Admission rates as an indicator of the prevalence of severe asthma in the community

Abstract

Background: A reliable indicator of the prevalence of severe asthma in the community is needed to monitor population-based asthma control strategies. We examined the potential use of asthma admissions to hospital as such an indicator. *Methods:* We recruited subjects from the Emergency Department (ED) of a children's hospital. The attending doctor completed the 'physician questionnaire' which included questions on the patient's asthma severity and interval severity/chronicity of asthma. The parent/guardian completed the 'parent questionnaire'. It included questions on demography, asthma knowledge and attitudes, asthma history and social support. We performed univariate and multiple logistic regression to determine predictors for hospital admission. *Results:* Interval severity of asthma, pre-treatment severity of wheeze and low post-treatment pulse oximetry best predicted whether children presenting with asthma were admitted. Demographic variables, factors associated with access to health services and factors related to the asthma history and management were not significant predictors of admission. *Discussion:* At the population level, it may be possible to utilise routine hospital admission rates as an indicator of the prevalence of severe asthma in the community, especially within the context of monitoring trends in asthma prevalence. Our study was conducted in a metropolitan tertiary paediatric hospital. The reliability of hospital admission rates as indicators of the prevalence of severe asthma in other hospital settings, in different population groups and over time remains to be established.

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Correspondence to:
Bin Jalaludin, Western Sector Public Health Unit, 13 New Street, North Parramatta, NSW 2151. Fax: (02) 9840 3608, e-mail: binj@phu.wsahs.nsw.gov.au

Bin Jalaludin, Tien Chey and Marvin Holmwood
Western Sector Public Health Unit, Western Sydney Area Health Service

Jennifer Chipps
New South Wales Health Department

Ralph Hanson
The New Children's Hospital, Westmead, New South Wales

Stephen Corbett
New South Wales Health Department

Stephen Leeder
Department of Public Health and Community Medicine, University of Sydney at Westmead Hospital, New South Wales

Asthma is a major health problem in New South Wales (NSW). In the 12 months from July 1990 to June 1991, there were approximately 12,000 admissions and a larger but unknown number of attendances at hospitals for emergency department and outpatient asthma treatment in NSW.[1] It is a common cause for admission of children to hospital.[2,3] The direct and indirect costs of asthma treatment to the NSW health system in 1989 were estimated at $200 million.[4]

Current strategies for population-based asthma control rely on better diagnosis, avoidance of trigger factors and an integrated approach to patient management. Successful implementation of these strategies will most likely result in an overall reduction in the prevalence of severe asthma in the community. We need a reliable indicator of this prevalence that could be used routinely and repeatedly to monitor the success or otherwise of population-based asthma control strategies.[5]

We can monitor outcomes of asthma control strategies in the community by repeated cross-sectional surveys, but such surveys are time consuming and expensive. One indicator that is both relatively accessible and inexpensive, and may potentially reflect variations in the magnitude of severe asthma in the community, is the admission rate to hospital for asthma. However, admission rates to hospital for asthma may be influenced by many other factors including: failures of medical treatment, changes in diagnostic and coding fashions, varying exposures to environmental agents, physician knowledge and experience, hospital admission policies and access to health services.

This project aimed to determine the predictors of admission to hospital for asthma for children aged between 12 months and 16 years, and to evaluate the usefulness of admission to hospital for acute asthma as an indicator of the prevalence of severe asthma in the community.

Method

We recruited subjects from the Emergency Department (ED) of The Royal Alexandra Hospital for Children (RAHC) (now The New Children's Hospital, Westmead). When the attending physician (resident medical officer, registrar, staff specialist) made a definitive diagnosis of asthma (ICD-9 493.9), he/she invited the patient's parent/guardian to take part in the study.

At the time of the consultation, the attending physician completed a questionnaire which included questions on the patient's asthma severity and interval severity/chronicity of asthma. Asthma severity was measured at the initial consultation and at four hours after commencement of treatment. The 'physician questionnaire' was incorporated into the ED information system and was completed electronically. Physicians com-

pleted the 'physician questionnaire' on all children diagnosed with asthma, regardless of their age.

All ED medical staff were instructed in the assessment of interval severity and assessment of the severity of an acute asthma attack.

Interval severity was assessed by frequency of wheeze, presence of nocturnal asthma and on waking, previous hospital admission for asthma, previous life-threatening attacks, bronchodilator use and lung function measures.[6] Measures of clinical severity included state of consciousness, physical exhaustion, pulsus paradoxus, central cyanosis, wheeze on auscultation, use of accessory muscles, sternal retraction, initial lung function and oximetry.[7]

The parent/guardian completed the 'parent questionnaire' in the ED at the time of consultation. It included questions on demography, asthma knowledge, asthma history and social support. If this questionnaire was not completed in the ED, it was either completed in a telephone interview or as a postal questionnaire. Parents' knowledge about asthma was assessed by asking parents to differentiate between preventer (anti-inflammatory) and reliever (bronchodilators) medications for asthma.[8]

A research nurse helped recruit subjects, collected completed questionnaires and checked data quality. The nurse ensured that all appropriate subjects were being enrolled by correlating ED log book records with completed questionnaires, checking with ED clinical records when diagnosis was not recorded in the ED log book, and also checking with ED clinical records all diagnoses recorded in the ED log book for upper and lower respiratory tract infections.

Decisions regarding whether to admit a child with asthma were made by the attending medical officer. We employed existing hospital protocols to define admission to hospital. Children with asthma were considered to have been admitted to hospital if they were transferred to a ward from ED or if they received care in the observation ward of the ED for more than four hours.

Statistical analysis

We coded and entered all data into an Access database,[9] and analysed the data using the SPIDA statistical package.[10] We performed simple univariate analyses for all data. We used the chi-squared test and t-test for comparing differences between the groups of interest for categorical and continuous data respectively, and a logistic regression model to determine risk factors for admissions and to adjust for covariates. We nominated statistical significance at the 0.05 level.

Results

Response rates

The study was conducted between 14 May 1995 and 7 October 1995 (inclusive), a period of 21 weeks. In this time, there were 12,425 presentations to ED for children of all ages, of which 707 (5.7%) were for asthma (ICD-9 493.9); 30.7% (n=217) of all presentations for asthma resulted in admission to hospital.

After excluding presentations of children less than 12 months or greater than 16 years of age, and those who re-presented to ED with asthma within two weeks, there were 644 presentations to the ED for asthma, of which 30.9% were admitted to hospital. Both 'physician questionnaire' and 'parent questionnaires' were completed for 364 presentations (56.5%).

Characteristics of children in the analysis and non-analysis groups

Table 1 presents demographic and clinical features of two groups

Table 1: Characteristics of children[a] with and without completed questionnaires who presented with asthma to RAHC, May to October 1995.

	Analysis group (n=364)	Non-analysis group (n=280)
Mean age (years±SD)	5.6±3.63	4.9±3.38
Male gender – n (%)	224 (61.5)	179 (63.9)
Admitted – n (%)	121 (33.2)	78[b] (29.2)
Children born in Australia – n (%)	335 (92.3)	257 (91.8)
Seen by:		
– RMO[c] – n (%)	175 (49.7)	128 (46.7)
– Registrar – n (%)	81 (23.0)	67 (24.5)
Pre-treatment wheeze – n (%)		
– None	134 (37.0)	Not applicable
– Mild	114 (31.3)	
– Moderate/severe	114 (31.3)	
– Missing	2 (0.5)	
Physician assessment of asthma severity – n (%)		
– Mild	215 (59.2)	Not applicable
– Moderate/severe	148 (40.8)	
Physician assessment of interval severity – n (%)		
– Mild	291 (80.0)	Not applicable
– Moderate/severe	73 (20.0)	

Notes:
(a) Children <12 months of age or >16 years of age excluded from both groups
(b) Missing = 13
(c) Resident Medical Officer

Table 2: Demographic characteristics of children and households enrolled in the study at RAHC, May to October 1995.

Demographic characteristics of children and respondents[a] (N=364 presentations)	Admitted to hospital (n=121)	Discharged from ED (n=243)
Mean age of children (years±SD)	5.2 ±3.6	5.8 ±3.6
Male gender – n (%)	76 (63)	146 (60)
Children born in Australia – n (%)	114 (94)	221 (91)
Mean age of respondents (years±SD)	35.5 ±7.3	35.0 ±6.4
Respondents born in Australia – n (%)	65 (54)	124 (51)
Households usually speak English at home – n (%)	93 (77)	178 (73)
Respondents have bachelor degree or higher – n (%)	37 (31)	67 (28)
Questionnaire completed by mother of child – n (%)	90 (74)	188 (74)

Note:
(a) Respondent refers to the person completing the 'parent questionnaire'

of children presenting to ED with asthma: children in the analysis group where both 'physician' and 'parent' questionnaires were completed (n=364) and those where only one or none were completed (non-analysis group; n=280). Only children ≥12 months and ≤16 years of age are included in Table 1.

There were no differences in the mean age, gender, proportion of children born in Australia and proportion admitted to hospital among the two groups of children who presented with asthma.

Characteristics of children in analysis group admitted to hospital and discharged from ED

We compared demographic, historical and clinical characteristics of children with asthma admitted to hospital and discharged from the ED. There were no significant differences for any of the demographic variables listed in Table 2.

Admission to hospital for asthma was associated with referral to ED by a doctor or another hospital and if the parental rating of their child's asthma episode at the time of ED attendance was classed as severe (Table 3). Fewer children with a previous doctor diagnosis of asthma were admitted to hospital.

We assessed a parent's knowledge about asthma by asking them to identify the 'preventer medication' if their child was regularly taking medication for asthma. All but one of the parents of children in both groups correctly identified the preventer component of their child's regular medications (admitted to hospital: n=50, 98%; discharged from ED: n=125, 99%).

There were no household characteristics that were associated with admission to hospital, except that children with asthma who were admitted to hospital reported slightly shorter times to get to hospital by their usual means of transport (Table 4).

Table 3: Asthma characteristics of children enrolled in the study at RAHC, May to October 1995.

Asthma history of children (N=364 presentations)	Admitted to hospital (n=121)	Discharged from ED (n=243)
Previous diagnosis of asthma by doctor – n (%)	93 (77)	210 (86)*
Previous history of wheeze/night cough – n (%)	112 (93)	227 (93)
Previous admission for asthma – n (%)	83 (69)	148 (61)
Mean age when first wheezed (months±SD)	26.5±27.3	25.6±23.4
Attended a doctor (including ED) in past 12 months for asthma/wheeze – n (%)	105 (87)	221 (91)
Fewer than 4 attendances to a doctor (including ED) in past 12 months for asthma/wheeze – n (%)	57 (47)	96 (39)
Attended a doctor (including ED) in past 7 days for asthma/wheeze – n (%)	73 (60)	152 (63)
Taking regular medications for asthma – n (%)	59 (49)	141 (58)
Taking regular preventer medications for asthma – n (%)	51 (42)	146 (52)
Have a written action plan for asthma – n (%)	68 (56)	146 (50)
Possess a peak flow meter (n=161) – n (%)	25 (51)	50 (45)
Family had asthma education – n (%)	105 (87)	207 (85)
Referred by another doctor/hospital – n (%)	38 (31)	41(17)**
Taking medications for current asthma attack – n (%)	98 (81)	202 (83)
Parent rating current asthma episode as severe – n (%)	64 (53)	58(24)**

Notes:
* $p<0.05$
** $p<0.01$

Table 4: Characteristics of households enrolled in the study at RAHC, May to October 1995.

Characteristics of households (n=364 presentations)	Admitted to hospital (n=121)	Discharged from ED (n=243)
Households with telephone – n (%)	118 (96)	242 (100)
Respondents[a] who drove own car to hospital – n (%)	105 (87)	213 (88)
Time taken to get to hospital by usual means of transport (minutes±SD)	22 ±15	26 ±16*
Respondents who found it somewhat/very difficult to get to hospital – n (%)	23 (19)	72 (30)
Respondents who have a regular local doctor or medical centre – n (%)	119 (98)	238 (98)
Time taken to get to regular local doctor or medical centre by usual means of transport (minutes±SD)	9 ±8	9 ±9
Respondents who found it somewhat/very difficult to get to local doctor – n (%)	6[b] (5)	16[c] (7)
Another adult available to care for the child – n (%)	116 (96)	226 (93)
Respondents who are current cigarette smokers – n (%)	29 (24)	50 (21)

Notes:
(a) Respondent refers to the person completing the 'parent questionnaire'
(b) 2 missing values
(c) 6 missing values
**p<0.05*

Clinical features of children presenting with asthma that were significantly associated with admission to hospital included: duration of presenting episode; time of presentation to ED; severity of pre and post-treatment wheeze; pre-treatment accessory muscle use; pre and post-treatment respiratory rate; pre and post-treatment oxygen saturation (measured by pulse oximetry); presence of pre-treatment pulsus paradoxus; and, whether oxygen therapy and nebulised $ß_2$-agonist were required (Table 5). These clinical features are markers of the severity of the acute asthma episodes.

Logistic regression model to determine predictors for hospital admission

We developed a logistic regression model to examine the independent and combined effects of demographic, household, historical and clinical factors on hospital admission.

Significant predictors of hospital admission after adjusting for child's age (dichotomised as ≥12 months and ≤6 years of age, and >6 years and ≤16 of age) and gender, and whether oxygen therapy was required in ED, included: attending medical officer's assessment of interval severity of asthma; low post-treatment oxygen saturation; and, moderate/severe pre-treatment acute asthma (Table 6). Demographic and household factors, and characteristics of the children's asthma (Tables 2-4) were not associated with admission to hospital in the logistic regression model.

Figure 1 presents the probability of admission based on the logistic regression model (n=214). If both the interval severity of

Table 5: Clinical features of children enrolled in the study at RAHC, May to October 1995.

Clinical characteristics of children (N=364 presentations)	Admitted to hospital (n=121)	Discharged from ED (n=243)
Bed available – n (%)	105 (87)	217 (89)
Duration of presenting episode of asthma ≤2 days – n (%)	78 (64)	120(49)**
Children presenting between 1800 and 0800 hours – n (%)	68 (56)	170 (44)*
ED doctor assessed acute asthma as moderate/severe – n (%)	101 (83)	47(19)**
ED doctor assessed interval severity of asthma as moderate/severe – n (%)	43 (36)	30(12)**
Pre-treatment moderate/severe wheeze – n (%)	84 (69)	30(12)**
Post-treatment moderate/severe wheeze – n (%)	35 (29)	6 (2)**
Pre-treatment moderate/severe accessory muscle use – n (%)	60 (50)	8 (3)**
Pre-treatment pulsus paradoxus present – n (%)	40 (33)	48(20)**
Pre-treatment respiratory rate[a] – breaths/min ±SD	44 ±11	31 ±9**
Post-treatment respiratory rate[b] – breaths/min ±SD	37 ±9	28 ±7**
Pre-treatment oxygen saturation – %±SD	91.4 ±2.9	94.7±2.2**
Post-treatment oxygen saturation – %±SD	93.5 ±3.0	95.7±2.0**
Oxygen therapy required – n (%)	87 (72)	69(28)**
$ß_2$-agonist nebuliser required £hourly- n (%)	95 (79)	30(12)**

Notes:
(a) Number of children = 317
(b) Number of children = 214
** p<0.05*
*** p<0.01*

Table 6: Odds ratios for hospital admission for children with asthma enrolled in the study at RAHC, May to October 1995.

	Adjusted Odds Ratios[a] (OR)	
	OR	(95% CI[b])
Interval severity of asthma:		
None/mild interval severity	1.0	
Moderate/severe interval severity	3.5	(1.5-8.2)
Oxygen saturation:		
Post-treatment oxygen saturation	0.7	(0.6-0.9)
Pre-treatment severity of acute asthma:		
None/mild pre-treatment wheeze	1.0	
Moderate/severe pre-treatment wheeze	9.9	(4.5-21.9)

Notes:
(a) Adjusted for age (dichotomous variable), gender and whether required oxygen therapy
(b) 95% confidence interval

asthma and pre-treatment wheeze were classified as moderate/severe, then the probability of admission to hospital was about 80% if the post-treatment oxygen saturation was 100% and rising to nearly 100% if the post-treatment oxygen saturation was 90% (top curve in Figure 1).

On the other hand, where both the interval severity of asthma and pre-treatment wheeze were classified as mild, the probability of admission to hospital was about 10% if the post-treatment oxygen saturation was 100% and about 60% if the post-treatment oxygen saturation was 90% (bottom curve in Figure 1).

The overall predicted probability of the logistic regression model as calculated by the area under the receiver operating characteristic curve (data not shown) was 0.90 (95% confidence interval: 0.85-0.95). This suggests that this model would correctly predict admission to hospital 90% of the time.

Discussion

We investigated the feasibility of using the rate of hospital admission for asthma as an indicator of the prevalence of severe asthma

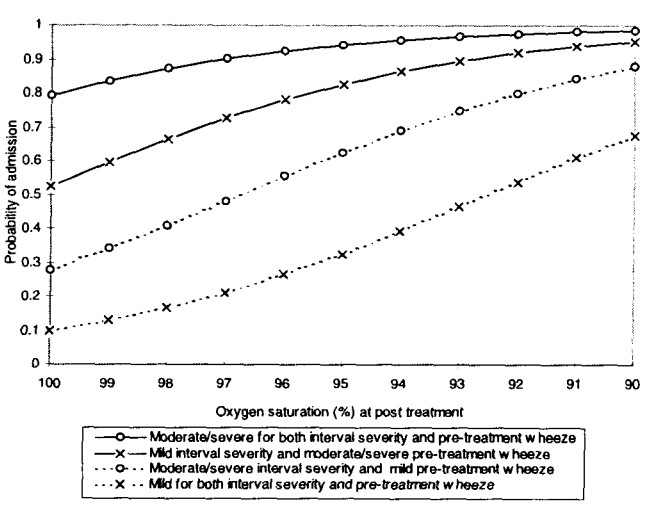

Figure 1: Probability of admission based on logistic model of children enrolled in the study at RAHC, May to October 1995.

in the community. Severity of asthma on presentation to ED and severity of interval asthma best predicted admission to hospital. In a logistic regression model, demographic factors, access to health services and factors related to asthma management did not predict admission to hospital. Therefore, it may be possible to use variations in hospital admission rates for asthma as an indicator of the changing prevalence of severe asthma in the community. Significant variations in hospital admission rates for asthma will also signal the need to determine reasons for the variations.

Excluding children who were less than 12 months of age and greater than 16 years of age or children who re-presented to ED for asthma within two weeks, the 'physician' and 'parent' questionnaires were completed for 57% of presentations for asthma. There were no significant differences for selected variables between children in the analysis group and children in the non-analysis group. Therefore, although response rates are low, selection bias does not seem likely.

In our logistic regression model, interval severity of asthma, pre-treatment severity of wheeze and post-treatment pulse oximetry best predicted whether children presenting with asthma were admitted to hospital.

The three significant predictor variables in the logistic model reflect asthma severity in three quite different ways. Interval severity is a historical measure of chronic asthma severity, while clinical assessment of wheeze and pulse oximetry are subjective and objective measures of acute asthma severity respectively.

Severity of wheeze and pulse oximetry are often utilised as measures of acute severity. Most often, they are used in combination with other severity indicators such as respiratory rate, pulse rate, accessory muscle use and peak expiratory flow rates or spirometry, to form part of an overall asthma severity score to assist decision making in the management of acute asthma.[11-13] However, although asthma clinical scores appear to be useful in assessing severity of asthma attacks, they are not sensitive and specific enough to be useful in predicting admission.[14-16]

Our study suggests that children with severe disease are more likely to be admitted to hospital. This view is supported by Henry et al.[17] who suggest that, in children, admissions for asthma represent as a more severe disease, and Payne et al.[18] who found that variations in admission rates for bronchitis/asthma in five communities were mainly related to severity of illness evidenced by failure of ambulatory care.

However, Payne et al.[18] also suggest that factors such as lack of adequate family support, inadequate home environment and lack of alternatives to hospitalisation may also lead to admission to hospital. Other factors thought to predict admission to hospital include configuration of health services[19,20] and changes in clinical management of asthma.[21,22] However, in our study, many such factors which were significantly associated with admission for asthma in univariate analyses were not significant in the logistic model. Demographic variables, factors associated with access to health services (either to general practitioners or to EDs), and factors related to the asthma history and management (e.g. previous diagnosis of asthma, previous admission for asthma, whether the child was on regular medications for asthma including preventer medications and the presence of written action plans for asthma) were not significant predictors of admission to hospital.

The important factors determining admission to hospital for children with asthma appear to be the severity of the acute attack as assessed clinically by ED physicians and by their use of pulse oximetry, and the severity of the chronicity of the asthma. Therefore, at the population level, it may be possible to utilise hospital admission rates as an indicator of the prevalence of severe asthma in the community. An important advantage of using hospital admission data is that they are relatively accessible and are routinely collected for health services planning.

We anticipate that trends in hospital admission rates for asthma will mirror trends in the prevalence of severe asthma in the community, whatever the reasons for changes in this prevalence, which may include inadequacies in asthma management and changing prevalence in the intensity of exposure to environmental agents.

There are several issues that need consideration before we can adopt the widespread use of hospital admission rates for asthma as indicators for the prevalence of severe asthma in different communities. Variations in hospital admission rates for asthma will not identify the factors responsible for changes in the prevalence of severe asthma. Hence, although variations in the prevalence of severe asthma in the community may be easily monitored by examining hospital admission rates, changing trends will need to be further investigated for causal associations.

Our study was conducted in a metropolitan tertiary paediatric hospital, and therefore it may not be valid to generalise our results and conclusions to communities served by district or regional hospitals or to the adult population with asthma. It will be necessary to validate the use of hospital admission rates as indicators of the prevalence of severe asthma in various hospital settings and in different population groups. Only then would we be confident of the validity of hospital admission rates for asthma as indicators for the prevalence of severe asthma in different communities.

Further, as there may be other factors which may also affect admission rates for asthma, for example changes in diagnostic fashion and coding practices, we need to review regularly the validity of admission rates as an indicator for severe asthma morbidity in the community.

In summary, we have demonstrated that it is reasonable to use hospital admission rates for asthma as indicators of the prevalence of severe asthma in a paediatric community that is serviced by a tertiary paediatric hospital. We recommend that health professionals consider using hospital admission rates for asthma as an indicator when exploring changing trends in the prevalence of severe asthma in the community.

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