

Emergency Department Asthma: Compliance with an Evidence-based Management Algorithm

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Abstract

Background: Recent surveys in emergency medicine departments show inadequacies in many aspects of acute asthma management. **Objective:** The objective of this study was to evaluate the adherence to management algorithm for acute asthma in the emergency department which focused on evidence-based treatment steps rather than documentation and patient classification. **Methods:** A retrospective audit of consecutive adult patients with acute exacerbations of asthma in the emergency medicine department of a university hospital managed in the context of a clinical algorithm. **Results:** We collated information from 344 episodes of acute asthma (94% of total) over a 4-month period. The first-line treatment was nebulised bronchodilators in 97%, combination of salbutamol and ipratropium bromide in 93% and the combination in recommended dosages in 87%. Systemic corticosteroid treatment was administered to 82% of patients. A further course of systemic corticosteroid was prescribed at discharge for 94% of patients. Overall, 93% of patients received some form of systemic corticosteroid treatment. The admission rate was 35.2%, and was significantly higher in women and the elderly. Of those who were admitted, 46.2% received ≥ 3 nebulised treatments and 69% received intravenous hydrocortisone. **Conclusions:** In the management of acute asthma, we found excellent compliance with specific treatment steps based upon clinical evidence. However, adherence to second-line treatment was less satisfactory. Nevertheless, whenever second-line treatment was complied with, reasonable outcomes were achieved. It may be more appropriate to emphasise evidence-based treatment rather than extensive documentation.

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Introduction

Attendance at the emergency medicine department (EMD) for acute exacerbation is an important milestone in the natural history of patients with asthma. It is an indication of clinically severe disease, inadequate preventive treatment and failure of self-medication for acute symptoms. During an acute exacerbation, the patients are at risk for an expensive hospital admission and even a fatal outcome.

Thus, every attempt should be made to prevent severe attacks of acute asthma and EMD attendance by optimising preventive drug treatment and implementing effective self-management programmes with written action plans. This is the corner stone of intervention programmes for asthma. However, failure of preventive care in asthma is a common experience. A recent Asthma Insights and Reality in Asia

Pacific survey showed that in Singapore, 31% of asthmatic patients reported unscheduled urgent or emergency visits to doctors per year [unpublished data—Asthma Insights and Reality in Asia Pacific (AIRIAP)]. Half of these episodes were severe enough to be managed in EMDs.

Many aspects in the current management of acute asthma recommended by practice guidelines are supported by clinical evidence.¹ However, recent audits of acute management in many EMDs show inadequacies in adherence to key steps in guidelines and expert recommendation.²⁻¹⁰

The objective of this study was to evaluate the adherence with and efficacy of a management algorithm for acute asthma in the emergency department which focus on evidence-based treatment steps rather than documentation and patient classification.

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Methods

An Evidence-based Treatment Algorithm for Acute Asthma

We designed an evidence-based clinical algorithm for the management of acute asthma in adult patients in the EMD. This was based upon a systematic search in the literature for clinical evidence on the management of acute spontaneous asthma by using MEDLINE (PUBMED) and COCHRANE electronic databases using the key words “acute asthma “ and “randomized” and/or “meta analysis” dated December 2000. A total of 169 articles were reviewed out of which 8 were meta analyses on efficacy of corticosteroids, ipratropium bromide, magnesium sulfate and aminophylline in acute asthma.¹¹⁻¹⁸ A critical review of current practice in the EMD by both emergency and respiratory medicine specialists was then conducted to decide on how to best apply the clinical evidence in the local context. It was decided that a multifaceted quality improvement intervention for acute asthma would be introduced with the following features (Appendix I):

1. Simple treatment algorithm rather than a complex clinical pathway
2. Emphasising evidence-based treatment steps rather than precisely documenting disease severity and pulmonary function
3. Enhancing second-line therapy to avoid inappropriate hospital admissions, patient disposition based upon symptoms and physical signs rather than pulmonary function testing, and
4. Initiating short and long-term preventive care at the EMD.

Note that not all treatment options indicated in the algorithm (Appendix I) are strictly evidence-based. For example, there was no conclusive evidence for magnesium or adrenaline as second- or third-line drugs in status asthmaticus. They were included in the algorithm because it was meant for practical use by EMD doctors in the “real world” and we felt that, despite the lack of strong evidence, it should contain a rapidly escalating intensity in bronchodilator treatment and thus a broad range of treatment options. However, these second- and third-line treatments, intravenous magnesium and adrenaline, were not subjected to analysis in this report.

The main interventions were (Appendix I):

1. First-line treatment with appropriate doses of combined nebulised beta agonist (salbutamol) and cholinergic antagonist (ipratropium bromide).
2. Intravenous hydrocortisone for patients who fail to respond to initial nebulised treatment.
3. Intravenous magnesium sulphate for patients who fail to respond to initial nebulised treatment.

4. Early administration of a systemic (either oral or intravenous) corticosteroid.
5. A course of oral prednisolone for all patients discharged from the EMD with no tail in the dose.
6. Fast track referral to a specialist clinic for all patients discharged from the EMD.

Implementation of the Intervention Plan for Acute Asthma

This was carried out in January 2001 with the dissemination of the algorithm (Appendix I) to residents, fellows and consultants (total of 25 doctors) and a one-hour briefing detailing the protocol, treatment steps and disposition of patients presenting with an asthmatic attack.

Evaluating Performance of the Algorithm for Acute Asthma

We conducted a retrospective analysis of the EMD electronic records and medical treatment cards of all adult patients who had an EMD ICD code of asthma (493.9).

Patients

All adult patients (age ≥ 14 years) with a discharge ICD code for asthma (493.9) admitted through the EMD were included. Following individual chart review, patients who had diagnoses of chronic obstructive pulmonary disease (COPD), cardiac asthma, tumour, bronchiectasis or acute bronchitis were excluded. Patients in whom the clinical diagnosis of asthma was not made with confidence were also excluded. Clinical severity was categorised according to simple rules developed in the EMD for triage and initial disposition (Appendix II).

Statistical Analysis

Data were analysed using SPSS software. All values were expressed as mean $\pm$ SD and, where appropriate, confidence intervals. Comparison between 2 groups were made using Student's unpaired *t*-test for parametric data and χ^2 tests for non-parametric data. *P* values of <0.05 were considered statistically significant.

Results

From February to May 2001, a total of 388 cases of adult asthmatics were identified from the EMD register. Twenty-one were excluded from analysis: 9 episodes which were not asthmatic and 12 which had an uncertain diagnosis. Of the remaining 367 eligible asthmatic episodes, 23 were excluded due to incomplete or missing data, leaving 344 asthma episodes for analysis (93.7%).

There was a total of 267 patients out of which 59 (22%) patients experienced 77 repeat episodes over the study period. The demographic characteristics of the patients and their clinical histories are summarised in Table I. The pulse oximetry was the most common test undertaken in the EMD (87%) but did not discriminate between patients

APPENDIX I: ASTHMA CLINICAL ALGORITHM

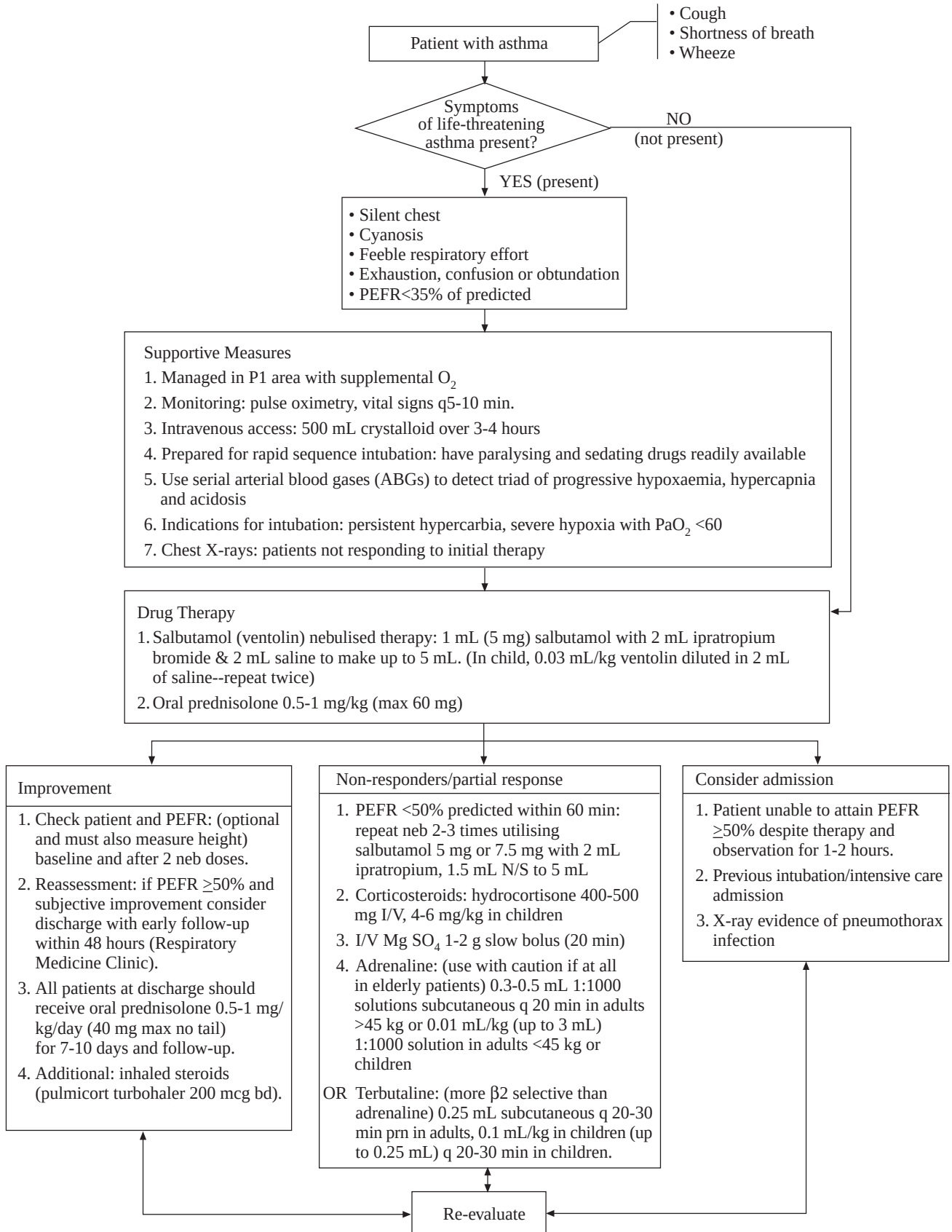


TABLE I: DEMOGRAPHIC AND CLINICAL INFORMATION PRIOR TO EMERGENCY MEDICINE DEPARTMENT ADMISSION

Age (y)	
Mean (SD)	44 (19)
Range	14 to 87
Gender	
Male/Female	51%/49%
Ethnic mix	
Chinese/Malay/Indian/Others	40%/30%/23%/5.8%
Previous admission	33.7%
Previous need for ICU/ETT	2%/8.1%
Readmissions to EMD over the study period	22.4%
Ambulance	14.5%

ICU/ETT: admission to intensive care/ required endotracheal intubation

TABLE II: TRIAGE CLASSIFICATION, INVESTIGATIONS AND ADMISSION RATES

Triage classification		Admission (%)	Chest radiograph (%)	Arterial blood gas (%)
P1	6	85	90	40
P2	89	33.3	36.9	2.6
P3	4	6.7	33.3	0
% of all 344 cases		35.2	40	5

TABLE III: COMPLIANCE WITH TREATMENT OF ASTHMA IN THE EMERGENCY MEDICINE DEPARTMENT

Steroid treatment	% of all cases	% of discharges
a) A single dose of prednisolone	64.8	
b) A course of prednisolone at discharge		94
c) Administration of steroid either as single dose/s and/or a course at discharge	94	
2 nd line treatment	% of all cases	% of admissions
a) Nebulised bronchodilators ≥ 3 times	30.8	46.2
b) Intravenous hydrocortisone	30.2	69

who were discharge and admitted. As our protocol did not emphasise peak expiratory flow rate (PEFR) measurements, the PEFRs were monitored in less than one-third of cases (overall 28%) and patients' height (necessary to calculate % predicted PEFR) was almost never documented.

Overall, 121 (35.2%) patients were admitted to the hospital for further management. These included 34.3% to the general ward and 0.9% to the intensive care unit. One patient was discharged from the EMD against doctors' advice. Table II shows the relationship between patient categorisation according to triage rules in the EMD (Appendix II), admission rates and investigations. Older patients (65 years old or above) (67% versus 29%; $P < 0.001$) and women (43% versus 27%; $P < 0.01$) had

APPENDIX II: TRIAGE CLASSIFICATION OF CLINICAL SEVERITY IN EMERGENCY MEDICINE DEPARTMENT

Priority 1 (P1):	Symptoms and signs of life-threatening asthma present: silent chest, cyanosis, feeble expiratory effort, exhaustion, confusion or obtundation or PEFR $< 35\%$ predicted
Priority 3 (P3):	Walk-in asthmatics that have minimal signs/symptoms of asthma
Priority 2 (P2):	All other asthmatics not classified as P1 or P3 were classified as P2

significantly higher risk of hospital admission. Patients who came by ambulance also experience a significantly higher admission rate (60%) than others. In general, the admission rates and intensity of investigations followed the triage severity index. However, nearly 90% of patients were classified as P2 (moderate in severity).

Table III summarises the treatment for asthma administered in the EMD. Compliance with the first-line treatment protocol was good for 86.6% of patients receiving the recommended dose combination of salbutamol, ipratropium and normal saline for nebulisation. The use of oral steroids in the EMD and for those that were discharged home was 64.8% and 94%, respectively. Overall, 94% of patients received systemic corticosteroid for the treatment of their acute asthma. Thirty-one per cent of patients (46% of admissions) received ≥ 3 nebulisations compared with 32% receiving intravenous systemic steroids (69% of admissions).

The average dose of medication was 43.5 mg for oral prednisolone in the EMD, 37.6 mg for oral prednisolone per day at discharge and 343.4 mg for intravenous hydrocortisone.

Discussion

This was a retrospective study based on a review of EMD case records over a 4-month period. Patients were selected based on the ICD code and individual charts were reviewed to exclude patients with either an alternative or uncertain diagnosis (e.g., first-time attendance for asthma). There were a few missing or incomplete records with an overall data capture rate of 94%. Despite the small sample size and short study period, we feel, however, that our results are representative of adult patients with acute spontaneous asthma presenting to the EMD. We did not exclude the elderly asthmatics and thus, we risk some overlap with patients who have chronic obstructive pulmonary disease. We feel that it is appropriate to include elderly patients with asthma as they represent an important and growing disease burden group.^{19,20}

In comparison with a recent French national survey of

EMD asthma treatment,⁹ our results show higher adherence rates to evidence-based treatment of asthma in the EMD. There were high (>90%) compliance rates with regards to treatment with nebulised salbutamol and ipratropium as first-line treatment, overall treatment with systemic corticosteroids and follow-up appointment at the respiratory clinic.

Most clinical pathways and guidelines on the management of acute asthma described in the literature tend to emphasise the documentation of objective evaluation and categorisation of asthma severity and response to treatment with systematic clinical examination and physiologic measurements.²¹ In contrast, we stressed specific evidence-based treatment steps rather than extensive documentation of disease severity. These treatment steps include nebulised combination of salbutamol and ipratropium plus the early use of systemic corticosteroids (either oral, inhaled or iv) in the EMD. Both of these interventions have shown to improve pulmonary function in the EMD and reduce admission rates.¹²⁻¹⁶ It has also been well established that a short course of corticosteroids at release from EMD will reduce early asthma relapse.

The importance of systemic corticosteroid treatment in acute asthma is further highlighted in a case control study from the state of Victoria in Australia, which showed that systemic corticosteroid use reduced the risk of death during an acute exacerbation by 90%.²² Overall, 94% of patients in our study received systemic corticosteroid treatment for their acute exacerbation in the EMD. We feel that this is more appropriate than the 60% reported by Salmeron et al⁹ from France and 59% by Reid et al⁷ from Canada. Failure to use systemic corticosteroids in the treatment of acute severe asthma may be viewed as a serious error.¹⁰

The efficacy of combining inhaled, short-acting beta-agonist with anti-cholinergic therapy in improving pulmonary function and reducing hospital admissions for asthmatic presenting to the EMD have been documented recently in several meta and systematic analyses.¹⁴⁻¹⁶ Because initial results from controlled studies were conflicting and since the clinical evidence is rather new, there is wide variation of 5% to 80% use of combination treatment in EMDs reported by Salmeron et al.⁹ In that study, 92% of patients received a combination of inhaled, short-acting beta-agonist with anti-cholinergic as first-line therapy.

In contrast with initial (first-line) treatment for acute asthma in the EMD, the optimal treatment for patients who fail to respond to first-line treatment is more uncertain. These are high-risk patients who have status asthmaticus. The majority of them will require hospital admission, some to the intensive care. As this was not a prospective study and we did not define initial treatment failure with any

uniform criteria, we were unable to formally evaluate the adherence to second-line treatment. Instead, we have examined, as surrogate, the treatment of patients who were eventually admitted to hospital. All of these patients have failed initial treatment and should therefore have been treated with second-line drugs before hospitalisation. The second-line treatment recommended in our algorithm was further nebulisations with a combination of β_2 -agonists and anti-cholinergic plus intravenous treatment with hydrocortisone and magnesium sulfate. Because the clinical evidence for the efficacy of second-line treatment of acute asthma is weaker than for first-line treatment, we were not able to recommend treatment with the same level of confidence as for first-line treatment. This is probably the main reason for the poorer compliance with second-line treatment compared with first-line treatment in this study.

The pattern of hospitalisation in this study—overall, one-third of patients admitted with women and older patients at higher risk—is comparable to most other studies.^{9,23} The low proportion of patients needing intensive care and 100% survival rate are also typical.

With regards to investigations, pulse oximetry and chest radiograph appear to have been over-utilised while peak flow rate and arterial blood gas measurements were under-used. All practice guidelines recommend objective measurement of asthma severity, but there have been few prospectively controlled studies to show how best to use this information to guide treatment.^{21,24}

In summary, we found good compliance with a simple algorithm for the routine management of asthma in the EMD, which emphasised specific evidence-based treatment steps rather than extensive documentation. However, adherence to second-line treatment was less satisfactory. Nevertheless, reasonable outcomes were achieved whenever second-line treatment was complied with. Further studies are indicated on the relative cost-efficacy of different second-line treatment regimens.

REFERENCES

1. FitzGerald M. Extracts from "Clinical Evidence": Acute asthma. *BMJ* 2001; 323:841-5.
2. Pearson M G, Ryland I, Harrison B D W, on behalf of the British Thoracic Society Standards of Care Committee. National audit of adults admitted to hospital. *Qual Health Care* 1995; 4:24-30.
3. Nelville R G, Hoskins G, Simth B, Clark R A. How general practitioners manage acute asthma attacks. *Thorax* 1997; 52:153-6.
4. McDermott M F, Grant E N, Turner-Roan K, Li T, Weiss K B. Asthma care practices in Chicago-area emergency departments. Chicago Asthma Surveillance Initiative Project Team. *Chest* 1999; 116 (4 Suppl 1):167S-73S.

5. Pinnock H, Johnson A, Young P, Martin N. Are doctors still failing to assess and treat asthma attacks? An audit of the management of acute attacks in a health district. *Respir Med* 1999; 93:397-401.
6. Simpson A J, Matusiewicz S P, Brown P H. Emergency pre-hospital management of patients admitted with acute asthma. *Thorax* 2000; 55:97-101.
7. Reid J, Marciniuk D D, Cockcroft D W. Asthma management in the emergency department. *Can Respir J* 2000; 7:255-60.
8. Stey C, Obrenovic R, Vetter W, Steurer J. Assessment and management of asthma at the emergency department: are guidelines implemented [abstract]? *Eur Respir J* 2001; 18:A428.
9. Salmeron S, Liard R, Elkharrat D, Muir J F, Neukirch F, Ellrodt A, et al. Asthma severity and adequacy of management in accident and emergency departments in France: a prospective study. *Lancet* 2001; 358:629-35.
10. Tattersfield A E, Harrison T W. Exacerbations of asthma—still room for improvement. *Lancet* 2001; 358:599-600.
11. Parameswaran K, Belda J, Rowe B H. Addition of intravenous aminophylline to β_2 -agonists in adults with acute asthma. *Cochrane Database Syst Rev* 2000; 4:CD002742.
12. Rowe B H, Spooner C. Early emergency department treatment of acute asthma with systemic corticosteroids. *Cochrane Database Syst Rev* 2000; 2:CD002178.
13. Rodrigo G, Rodrigo C. Corticosteroids in the emergency department therapy of acute adult asthma: an evidence-based evaluation. *Chest* 1999; 116:285-95.
14. Plotnick L H, Ducharme F M. Should inhaled anticholinergics be added to β_2 -agonists for treating acute childhood and adolescent asthma? A systematic review. *BMJ* 1998; 317:971-7.
15. Rodrigo G, Rodrigo C, Burschtin O. A meta-analysis of the effects of ipratropium bromide in adults with acute asthma. *Am J Med* 1999; 107:363-70.
16. Aaron S D. The use of ipratropium bromide for the management of acute asthma exacerbation in adults and children: a systematic review. *J Asthma* 2001; 38:521-30.
17. Rowe B H, Bretzlaff J A, Bourdon C, Bota G W, Camargo C A Jr. Intravenous magnesium sulfate treatment for acute asthma in the emergency department: a systematic review of the literature. *Ann Emerg Med* 2000; 36:181-90.
18. Rodrigo G, Rodrigo C, Burschtin O. Efficacy of magnesium sulfate in acute adult asthma: a meta-analysis of randomized trials. *Am J Emerg Med* 2000; 18:216-21.
19. Cydulka R K, McFadden E R Jr, Emermasn C L, Sivinski L D, Pisanelli W, Rimm A A. Patterns of hospitalisation in elderly patients with asthma and COPD. *Am J Respir Crit Care Med* 1997; 156:1807-12.
20. Lee K H, Chin N K, Lim T K. Asthma in the elderly—a more severe disease. *Singapore Med J* 2000; 41:579-81.
21. Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention. NHLBI/WHO Workshop Report. Bethesda: National Institutes of Health, 1995.
22. Abramson M J, Bailey M J, Couper F J, Driver J S, Drumer O H, Forbes A B, et al. Are asthma medications and medication related to deaths from asthma? *Am J Respir Crit Care Med* 2001; 163:12-8.
23. Singh A K, Cydulka R K, Stahmer S A, Woodruff P G, Camargo C A Jr, for the Multicenter Asthma Research Collaboration Investigators. Sex differences among adults presenting to the emergency department with acute asthma. *Arch Intern Med* 1999; 159:1237-43.
24. Abisheganaden J, Ng S B, Lam K N, Lim T K. Peak expiratory flow rate guided protocol did not improve outcome in emergency room asthma. *Singapore Med J* 1998; 39:479-84.