clinic, the median age was forty-seven and a half months (range, nine months to fifteen years).

Wheezing in young children is common to a heterogeneous group of diseases. In the present study, the differential diagnosis was carefully studied. The characterization of wheezing phenotypes is one of the most important aspects.[25] Approximately 70% of the children present intermittent wheezing, and 30% still present wheezing during their school age. Early onset and late onset of symptoms in patients with atopic wheezing are defined as prior to and after three years of age, respectively. The other phenotype, not associated with atopy, has a better prognosis, since the wheezing symptoms cease during adolescence.[26] One phenotype can become predominant in the first years of life,[13] and certain criteria(27) are used to define the risk of asthma.

In the patient sample evaluated in the present study, the diagnoses of asthma could be made because the children presented various exacerbations (median of two per month, which were responsive to bronchodilators and/or systemic corticoids), a previous diagnosis of asthma according the referral document, and strong evidence of a family history of asthma. In addition, all the children evaluated at the Campos Sales Pediatric Pulmonology Outpatient Clinic in 1994 were examined by the same physician, and, since the data were reviewed in 1997, it was possible to exclude from this cohort those who presented transitory wheezing.

The decision to include children younger than three years of age was made based on clinical parameters compatible with the diagnosis of asthma and the need to study the high morbidity occurring in this age bracket. In the under four years of age bracket, morbidity is proportionally higher than in the other age brackets.[19-28]

Subsequent asthma hospitalizations of children younger than four years of age constitute an undeniable public health problem.[1,8,11-12] It has been recommended that prophylactic treatment be given to suckling infants, as well as to young children, presenting severe exacerbations that occur less than six weeks apart.[28] However, there are controversies regarding prophylaxis in suckling infants, and the children receiving such prophylaxis must be selected very carefully from among the candidates.[5,29]

It is important to diagnose asthma as early as possible and to define which children suffer from the persistent form of the disease, which can help reduce morbidity and mortality.[26] The prevalence of asthma in young children increased from 3.7% in 1980 to 8.7% in 2002.[28] In this age bracket, a diagnosis of asthma is made predominantly on the basis of clinical findings, since functional evaluations are not routinely available.[28] In the present study, it was possible to perform spirometry in only 39.6% of the patients.

The models employed to clinically classify the severity of asthma are adapted to the standards defined for older children and adults and are therefore inappropriate for use in young children. Since there is no other system of classification available, the criteria recommended in the Global Initiative for Asthma were used.[28] We chose to use the frequency of symptoms, rather than the incidence of hospitalization, as the criterion of

severity.(6,28) For the same clinical condition, there might be great variability in the criteria used for hospital admission among the various facilities.[9]

Official Brazilian statistical data do not discriminate between multiple hospital admissions and the total number of hospitalizations,[18] which would have facilitated the implementation of intervention strategies for this subgroup and allowed comparisons with international studies that separate data related to multiple hospital admissions for asthma from those related to single hospitalizations for asthma.[1,8,21]

From the first to the fourth hospitalizations, the children evaluated in the present study were predominantly diagnosed with pneumonia, whereas, from the fourth hospitalization on, they were predominantly diagnosed with asthma (Table 1). This has great epidemiologic importance since it might cause an artificial increase in pneumonia statistics, thereby impeding the early diagnosis of asthma. Many Brazilian children with asthma have been misdiagnosed with pneumonia and have therefore not received appropriate treatment.[4,24,30]

We highlight the fact that a low percentage of children are diagnosed with bronchiolitis in their first hospital admission, and that timely diagnosis would allow the earlier identification of those children who are more likely to suffer from asthma.[27] This was a surprising percentage, although it was consistent with the analysis of the data on hospital morbidity in Belo Horizonte from 1998 to 2005. In one study, it was reported that only 5.7% of all children up to four years of age hospitalized for respiratory diseases were diagnosed with bronchiolitis.[18]

The diagnosis reported in the discharge summary is initially that recorded in the authorizations for hospital admission and, therefore, these data are used in the official morbidity statistics.

A critical analysis of the results of the present study and its limitations is called for. Since the children, at the time they were treated at the Pediatric Pulmonology Outpatient Clinic, had already been hospitalized, it was not possible to properly investigate the criteria used for their hospitalization and for the diagnosis of pneumonia. Therefore, those criteria were determined on the basis of the information contained in the discharge summary. However, what called our attention was the fact that many children with asthma were hospitalized repeatedly with a diagnosis of pneumonia.

We concluded that the incidence of multiple hospital admissions was high, and that the principal risk factors involved were asthma severity and age at the first admission. Frequent hospital admission carries inherent risks and can result in psychosocial damage. Data from the present study indicate that, when children who have been hospitalized once for asthma or pneumonia present to basic health care clinics, they should be submitted to further testing in order to clarify the diagnosis. Those diagnosed with persistent asthma should be treated with anti-inflammatory drugs. Prospective studies, adopting diagnostic criteria for a more accurate analysis of admissions and re-admissions due to asthma within the SUS, should be strongly encouraged.

ACKNOWLEDGEMENTS

We would like to thank the Belo Horizonte Municipal Secretary of Health, its managers and directors, as well as the nursing and pharmacy staff of the Campos Sales Medical Clinic. Without their help, this study would not have been possible.

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