

Preventable factors in hospital admissions for asthma

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Abstract

Asthma remains the second most common cause for admissions to a paediatric hospital bed. The aim of this study was to describe the characteristics of children admitted to hospital with an acute asthma attack and to identify factors that may prevent future hospital admissions. Parents of all children aged 3 to 15 years admitted to hospital for acute asthma were interviewed and the child's case record reviewed. Children were recruited consecutively in two groups: 141 summer/autumn and 125 winter/spring 1996. According to the pattern of symptoms in the previous 12 months, 61% of the children had infrequent episodic asthma, 26% had frequent episodic asthma, and 13% persistent asthma. Only 8% of children aged 8 years or less had persistent asthma, in contrast to 22% of those aged > 8 years. There was evidence of both inadequate prescription of preventive treatment and poor compliance in the frequent episodic and persistent asthma groups. Of the whole group, 44% had previously been given an acute asthma management plan, but only 9% of them used it before the current hospital admission. There was a delay in seeking medical advice (> 24 hours after the onset of symptoms) in 27% of all admissions. This study has identified potential areas where intervention may reduce the number of future admissions.

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Asthma remains the second most common cause for admission to a paediatric hospital bed despite extensive educational programmes and an exponential increase in the sales of preventive drugs. The admission rate in Australia has doubled over the past two decades¹ to a level of 589/100 000 per annum in children up to 19 years. The prevalence of childhood asthma in this country has been reported to be between 10% and 25% of all children.² This means that between 300 000 and 600 000 Australian children are affected by the disease.³ There is also evidence that the prevalence, severity, and hospital admission rates of asthma in children are increasing in many countries.⁴ The total cost of asthma in Australia in 1991 was in the range of \$585 to \$720 million. The value of asthma drugs and appliances used for treatment of the disease in the same year was calculated at over \$120 million.³ Every hospital admission represents a substantial amount in terms of time and

money spent by the children and their families, as verified in a recent study relating the cost of childhood asthma to Australian families.⁵ It has been shown that an admission in the previous 12 months is a strong marker of severity and subsequent risk of readmission and death.⁶⁻⁸

Several factors have been identified that may influence and possibly prevent admission of children to hospital with an attack of asthma.⁹ These include appropriate preventive treatment,⁹⁻¹⁵ regular review by a physician (at least every three months),^{16 17} provision of an individualised written management plan,^{16 18 19} adequate early management of asthma in the home,^{8 20 21} good compliance with preventive treatment,^{8 22} and an acceptable level of asthma knowledge.^{16 23}

The relatively high admission and readmission rates for asthma in children are still of concern. Previous studies have identified one or two preventable factors in isolation, most of them retrospectively. This study describes characteristics distinguishing children admitted for asthma and identifies factors that might prevent future hospital admissions for asthma.

Methods

Parents of children aged 3 to 15 years admitted with asthma to the Royal Children's Hospital, Melbourne, were prospectively and consecutively recruited in two groups: summer/autumn (February/March) and winter/spring (August/September) 1996. During the period of the study, only the first visit for each child was analysed. Children were excluded when admitted with asthma combined with other lung disease or concomitant major illness.

All the participants in the study were interviewed using a questionnaire, and the child's case record was reviewed. The questionnaire was designed to obtain demographic data, personal and family history of asthma, medical treatment, asthma general knowledge, and details of the current episode of asthma. When necessary, an interpreter was used. Parents and children were contacted in the ward within 12 hours of hospital admission and invited to participate. Informed written consent was obtained before their inclusion in the study. The study was approved by the Royal Children's Hospital ethics in human research committee.

The functional severity scale of asthma in children, used in this study, ranks the severity of asthma as low, mild, moderate, or severe.²⁴ In addition, we described the pattern of asthma in the previous 12 months, as defined by Phelan *et al.*¹⁵ Children with infrequent episodic asthma have isolated episodes of wheeze with an

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Table 1 Details of the personal history of asthma in children admitted to hospital with an exacerbation (*n* = 266)

	No of children	(%)
Age of asthma onset (years)		
1–3	201	(75.6)
4–6	51	(19.2)
7–15	14	(5.3)
Median (IQR) = 2 (2–3)		
Functional severity scale of underlying asthma		
Low	41	(15.4)
Mild	79	(29.7)
Moderate	94	(35.3)
Severe	52	(19.5)
Pattern of asthma (previous 12 months)		
Infrequent episodic asthma	162	(60.9)
Frequent episodic asthma	69	(25.9)
Persistent asthma	35	(13.2)
Seasonal pattern of symptoms		
Winter	77	(28.9)
Spring	14	(5.3)
Summer	20	(7.5)
Autumn	10	(3.8)
No pattern	145	(54.5)
Asthma attendances in the emergency department in the last 12 months	144	(54.1)
Hospital admission over the last 12 months	121	(45.5)
Previous admissions to the intensive care unit	30	(11.3)
Limitation during exercise (more often than monthly)	101	(38)
Daily use of β_2 agonists	73	(27)
School absenteeism: median number (IQR) of days off school in the past 12 months because of asthma symptoms = 7 (3–15)		

IQR = interquartile range.

asymptomatic interval of at least four weeks. In frequent episodic asthma the interval is less than four weeks. Children with persistent asthma have symptoms such as sleep disturbance due to cough or wheeze, exercise limitation, or the need for bronchodilators to relieve wheeze in the interval period. Compliance with preventive treatment was classified as poor or good according to a validated four item self reported adherence measure, which has concurrent and predictive validity.^{25 26} The current acute episode of asthma was classified as mild, moderate, severe, or very severe according to the clinical severity scale for acute asthma in children.^{27 28} The asthma knowledge questionnaire included in our survey was validated by Fitzclarence and Henry.^{23 29} It scores the responses from 0 to 31 and divides the result into a low (≤ 18) or a high (> 18) level of asthma knowledge. The admission policy was not modified throughout the period of this study.

The following were considered as possibly preventable factors:

- (1) Inappropriate preventive treatment: defined as lack of preventive treatment in children with frequent episodic asthma or persistent asthma.
- (2) Poor compliance with preventive treatment.
- (3) Failure to use the asthma crisis management plan.
- (4) A low level of asthma knowledge.
- (5) A delay of more than 12 hours in starting β_2 agonists at home after the onset of symptoms for the current asthma episode before the present hospital admission.

Table 2 Preadmission asthma management in 266 children admitted to hospital with an exacerbation

	No of patients	(%)
Preventive drugs		
Inhaled steroids	111	(42)
Sodium cromoglycate	29	(11)
Salmeterol	27	(10)
Oral steroids	7	(3)
Theophylline	3	(1)
None	128	(48)
Use of spacer with metered dose inhaler	121	(45)
Poor compliance (from 139 children with preventive treatment)	52	(37)
Medical attendance for asthma		
Regularly (at least every three months)	114	(43)
Only if wheezy	136	(51)
Never	16	(6)
Possession of a written crisis plan	117	(44)
Using peak flow meter at home (from 119 children older than 7 years)		
Daily	7	(6)
During episodes of wheezing	57	(48)
Never	55	(46)
Spirometry over the last year (from 119 children older than 7 years)	29	(24)

- (6) A delay of more than 24 hours in seeking medical care after starting β_2 agonists at home, despite their use more often than every three hours just before coming to the hospital.
- (7) Not using prednisolone before the current admission, in spite of an attack lasting more than 24 hours and using β_2 agonists more often than every three hours just before coming to the hospital.
- (8) Not visiting a physician regularly (at least every three months) in children with frequent episodic asthma and persistent asthma.

All the newly diagnosed asthmatics were excluded when analysing these preventable factors.

STATISTICAL ANALYSIS

Percentages were used for categorical variables and medians (m) with the interquartile range (IQR) according to the skewness of continuous data. A non-parametric test (the Kruskal-Wallis test) was used to examine differences between some variables (using the SPSS software). Significance was accepted at the $p < 0.05$ level.

Results

There were 266 children in the study—141 from February to March and 125 from August to September. Only six parents refused to participate.

DEMOGRAPHIC DATA

The male/female ratio was 173/93 and the median (IQR) age was 7 years (5–11); 64% of children were less than 9 years old. Ninety seven percent of the children were born in Australia; 54% had at least one parent who was born outside Australia. The language spoken at home was English in 77% of these families. However, for 53% of the parents English was

Table 3 Details of the current exacerbation in children admitted to hospital because of asthma

	No of children	(%)
Severity of the current attack of asthma		
Mild	25	(9)
Moderate	114	(43)
Severe	97	(37)
Very severe	30	(11)
Delay to start of treatment at home (hours)		
0-6	211	(79)
7-12	17	(6)
13-24	16	(6)
More than 24	22	(9)
Mean (SD) = 6.6 (18.3)		
Delay to seek medical care (hours)		
0-6	90	(34)
7-12	50	(19)
13-24	56	(21)
More than 24	70	(26)
Mean (SD) = 21.7 (35.3)		
Prehospital duration of the current exacerbation (hours)		
0-6	63	(24)
7-12	43	(16)
13-24	62	(23)
More than 24	98	(37)
Median (IQR) = 16.5 (7-35)		
Mean (SD) = 28.3 (40.1)		
Use of reliever treatment at home for the current attack	236	(89)
Levels of health care before hospital admission		
Local doctor	125	(47)
Local hospital	22	(8)
Pharmacy	9	(3)
Drugs used before hospital admission		
β_2 Agonists	236	(89)
Prednisolone	49	(18)
Ipratropium bromide	27	(10)
Inhaled steroid	4	(2)
Sodium cromoglycate	3	(1)
Use of asthma crisis plan before admission	13	(5)

IQR = interquartile range.

not their first language. A family history of asthma (parents or siblings) was present in 60% of the families. Almost half (47%) of the children were exposed to cigarette smoke at home.

PERSONAL HISTORY OF ASTHMA

Information on the personal history of asthma is shown in table 1. Asthma had been diagnosed previously in 250/266 (94%) of the children. The pattern of asthma was influenced by age. Infrequent episodic asthma was more common (68%) in young children (< 9 years old) than older children (48%). Persistent asthma was much more common in the older children (22% v 8%).

Table 4 Preventable factors in children admitted to hospital and previously diagnosed with asthma (n = 250)

	No (%) of children
Failure to use the asthma crisis management plan	238 (95)
Low level of asthma knowledge	128 (51)
Inappropriate preventive treatment	77 (31)
Poor compliance with preventive treatment	52 (21)
Not using prednisolone before the current admission, in spite of an attack lasting >24 h and use of β_2 agonists more often than every 3 h just before coming to hospital	44 (18)
Not visiting a physician regularly (at least every three months) in children with FEA and PA	41 (16)
Delay of >12 h in starting β_2 agonists at home after onset of asthma symptoms	37 (15)
Delay of >24 h in seeking medical care after starting β_2 agonists at home, despite their use more often than every 3 h just before coming to hospital	26 (10)

FEA = frequent episodic asthma; PA = persistent asthma.

REGULAR TREATMENT

Information regarding preventive treatment and compliance, use of spacers, written crisis plans, monitoring of lung function, and medical attendances is shown in table 2.

During the last 12 months, 138 of 266 children (52%) had been using preventive treatment on a regular basis (daily) as prescribed by their physicians. Of the 104 children with frequent episodic asthma or persistent asthma, 26 (25%) had been prescribed preventive drugs. Only 51/101 (50%) of those children with exercise limitation used any drug before exercising.

MEDICAL REVIEW

Of those children who had a regular medical review for their asthma (n = 114), 50% attended a general practitioner and the other 50% visited a specialist (paediatrician, thoracic physician, or allergist). When they had symptoms suggesting an asthma exacerbation, most children (171/266 (64%)) visited their local doctor, 47 (18%) went directly to the hospital, and 16 (6%) attended a specialist. When asked about attendance to non-medical practitioners for asthma care in the last 12 months, 33/266 (12%) had consulted a pharmacist, and 32 (12%) had visited a naturopath, homoeopath, chiropractor, acupuncturist, or relaxation therapist.

ASTHMA KNOWLEDGE

The asthma knowledge questionnaire showed a mean (SD) score of 19.9 (5.6); 129 of 266 (49%) had a low level of asthma knowledge with a mean score of 15.4 (3.9), while 51% had a high level of knowledge with a mean score of 24.4 (2.1).

CURRENT ASTHMA ATTACK AND HOSPITAL ADMISSION

Details of the current asthma attack and circumstances preceding this hospital admission are shown in table 3.

For 74 children (28%) it was the first hospital admission with asthma, while for 16 children, the current exacerbation represented the first diagnosis of asthma. The most common trigger for this attack identified by 194 of 266 parents (73%) was a "cold", followed by a change in the weather in 56 (21%), dust in 21 (8%), and exercise in 15 (5%). Very few people referred to tobacco smoke, contact with animals or chemicals, stress, or foods as being trigger factors. In 28 cases (11%) there was no trigger identified.

The majority of children—93% (232/250) of those previously diagnosed as asthmatic—used specific anti-asthma drugs during the current asthma exacerbation: 173/250 children (69%) used nebulised β_2 agonists, 34 (14%) used inhaled β_2 agonists with a spacer device, and 16 (6%) used metered dose inhalers without spacers. There were also six children (2.5%) who used an oral β_2 agonist preparation.

Of those children with a bronchodilator at home, 60% (149/250) used them one to two hourly, while 27% used them every three to four hours. Surprisingly, only 10/117 (9%) of families possessing an asthma crisis plan at home actually used it.

PREVENTABLE FACTORS FOR ADMISSION TO HOSPITAL

Factors that may have prevented an admission to hospital are shown in table 4. From the eight possible preventable factors, 98% of the population previously diagnosed with asthma had at least one preventable factor, and 85% had three or more. The number of preventable factors was significantly greater in children with frequent episodic asthma and persistent asthma ($p < 0.001$).

Discussion

An admission to hospital is one of the most serious consequences of asthma.⁴ Every hospital admission generates stress, anxiety, and interruption to the normal lifestyle of children and their parents, as well as high costs for the health care system and the family.^{9 10} The purpose of this prospective study was to describe the characteristics of children admitted to hospital with an acute asthma attack and to identify factors which may prevent future hospital admission for an acute exacerbation of asthma.

The majority of children admitted to hospital with an acute asthma attack in this study had infrequent episodic asthma. Almost half had a previous attendance to an emergency department review or a hospital admission in the last 12 months. School absenteeism, sleep disturbance, or exercise inducing wheezing were also common. Furthermore, there was evidence suggesting suboptimal asthma control and poor use of self management strategies in each of the three patterns of asthma. The group of children with frequent episodic asthma and persistent asthma also had evidence of inadequate use of preventive treatment. Interestingly, 98.4% of the population studied had at least one of the eight possible factors that we thought likely to prevent future hospital admissions.

Previous studies in the general community have documented the functional severity of asthma to be low and mild in 77% of children.^{15 24} In contrast, the population included in this study had a higher proportion within the bands of moderate to severe asthma. Our finding that 13% of children had persistent asthma is more than expected for the general childhood population—Phelan *et al* quote 5%.¹⁵ The proportion of children with persistent

asthma admitted with an acute exacerbation was 2.6-fold higher in children older than 8 years.

In this study we proposed eight factors that could contribute and potentially prevent future hospital admissions in asthmatic children. A large proportion (72%) of children, previously diagnosed with asthma, had between two and four preventable factors. Children with more frequent exacerbations and interval symptoms had more of these factors. This suggests that children classified with frequent episodic or persistent asthma would be more likely to benefit from programmes focusing on prevention.

The treatment of airway inflammation in asthma with preventive drugs (inhaled steroids, sodium cromoglycate) is recognised to be important in decreasing morbidity and the number of hospital admissions.^{10-13 18} Some studies have shown poor control and suboptimal treatment preceding the attendance to the emergency service, perhaps contributing to the acute crisis.^{9 14 16} Recent asthma management guidelines suggest that children with frequent episodic asthma and persistent asthma should be treated with preventive drugs.³⁰ According to these guidelines, a quarter of the children in this study with frequent episodic asthma and persistent asthma were undertreated. Control of interval symptoms is largely dependent on compliance with appropriate drug treatment.²² Adherence to treatment regimens has been measured in several studies, using objective and subjective methods,²⁵ and estimates of satisfactory adherence vary between 10% and 50%.³¹ In this study 60% of the children had good subjective compliance. However, only 39% of children had frequent episodic asthma and persistent asthma.

Several studies have indicated that at least one third of the hospital admissions are in some way related to improper actions taken by the patient, his family, or the health care professional.^{22 32} One of the strategies promoted to manage exacerbations is the need for parents and patients to have an action plan.^{6 16 19 33-35} These individualised written instructions have become an integral part of self management and contain information on how to detect the early stages of an asthma attack and what action needs to be taken.¹⁸ In the present study, 95% of families did not use any written instructions during the current attack. Although 44% had previously been given an acute asthma management plan, only 9% of them used it before the current hospital admission. Health professionals involved in the management of asthmatic children should consider strategies to provide a more attractive, practical, and handy written crisis plan to improve and motivate parents and patients to use it.

Concern has recently been expressed over the need for asthmatics with acute attacks to receive intensive initial management,^{8 19} including optimal bronchodilator treatment, steroids in the form of oral prednisolone when included by the doctor in the crisis plan, early recognition of signs suggesting a worsening attack, and prompt evaluation by physicians to

avoid more severe exacerbations requiring unavoidable admissions. As in a recent study on near fatal asthma in childhood,⁸ there was a group of children in our study in whom there was a delay in starting reliever drugs and seeking medical help. We found that 18% of children previously diagnosed with asthma and with an exacerbation lasting more than 24 hours used bronchodilators more often than every three hours and no systemic corticosteroids before the current hospital admission. This is similar to a previous study on the prehospital management of children with acute asthma.²⁰

Several publications have stressed the importance for asthmatic children of visiting a physician regularly.¹³⁻¹⁶ Such visits may have a positive effect in promoting periodic evaluation of asthma severity and its treatment, monitoring lung function when feasible, improving compliance and proficiency with the use of drugs, and instructing parents and patients about taking adequate measures to reduce exposure to allergens and irritants. However, the results in our study showed that 40% of children with frequent episodic asthma and persistent asthma did not have a regular medical review. Furthermore, only 40% of the children in these categories and older than 7 years had had lung function tests in the previous year.

In this study population, 69% of those with previously diagnosed asthma had used a nebuliser at home for administration of β_2 agonists. The use of home nebulisers for β_2 agonists has been established for many years as part of the management of asthma in the community. This practice has continued in spite of the increasing evidence in favour of the combination of metered dose inhaler and a holding chamber for the management of acute asthma.³⁶ Current paediatric teaching is attempting to address the issue in this country, popularising the benefits of the use of a metered dose inhaler and holding chamber.

This prospective study has identified several well known preventable factors for asthma hospital admissions, including some that are the cornerstone of the asthma treatment plan—that is, the early use of bronchodilators and oral prednisolone, and early medical consultation. We have shown that treatment plans are underused by doctors, but we are more concerned by the fact that when issued they are often not followed by patients. There is a need to evaluate different strategies to improve patients' use of treatment plans.

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