

PREDICTORS OF SHORT-TERM HOSPITAL READMISSIONS OF ASTHMATIC CHILDREN

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خلفية: إن عدد حالات القبول للمستشفى للمصابين بالربو القصبي قد ازداد بشكل ملحوظ على مستوى العالم. و إن جزءاً من هذا الازدياد يرجع إلى تكرار إدخال المريض نفسه إلى المستشفى. **هدف الدراسة:** دراسة عوامل الخطورة المرافقة و المسببة لتكرار إدخال الأطفال المصابين بالربو إلى المستشفى و ذلك خلال فترة شهرين من الإدخال الأول.

طريقة الدراسة: تمت الدراسة بالطريقة الاسترجاعية التأملية للحالات الربوية التي أعيد إدخالها للمستشفى و الحالات التي لم يعد إدخالها للمستشفى و التي استخدمت كشاهد و ذلك بدراسة السجلات الطبية الموضحة للدخول و الخروج من مستشفى عسير المركزي ، و ذلك خلال الفترة من شهر آب 1998م و حتى كانون الأول 2002م. المرضى الذين تم إدخالهم إلى المستشفى خلال هذه الفترة ثم أعيد إدخالهم خلال مدة شهرين من تاريخ الإدخال الأول شكلوا مجموعة الدراسة و عددهم (28) مريضاً بينما شكل المرضى الذين تم إدخالهم إلى المستشفى بنفس الفترة و لكن لم يعد إدخالهم مرة ثلثية خلال شهرين ، شكل هؤلاء المرضى مجموعة الشاهد و عددهم 45 مريضاً. تم دراسة و تحليل المتغيرات البيئية و طرق الإدخال للمستشفى و الحالة المرضية السابقة و التقييم السريري و العلاج بالمستشفى و كذلك العلاج عند التسريح من المستشفى .

نتائج الدراسة: أوضحت الدراسة أنه تم إعادة إدخال (28) مريضاً (17 ذكر و 11 أنثى) إلى المستشفى خلال شهرين من الإدخال الأول و كان 70% من هؤلاء المرضى تحت عمر الأربع سنوات . و كانت المتنبآت المهمة في إعادة الإدخال هي وجود إدخال سابق للمستشفى بسبب الربو ووجود المريض السابق في العناية المركزة للمواليد ، وجود عسر تصنع قصبي رئوي وجود متكرر للاستنشاق الرئوي، استمرار أعراض الربو لأكثر من (5) أيام وجود تقييم سريري للحالة يصفها شديدة أو معتدلة الشدة و جود معطيات واضحة في الصور الشعاعية وجود قصة قبول للعناية المشددة و جود تاريخ مرضي التهوية الألية ووجود تاريخ مرضي لاستخدام القشريات الكظرية بالوريد. **الخلاصة:** إن وجود العوامل السابقة الذكر أعلاه شكل علامات مهمة للتنبؤ بإمكانية الإدخال الثاني للمستشفى و ذلك خلال شهرين من الإدخال الأول لمرضى الربو.

الكلمات المرجعية: الربو ، الأطفال ، عوامل الخطورة ، إعادة الإدخال للمستشفى .

Background: The admission rate for bronchial asthma has increased dramatically all over the world. Part of this increase in hospital admissions is due to patient readmission.

Objective: To determine the risk factors associated with short-term hospital readmission of pediatric patients with asthma within two months of the last hospital admission.

Methods and setting: A retrospective case-control study using the registration books of both admissions and discharges to identify patient groups. All hospital records of patients admitted from August 1998 through December 2002 at Aseer Central Hospital, southwestern Saudi Arabia were reviewed. Patients who were admitted during this period of study and readmitted to hospital within two months were used as the study group (n=28) and those patients admitted within the

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same period but not readmitted within two months constituted the control group (n=45). Demographic variables, route of admission, patient's previous medical history, clinical assessment, hospital treatment as well as discharge treatment were obtained and entered for analysis.

Results: Twenty-eight patients were readmitted within two months of their discharge from hospital (17 boys and 11 girls). Seventy percent of these were less than four years of age. Significant predictors of readmission were: prior history of asthma admission (adjusted OR 2.21, 95% CI 1.08-9.10), neonatal intensive care graduate (adjusted OR 4.44, 95% CI 1.67-9.34), bronchopulmonary dysplasia (adjusted OR 3.06, 95% CI 2.01-7.95), recurrent aspiration (adjusted OR 1.96, 95% CI 1.08-4.27), duration of asthma symptoms more than five days (adjusted OR 0.15, 95% CI 0.03-0.42), moderate to severe clinical assessment (adjusted OR 1.12, 95% CI 1.01-2.94), positive X-ray findings (adjusted OR 0.04, 95% CI 0.011-0.230), intensive care admission (adjusted OR 1.96, 95% CI 1.08-4.63), mechanical ventilation (adjusted OR 0.010, 95% CI 0.002-0.130), intravenous steroids (adjusted OR 0.104, 95% CI 0.016-0.321).

Conclusion: Prior neonatal intensive care unit admission, bronchopulmonary dysplasia, history of previous asthma admissions, recurrent aspirations, intensive care unit admission, intravenous steroids, positive X-ray findings and mechanical ventilation were significant predictors of asthma short-term hospital readmissions.

Key Words: Asthma, Children, Risk factors, Readmission

INTRODUCTION

Despite significant advances in the therapy of asthma over the past decade, asthma remains the primary chronic illness of childhood¹ and the most common medical emergency in children. Admission rates have increased dramatically in many countries over the last two decades² and continue to increase.³

Asthma is the most frequent cause for preventable childhood hospital admission. Several studies have used hospital discharge data to investigate increase in asthma admission and changes in asthma morbidity.⁴⁻⁷ However, other studies were not able to distinguish between first admission and re-admission, and therefore were not able to determine whether the apparent increase in hospital admissions were due to increase in the number of readmissions or an increase in the prevalence of asthma. Anderson⁸ investigated readmissions for asthma among children and concluded that part of the increased number of admissions for asthma in children under 15 years of age might be due to readmission.

Readmission of previously hospitalized asthma patients accounts for a substantial proportion of all hospital admissions.^{9,10} Some studies report that as one out of five admissions

for asthma exacerbation was in reality readmission.¹¹

This survey was done to determine the possible predictors of short-term hospital readmission of pediatric patients with asthma within two months of previous hospital admission.

METHODS AND SETTING

A retrospective case-control study was conducted using registration books of both admissions and discharges to identify patient groups. All hospital records were examined for patients admitted from August 1998 through December 2002 at Aseer Central Hospital, southwestern Saudi Arabia. Patients who were diagnosed with asthma as defined by ICD_9 code specific to asthma or status asthmaticus (493.0 493.1 493.2 and 493.9) were listed. Patients who were admitted in this period of study and were readmitted to the hospital within two months were used as the study group (n=28), and those patients who were admitted within the same period but not readmitted within two months constituted the control group (n=45).

The following data were extracted from medical records of the studied subjects: Demographic variables (gender, race) route of admission, i.e. emergency room or outpatient clinic, months of admission, number of previous

admissions for asthma, history of other atopic disorders, neonatal intensive care unit admission, bronchopulmonary dysplasia (chronic pulmonary diseases of infancy that was followed by ventilator and oxygen therapy), congenital lung anomalies, tracheoesophageal fistula, recurrent aspiration, family history of asthma, exposure to smoke, duration of asthma symptoms before admission (in days) and severity of asthma attack.

Variables related to the inpatient treatment of index episode such as; admission to intensive care, prescribed nebulized β agonist, intravenous treatment with, steroids, theophylline and antibiotics in addition, patients' progressive notes were examined for radiographic changes in the chest x-rays.

Lastly, collected were variables relating to discharge from the hospital, such as length of hospital stay (in days), prescribed β agonists, oral steroids and prophylactic inhaled steroids, follow up arrangement and whether or not there was a copy of a written action plan in the records. Patients with co-morbid and chronic diseases such as immunodeficiency disorders, morbid obesity, congenital heart defects, fibrosis and cerebral palsy were excluded. The index episode was the last episode for the control group, while for the study group it was the one followed by readmission within two months.

Data Analysis

The data was analyzed by the Statistical Package for Social Science (SPSS) version 10.0 and the Epi_ifo (version 6.02) soft wares, on IBM computer of the College of Medicine at King Khalid University, Family and Community Medicine Department. Odds ratios (OR) with the corresponding 95% confidence intervals (CI), were calculated for possible predictors of hospital readmission. Multivariate logistic regression analysis was used to model hospital readmission as the function of some predictors.

RESULTS

Twenty-eight patients were identified during the four-year study period, from August 1998 through December 2002. These patients were readmitted within two months of discharge from hospital. The first analysis showed there were more boys than girls (17 boys and 11 girls). Seventy percent of the patients were below four years of age, and

of these, males and those below four years of age were significantly related to the increased risk of readmission. About 71% were admitted through the ER and 57% were hospitalized between the months of August and February. Sixty-eight percent had a history of other atopic disorders, and 79% had a history of previous admission. Fifty-Four percent had a history of neonatal intensive care admissions, 61% bronchopulmonary dysplasia, 14% had congenital lung anomalies, 36% had tracheoesophageal fistula, 50% had a history of recurrent aspiration, 46% had a family history of asthma, and 36% had been exposed to smoke. Some of these factors were statistically significant in asthmatic children who needed short-term hospital readmissions as compared to the control group (Table 1).

The second analysis, in addition, included factors related to the assessment and treatment in the hospital, 43% had had asthma symptoms for more than five days, 82% of patients were assessed as suffering from moderate to severe asthma attack, 54% of patients were admitted into pediatric intensive care unit, 82% received intravenous steroids, 25% were intubated and had mechanical ventilation, 85% were treated with oral steroids, 68% received anticholinergic (ipratropium bromide), 82% received antibiotics, 92% had abnormal chest x-ray (hyperinflation and or infiltrate and atelectasis). These assessments and treatment factors were significantly related to increased short-term hospital readmissions but not to patients treated with oral steroids (Table 2).

Ninety-six percent of the patients were discharged on Beta-agonist treatment, 71% on oral antibiotics, 68% on oral steroids, and 68% on inhaled steroids. About 32% of the patients had stayed in hospital for more than three days and follow-up arrangement was performed in 64% of the patients. Only 32% of the patients had received documented action plan if they developed symptoms again. All these factors were not significantly associated with increased risk of short-term hospital readmissions (Table 2).

Multiple logistic regressions was then carried out finally with hospital readmissions as the dependent variable and these were identified as having a significant association with it during univariate analysis as the independent variables. The analysis revealed that the following factors were statistically significant predictors of

Table 1: Patient characteristics of control and study groups

Factor	Control (n=45) %	Case (n=28) %	OR	95% CI
Sex:				
Male : Female	60:40	60:40	0.98	0.42-3.43
Age*	68	68	1.06	0.34-3.26
Route of admission†	63	71	1.52	0.49-4.76
Previous history of:				
Asthmatic admission	47	79	4.19	1.30-14.84
Other atopic disorders	38	68	3.48	1.16-10.70
NICU admission‡	8	54	11.83	2.95-55.52
Bronchopulmonary dysplasia	20	61	6.18	1.92-20.56
Congenital lung anomalies	8	14	1.71	0.29-10.01
Tracheoesophageal fistula	15	36	3.02	0.87-10.70
Recurrent aspiration	22	50	3.50	1.13-11.10
Family history of asthma	43	46	1.19	0.41-3.41
Exposure to smoke	35	36	1.01	0.34-3.01

*Age (using age > 4 years as reference category); †Route of admission (using outpatients as reference category);

‡NICU=Neonatal Intensive Care Unit

Table 2: Disease characteristics of control group and study group for the index episode

Factor	Control (n=45) %	Case (n=28) %	OR	95% CI
Sex:				
Duration of symptoms (> 5 days)	22	43	0.353	0.117-0.949
Severity assessment – Moderate to severe	25	82	0.070	0.022-0.229
Treatment:				
Intensive care	9	54	0.85	0.24-0.300
Nebulized β -agonist	100	100	-	-
Intravenous steroid	49	82	0.208	0.067-0.644
Intravenous aminophline	18	46	0.249	0.860-0.724
Intubations	2	25	0.68	0.008-0.591
Oral steroid	68	85	0.369	0.108-1.266
Anticholinergic	47	68	0.346	0.129-0.931
Antibiotics	59	82	0.190	0.061-0.589
X-ray findings (hyperinflation or/and infiltrates)	64	92	0.115	0.24-0.547
Discharge from hospital:				
β -agonist	90	96	0.380	0.401-3.582
Antibiotics	54	71	0.457	0.167-1.252
Oral steroids	51	68	0.495	0.1895-1.326
Inhaled steroids	79	68	1.895	0.645-5.569
Length of stay (>3 days)	21	32	0.526	0.180-1.551
Follow-up arrangement	75	64	1.52	0.553-4.224
Documented action plan in the file	20	32	0.528	0.180-1.551

readmission: prior history of asthma admission (adjusted OR 2.21,95% CI 1.08-9.10), history of neonatal intensive care (adjusted OR 4.44,95% CI 1.67-9.34), bronchopulmonary dysplasia (adjusted OR 3.06,95% CI 2.01-7.95), recurrent aspiration (adjusted OR 1.96,95% CI 1.08-4.27), asthma symptoms for more than five days (adjusted OR 0.15,95% CI 0.03-0.42), moderate to severe clinical assessment (adjusted OR 1.12,95%CI 1.01-2.94), positive X-ray findings (adjusted OR

0.04,95%CI 0.011-0.230), intensive care admission (adjusted OR 1.96,95%CI 1.08-4.63), mechanical ventilation (adjusted OR 0.010,95%CI 0.002-0.130), and intravenous steroids (adjusted OR 0.104, 95%CI 0.016-0.321) (Table 3).

DISCUSSION

Asthma is the most common medical cause of hospital admission in childhood.^{2,12} Readmission to hospital for asthma is also very frequent.¹¹ In

Table 3: Predictors of short-term hospital readmissions of asthmatic patients

Predictor	Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Previous admissions:		
0 (no admission)	1.00	1.00
1 admission	4.19 (1.30-14.84)	2.21 (1.08-9.10)
2 admissions	4.79 (1.44-16.32)	2.78 (1.43-10.98)
3 admissions or more	6.23 (1.62-18.73)	3.86 (1.70-11.09)
NICU admission	11.83 (2.95-55.52)	4.44 (1.67-9.34)
Bronchopulmonary dysplasia	6.18 (1.92-20.56)	3.06 (2.01-7.95)
Tracheoesophageal fistula	3.02 (0.87-10.70)	3.19 (1.08-8.74)
Recurrent aspiration	3.50 (1.13-11.10)	1.96 (1.08-4.27)
Duration of symptoms (>5 days)	0.38 (0.24-0.57)	0.15 (0.03-0.42)
Moderate to severe clinical assessment	1.98 (1.21-4.06)	1.12 (1.01-2.94)
X-ray findings	0.43 (0.22-0.85)	0.04 (0.011-0.230)
ICU admission	3.90 (1.29-10.76)	1.96 (1.08-4.63)
Mechanical ventilation	3.24 (1.37-4.05)	0.010 (0.002-0.130)
Intravenous steroid	2.81 (1.79-5.66)	0.104 (0.016-0.321)

this study, 38.4 % were readmitted within two months. Very high readmission rates particularly over a six-month period were also reported in studies in the United Kingdom.^{13,15} Risk factors for admission to hospital for asthma have previously been reported in New Zealand¹⁶ where Maoris and Pacific Islanders, have an increased risk of admission compared with Europeans.⁹

This study has shown that demographic factors such as sex and age may adversely affect the readmission. The risk was increased significantly by being a boy. Other investigators have also concluded that boys had an increased risk of admission for asthma compared with girls.⁹ Similarly, the younger child has an increased risk of admission compared with older children, and similar results have been obtained in other countries.⁹ This finding is not surprising as management of preschool children is difficult and preventive therapy may be unhelpful.

The strongest independent risk factors for short-term readmission in the present study were prior neonatal intensive care unit admissions, bronchopulmonary dysplasia, previous history of admissions (particularly if there was past history of three or more admissions), recurrent aspiration, more than five days' duration of symptoms. Our data showed that many of the former neonatal intensive care patients were premature or had low birth weight. This might account for a substantial

proportion of asthma admissions (23%,30/129) and the increased risk of short-term readmission (54% with adjusted OR 4.44 and 95% CI: 1.67-6.34). A previous history of neonatal intensive care unit admissions and low birth weight have been shown to be risk factors for the eventual development of asthma.^{17,18} Similarly, bronchopulmonary dysplasia has been shown to be a risk factor for the development of asthma,¹⁸ possibly due to airway hyperactivity¹⁸ associated with increased rate of asthma readmission.

On the factors related to the clinical assessment and treatment and investigation in the hospital, the following factors were independently associated with a high risk of hospital readmission of asthmatic patients: moderate to severe attacks of asthma, intensive care admission, mechanical ventilation, intravenous steroids and radiographic evidence of hyperinflation and atelectasis or infiltrates. Asthmatic children whose physical examinations show the above findings require the above interventions, have a severe form of the disease and therefore, more likely to require readmissions.¹⁹

It was expected that the follow-up arrangement of patients would provide education, treatment titration and assessment of asthmatic patients in order to reduce the likelihood of readmission but this was not significant in this research (OR 1.52,95% CI 0.553-4.224) and remained unexplained.

An action plan has been put in place as an essential component of asthma management to improve the clinical status of patients, reduce the severity of symptoms, and mortality of asthma attacks.^{20,21} It is therefore, postulated that an action plan may reduce the asthma readmission though this cannot be proved. This is because most action plans instruct parents to bring their children to the emergency room or to seek urgent medical attention or to call an ambulance if relief from salbutamol was not optimum and asthma symptoms did not improve, or if the children had difficulty speaking, or were cyanosed since these might increase the rate of readmission.

Efficient management of asthma requires periodic monitoring of the respiratory status.²² Measurement of pulmonary function by spirometry or peak flow monitoring in the hospital as well as at home provides an objective assessment of the status of the airways. These

parameters can be more reliable in addition to clinical examination and auscultation of the lung fields²³ in detecting the airways obstruction and the severity of the disease. This would make patients seek medical attention earlier. Interestingly enough, pulmonary function tests were mentioned in less than 3% of all patients. The lack of objective monitoring in this research may reflect the fact that the majority of patients (68%) were under 4 years of age, and patients at this age are unable to perform this maneuver.

The limitations of this study should be recognized. Factors other than severity of illness influence the decision to admit or readmit. These include time of day, distance from hospital, and family psychological factors. These factors were not studied. Some of the data such as previous history and medical treatment at home were poorly recorded. Furthermore, information as to whether prophylactic drugs were taken, clinics attended or action plan was followed as taught were lacking.

In conclusion, the most consistent risk factors associated with short-term readmissions for asthma are related to the patients' past medical history such as previous neonatal care unit admissions, bronchopulmonary dysplasia, history of previous asthma admissions, recurrent aspirations, more than five days of asthma symptoms, moderate to severe clinical assessment, positive X-ray findings, intensive care unit admission, mechanical ventilation and intravenous steroids. These factors should be considered when evaluating a patient for discharge.

Our study suggests that proper follow-ups and consideration of the above risk factors may decrease the rate of short-term hospital readmission in children with bronchial asthma. Lack of appropriate outpatients' utilization has been shown to lead to increased hospitalization.²⁴ An in-depth examination of birth history for the many former neonatal intensive care unit patients, including information of birth weight, gestational age, days of ventilation, and other pertinent data may shed some light on the association determined in this study.

Another important factor that may be helpful would be a standard determinant of the severity of asthma. In one study, asthma patients readmitted within seven days of discharge had an increased

severity of asthma on readmission compared to those not readmitted.²⁵ They were probably not appropriately assessed at the time of previous admission. Strategy and policy to reduce the high readmission rate for asthma in childhood need to be developed.

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