Management of Acute Asthma in Southeast Asian Tertiary Care.

MAU-ERN POH (ernestpoh@gmail.com)
University of Malaya Faculty of Medicine https://orcid.org/0000-0003-0971-2795
SUNDARI AMPIKAIPAKAN
Pantai Hospital Kuala Lumpur
CHONG-KIN LIAM
University of Malaya Faculty of Medicine
CHEE-SHEE CHAI
Universiti Malaysia Sarawak
DEVENTHARI RAMANAIDOO
University of Malaya Faculty of Medicine
HELMY HAJA MYDIN
Pantai Hospital Kuala Lumpur

Research

Keywords: Acute care, Asian, asthma, international guidelines, management

Posted Date: June 10th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-34318/v1

Abstract

Background:

There have been limited reports looking into acute asthma care for patients admitted to tertiary hospitals in Southeast Asia. This study aims to determine the extent in which the 2019 Global Initiative for Asthma (GINA) guidelines were being met. It highlights aspects of excellent clinical management and areas requiring improvement.

Methods:

A cross-sectional prospective study of patients with acute asthma exacerbations admitted to the University of Malaya Medical Centre (UMMC) and Pantai Hospital Kuala Lumpur (PHKL), Malaysia from 1st July 2019 to 31st December 2019.

Results:

Of 172 patients admitted, 67.4% were females. There was proper documentation of asthma control assessment (100%), baseline controller and reliever medications (100%), peak expiratory flow measurements (78%), and inhaler technique review (69.8%). However, there was poor documentation of written asthma action plans (25%).

51.2% had not been admitted in the previous year. At baseline, 90% of patients had been prescribed inhaled corticosteroid (ICS). However, 40.5% of patients were not compliant with controller medications. Based on the GINA assessment for asthma control, 68% had uncontrolled asthma.

While 91.9% of patients had a previous diagnosis of asthma, only 48.8% of patients had objective testing to support the diagnosis. All patients with newly-diagnosed asthma (8.1%) were commenced on a corticosteroid-containing-inhaler.

Conclusion:

Although acute asthma management in tertiary hospitals in Southeast Asia is relatively congruous with international guidelines, there is room for improvement. As the majority of patients found to have uncontrolled asthma were non-compliant with their controller medications, efforts to increase awareness on the perils of uncontrolled asthma is warranted.

Background:

Bronchial asthma (BA) is defined by the presence of respiratory symptoms such as wheeze, shortness of breath, chest tightness and cough, together with variable expiratory airflow limitation.[1] The global prevalence of asthma is projected to increase to more than 400 million by 2025, expected in part due to a large proportion of the world's population living in urban areas by this time.[2]

In Southeast Asia, asthma is among the commonest non-communicable disease.[3] More than 73% of outpatient health clinic visits are for respiratory symptoms, among which many are asthma-related.[4] According to the National Health and Morbidity Survey in 2011, the national prevalence of self-reported, doctor-diagnosed asthma in Malaysia was 6.4%.[5] It is estimated that there are about 1.6 to 2 million patients with asthma in Malaysia.[6] Of the asthma cases, 9.9% and 2.7% were of moderate and severe grades that required hospitalization, respectively.[6] Each acute asthma attack lasted for about 3.7–4.6 days. This translates into loss of productivity and quality of life for 2.4 days per episode.[6]

Many countries have formulated and published their own asthma management guidelines to improve overall asthma care. Nevertheless, evidence from countries such as Sweden, Australia, Pakistan, Egypt and Taiwan indicate that clinical practice guidelines are not necessarily adhered to despite their availability.[7–11]

Although international guidelines are available, the awareness towards acute asthma management may be lacking and real-world data is necessary to look at differing management towards improving the standard of care in individual countries based on local practices. In the regional setting, the GINA guidelines are well known and hence, the standards of this study were drawn from the 2019 version.

This study aims to evaluate the quality of care of patients presented to emergency department of two tertiary centers for acute asthma exacerbations, which include the initial assessment, management and discharge arrangements.

Methods:

This prospective cross-sectional study included all adult patients admitted to University Malaya Medical Centre (UMMC) and Pantai Hospital Kuala Lumpur (PHKL) for acute asthma during the period of 1st July 2019 to 31st December 2019. For patients with recurrent admissions, only the first admission for asthma exacerbation during the study period was analysed.

A patient with asthma was defined by having a history of respiratory symptoms such as wheeze, shortness of breath, chest tightness and cough that vary over time and in intensity, together with variable expiratory airflow limitation, as documented by a spirometry with bronchodilator reversibility testing.[1]

An asthma exacerbation was an acute or sub-acute worsening in respiratory symptoms and lung function from the patient's usual state, and in some cases, a patient may present for the first time during an acute exacerbation.[1]

All adults aged 18 years and above with a prior documented diagnosis of asthma by a physician were eligible for inclusion. Patients without a prior objective spirometry demonstrating reversible expiratory airflow limitation were included if they had the diagnosis confirmed by spirometry testing upon discharge or on follow-up in the outpatient clinic. Patients with newly diagnosed asthma who first presented with an

acute exacerbation were also included provided the diagnosis was confirmed in a similar manner. Patients who did not fulfil these criteria were excluded.

Instructions and data capture forms were made available at both hospitals before the start of the study, and data entry was via the secure online Google form.

The data capture form included questions to assess asthma control within the last 4 weeks according to the GINA guidelines prior to the current exacerbation requiring hospital admission.[1] Patients were also characterized by the treatment step that they were placed under prior to the exacerbation according to GINA guidelines, namely Step 1 to Step 5.[1] Smoking status were defined by the Centers for Disease Control and Prevention (CDC), 2017.[12] A patient was deemed compliant to treatment if they comply to daily controller medications as recommended by GINA according to the preferred controller medications for Step 2 to Step 5.

The assessment was carried out with the performance indicators set based on the management of asthma exacerbations in the acute care setting found in the 2019 GINA guidelines. These included:

1. Assessment of severity from the history, degree of dyspnea, respiratory rate, pulse rate, oxygen saturation and lung function, while starting short-acting $beta_2$-agonist (SABA) and oxygen therapy.
2. Arrangement for immediate transfer to intensive care if the patient was drowsy, confused, or had a silent chest.
3. Starting treatment with repeated administration of SABA, early introduction of oral corticosteroids, and controlled flow oxygen.
4. Review of response of symptoms, oxygen saturation and lung function after 1 hour. Consideration of intravenous magnesium sulfate for patients with severe exacerbations not responding to initial treatment.
5. Arrangement for ongoing treatment before the patient was discharged home. This should include starting controller treatment or stepping up the dose of the existing controller treatment for two to four weeks and reducing reliever medication to as-needed use.
6. Arrangement for a follow-up appointment within one week of discharge. This should include addressing medications, inhaler skills and written asthma action plan.

Descriptive analysis was performed on participants' sociodemographic details and asthma-related variables. These values were presented as mean ± standard deviation (SD) for continuous variables and number (percentage) for categorical variables. Initial data entry was cross-checked by two independent individuals to ensure correct data entry. Before each analysis, data were again checked for consistency. All computations including mean and standard deviation (SD) were made using statistical SPSS software (Statistical Package for the Social Sciences) programme version 25 (Chicago, IL, USA).

The study was granted ethical clearance by the medical ethics review boards of both institutions (MECID No: 2018725-6524),

Results:

A. Sociodemographic and clinical characteristics of patients:

Table 1
Sociodemographic characteristics of patients

Characteristic	No. of patients, N = 172
Gender, N (%)	56 (32.6)
Male	116 (67.4)
Female	
Age group (years)	32 (18.6%)
18–30	34 (19.8%)
31–40	20 (11.6%)
41–50	26 (15.2%)
51–60	60 (34.9%)
> 60	
Ethnicity, N (%)	80 (46.5)
Malay	62 (36.0)
Indian	18 (10.5)
Chinese	12 (7.0)
Others	
Level of education, N (%)	70 (40.7)
Primary	74 (43.0)
Secondary	28 (16.3)
Tertiary	
Smoking status, N (%)	144 (83.7)
Never smoker	18 (10.5%)
Current smoker	10 (5.8%)
Former smoker	

Characteristic	No. of patients, N = 172
Co-morbidities, N (%)	65 (37.8)
No	107 (62.2)
Yes	*72 (67.3)*
Hypertension	*6 (5.6)*
Atrial fibrillation	*12 (11.2)*
Ischaemic heart disease	*8 (7.5)*
Depression / Anxiety disorder	*16 (15.0)*
Gastro-oesophageal reflux disease (GERD)	*4 (3.7)*
Cancer	*40 (37.4)*
Diabetes mellitus	*22 (20.6)*
Dyslipidaemia	*2 (18.7)*
Obstructive sleep apneoa syndrome	*8 (7.5)*
Osteoporosis	*8 (7.5)*
Chronic kidney disease	*54 (31.4)*
Atopy	
Atopy	118 (68.6)
No	54 (31.4)
Yes	
Previous admission for asthma, N (%)	16 (9.3)
None	12 (6.9)
Within 1 month	28 (16.3)
Between 1 to 3 months ago	28 (16.3)
More than 3 but less than 12 months ago	88 (51.2)
More than 12 months ago	
Previous ICU admission for asthma, N (%)	160 (93.0)
No	12 (7.0)
Yes	

Table 1 shows the sociodemographic characteristics of the patients. A total of 172 patients were admitted for acute asthma exacerbation during the study period with a female preponderance (67.4%).

46.5% of patients were of Malay ethnicity, 36% were Indian, 10.5% were Chinese and the remainder 7% were from other ethnic pribumis of Sabah and Sarawak. 18% of patients were current smokers and 10% were former-smokers.

There were significant numbers of patients with previous admissions for asthma in both centres. Twelve (6.9%) patients were re-admitted within one month of discharge for asthma exacerbation. Of these twelve patients, five of them admitted to not fully recovering from the previous admission, whereas another seven had a new trigger precipitating the exacerbation.

Twenty-eight (16.3%) patients were admitted between one to three months whilst another twenty-eight (16.3%) patients had been admitted between three months and one year. Twelve (7.0%) patients had previously been admitted to intensive care unit (ICU) for their asthma. The majority of patients either had not been admitted in the previous year (51.2%) or had no previous admission (9.3%).

Table 2
Clinical characteristics of patients

	No. of patients **N = 172**
Assessment of asthma control before exacerbation, N (%)	11 (6.4)
Well controlled	44 (25.6)
Partially controlled	117 (68.0)
Uncontrolled	
Diagnosis of asthma pre-admission, N (%)	158 (91.9)
Yes	14 (8.1)
No	
Evidence of prior objective assessment, N (%)	84 (48.8)
Yes	88 (51.2)
No	
Spirometry values, mean ± SD, **(% predicted)**	66.7 ± 20.9
FEV_1	69.6 ± 17.6
FVC	

	No. of patients N = 172
Treatment prescribed prior to exacerbation, N (%)	24 (14.0)
GINA step 1:	*18 (75.0)*
As needed short-acting beta$_2$-agonist (SABA) only	*6 (25.0)*
As-needed low dose inhaled corticosteroids (ICS) -formoterol	12 (7.0)
GINA step 2:	*10 (83.3)*
Low dose inhaled ICS with as-needed SABA	*2 (16.7)*
Leukotriene receptor antagonist (LRTA) only	86 (50.0)
GINA step 3:	*46 (53.5)*
Low dose ICS-long acting beta$_2$-agonist (LABA) with as-needed SABA	*28 (32.6)*
Low dose ICS-formoterol with as-needed ICS-formoterol	*12 (13.9)*
Low dose ICS and LRTA	48 (27.8)
GINA step 4:	*36 (75.0)*
Medium dose ICS-LABA with as-needed SABA	*12 (25.0)*
Medium dose ICS-LABA with Tiotropium and LRTA	2 (1.2)
GINA step 5:	1 (100)
Add-on anti-IgE	
Compliance to treatment (excluding GINA step 1), N (%)	**N = 148**
Yes	88 (59.5)
No	60 (40.5)
Reported main triggers, N (%)	18 (10.5)
No trigger identifiable	86 (50.0)
Upper respiratory tract infection	68 (39.5)
Haze	

Table 2 shows important clinical information on asthma collected upon presentation to the emergency department at both hospitals. Based on the GINA assessment for control, only 6.4% of patients were deemed to have good control of their asthma while asthma was partially controlled in 25.6% and uncontrolled in 68%.

There was evidence of a previous diagnosis of asthma in 91.9% of patients. However, documentation of reversible expiratory airflow limitation by spirometry to support the diagnosis was only available in approximately half of the patients (48.8%). The remaining patients' asthma were confirmed by spirometry on follow-up after the acute episode. Pooling the spirometry results of all 172 patients together, the patients had a mean FEV_1 of 66.7% predicted and FVC of 69.6% predicted.

Approximately 40.5% of patients on GINA treatment step two to four who were admitted with acute asthma did not comply to daily controller medications despite being prescribed an inhaled corticosteroid (ICS) previously.

B. Management of asthma exacerbation

Table 3
Management in hospital

	No. of patients, N = 172
PEFR on initial assessment, N (%)	134 (77.9)
Yes	38 (22.1)
No	
Oxygen saturation at presentation, mean ± SD, (%)	95 + 2.9
Systemic corticosteroids (CS), N (%)	172 (100)
Yes	0
No	
Regular nebulized bronchodilators, N (%)	172 (100)
Yes	0
No	
Length of hospital stay, mean ± SD (days)	4 ± 1.5
Critical care team review, N (%)	58 (33.7)
Yes	114 (66.3)
No	
Admission to intensive care unit (ICU), N (%)	152 (88.4)
No	20 (11.6)
Yes	*5 (25.0)*
Invasive mechanical ventilation	*15 (75.0)*
No invasive mechanical ventilation	
Mean length of ICU stay, mean + SD (days)*	4 ± 1.5
Total hospital stay, mean ± SD (days)*	8 ± 2

*For those with ICU admission only

Table 3 highlights important aspects of management upon presentation to the emergency department of both hospitals.

First peak expiratory flow (PEF) was recorded as part of initial assessment in 78% of cases amongst patients that were not intubated and were not confused upon presentation. Sixty-eight (39.5%) patients had oxygen saturations lower than 95% on room air. Supplemental oxygen was administered to all of

these patients. Of these, twenty (11.6%) patients went on to have an arterial blood gas (ABG) analysis when they were deemed not responding or were deteriorating despite initial treatment. Of those with their ABG analysed, five (25.0%) patients had hypercapnia. These patients were admitted to the ICU and received invasive mechanical ventilation.

Systemic corticosteroids were given in all patients admitted at both centres within one hour of arrival at the emergency department.

The length of hospitalization was variable with a mean stay of 4 days. For patients not admitted to the ICU, the longest stay was 10 days. A significant proportion of patients (33.7%) were reviewed by a member of the critical care team. Twenty patients were admitted to the ICU and five patients required tracheal intubation and mechanical ventilation. Of these patients admitted to the ICU, all received intravenous magnesium sulphate. The mean length of stay in the ICU was 4 days, the longest was 10 days.

C. Discharge from hospital

Table 4
Discharge plans

	No. of patients, N = 172
PEFR upon discharge, N (%)	172 (100)
Yes	0 (0)
No	
Discharged on ICS therapy, N (%)	172 (100)
Yes	0 (0)
No	
Inhaler technique review, N (%)	120 (69.8)
Yes	52 (30.2)
No	
Written personal asthma action plan, N (%)	43 (25)
Yes	129 (75)
No	

Pre-discharge peak flow was performed in all (100%) patients at both centres. All newly-diagnosed asthmatics were discharged on ICS therapy, as recommended by GINA. Of those non-adherent to previously prescribed treatment, the reasons for poor adherence were discussed and addressed. 78% of

patients were sent home on oral corticosteroids. The remaining 22% completed five days of systemic corticosteroids during hospitalization.

Prior to discharge, inhaler technique review was completed in 69.8% of cases. Amongst patients who were on a pressurized metered-dose inhaler (pMDI) and had their inhaler technique checked, only 58% had good inhaler technique when using the pMDI. Reassuringly, majority of patients improved either by education or by supplementation of a spacer prior to discharge and only 5% required a change to a dry powder inhaler.

A written personal asthma action plan was only provided to 25% of patients. Most were verbally communicated and triggers and exacerbating factors discussed without actual provision of a written action plan.

A clinic review appointment was scheduled in all patients at both centres with a mean follow-up appointment of 2 weeks after discharge. There were no deaths recorded for acute asthma during the study period.

Discussion:

To our knowledge, this is the first study focusing on the quality and organization of acute asthma management in tertiary centres in Southeast Asia. The Asthma Insights and Reality in Asia-Pacific (AIRIAP) survey in 2000 is the only regional survey to date reporting asthma severity and management in the urban centres of eight areas of the Asia-Pacific regions.[13–14] The survey highlighted only 13.6% of respondents were using ICS as a controller medication despite almost half of the respondents meeting the criteria for persistent asthma.[13]

The Asthma Insight and Management (AIM) study from 2009 to 2011 also reported a lack of knowledge and conviction for treatment recommendations across Asia-Pacific regions despite having persistent asthma.[15] Amongst 413 Malaysians included in this study, 22% of patients reported daytime symptoms, 24% of patients reported night-time symptoms, and 42% required an emergency visit for treatment of acute asthma within the previous year.[15]

The presence of haze during the study period could be a confounding factor. This is a trans-boundary increase in air pollution caused mainly by forest and peatlands' fire affecting countries in Southeast Asia that was particularly severe in the months of August and September 2019.[16] The haze comprises of high concentration of particulate matter, predominantly less than 2.5 microns in size (PM2.5) that are sufficiently small enough to penetrate deep into the respiratory tract.[17] Approximately 39.5% of patients developed an acute exacerbation triggered by haze. More than half of the admissions due to acute asthma were recorded in these two months. Increases in respiratory admissions have also been documented in Malaysia during the Southeast Asia haze in 2014 and 2015.[18] Furthermore, neighbouring country Singapore documented a 20% increase in hospitalisations for asthma during the haze.[19]

GINA recommends assessment of clinical status and lung function one hour after commencement of treatment to guide the need for hospitalisation.[20–21] These admission criteria includes pre-treatment FEV_1 or PEF < 25% predicted or personal best; or post-treatment FEV_1 or PEF < 40% predicted or personal best.[22] For our cohort, the first PEF was only performed in 77.9%. The PEF measurement informs the decision to admit and is an objective variable in assessing a patient for severity and subsequent treatment. Further work is required in acute areas of busy tertiary hospitals to ensure that a simple PEF measurement is carried out as part of an acute asthma assessment.

Pre-discharge PEF was performed in all patients at both centres. GINA recommends discharge if post-treatment PEF is > 60% predicted or personal best. As an important indicator of stability prior to discharge, this figure reflects the quality of care at both centres.

Approximately 40.5% of patients on GINA treatment step 2–4 refused to comply with daily controller medications, which is a robust predictor of future risk of developing near fatal or fatal asthma. This is consistent with the findings of the AIRIAP study.[14] Again, this highlights the importance of intervention with education and a clear asthma management plan on discharge emphasising the importance of ICS use.

Upon discharge, inhaler technique review was completed in only 69.8% of cases. From these, only 58% had good inhaler technique when reviewed. Studies have demonstrated that instruction by health care providers on correct metered-dose inhaler use is a modifiable factor for reducing incorrect inhaler technique.[23]

A clinic review appointment was scheduled in all patients at both centres at a mean duration of two weeks upon discharge. GINA recommends a follow-up appointment within two days of discharge with the patient's usual health care provider to ensure continuity of treatment. Unfortunately, this is very difficult to achieve within the context of many Southeast Asian healthcare system. Malaysia differs from other countries in the region such as Indonesia and the Philippines in that it does not have an administratively decentralized public sector health care system.[24] Most primary health care in urban areas are provided by the private sector.[24] Thus, the scheduling of follow-up visits cannot reach guidelines recommendation due to inadequate capacity in the public primary care system whilst private primary care can be costly. More efforts need to be placed on decongesting specialist respiratory clinics at the tertiary level to allow more severe cases to be seen in a shorter timeframe.

There were limitations in this study. Firstly, only two tertiary centres were selected to be part of this study, which may not be fully representative of asthmatic care in the region. Secondly, this study also assessed documentation of care as a proxy for actual care, which could have led to an over-, or underestimation of the quality of care actually offered.

Conclusion

Despite the availability of global recommendations, there is room for considerable improvement in acute asthma care in Southeast Asia. The study provides useful and important information for health care planners for policy implementation as well as evaluation of health care services regionally. As the majority of patients found to have uncontrolled asthma were non-compliant with their controller medications, further education to increase awareness on the perils of uncontrolled asthma is warranted.

Declarations

Ethics Approval and consent to participate

The study was granted ethical clearance by the medical ethics review boards of both institutions (MECID No: 2018725-6524). Patients recruited for the study consented for data to be analysed without any identifying information.

Consent for publication

Patients recruited for the study consented for publication without any identifying information.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

Not applicable

Authors' contributions

MEP, SA and HHM were involved in conceptualization of the research. MEP, SA, HHM and DR were involved with data curation. MEP, SA, DR and CSC analysed and interpreted the datasets. MEP, SA, CKL, CSC and HHM contributed to the writing of the manuscript. All authors read and approved the final manuscript.

Acknowledgements

None

References

1. Global Initiative for Asthma (GINA). Global strategy for asthma management and prevention, 2019.

https://ginasthma.org/wp-content/uploads/2019/06/GINA-2019-main-report-June-2019-wms.pdf

2. World Health Organization (WHO). Global surveillance, prevention, and control of chronic respiratory diseases: a comprehensive approach, 2007. https://www.who.int/gard/publications/GARD%20Book%202007.pdf

3. Bahari MB, Mohd Nur M, Rahman FAB. A knowledge of asthma in school children: A survey among primary school teachers. Singapore Med J 2003; 44: 131-35.

4. Rozlan I. The study on asthma admissions in Malaysia. Disease Control Division (NCD), Ministry of Health Malaysia 2002; 1: 10-17.

5. Ministry of Health, Malaysia. National health and morbidity survey: Healthcare demand and out-of-pocket health expenditure, 2011.

http://iku.moh.gov.my/images/IKU/Document/REPORT/NHMS2011-VolumeIII.pdf

6. Bakri R, Mohd Said N, Mohan J, et al. Ministry of Health, Malaysia. National Health and Morbidity Survey, 1999.

7. Jonsson M, Egmar AC, Kiessling A, et al. Adherence to national guidelines for children with asthma at primary health centres in Sweden: potential for improvement. PrimCare Respir J. 2012; 21: 276– 282.

8. Barton C, Proudfoot J, Amoroso C, et al. Management of asthma in Australian general practice: care is still not in line with clinical practice guidelines. Prim Care Respir J. 2009; 18: 100– 105.

9. Hussain SF, Zahid S, Khan JA, et al. Asthma management by general practitioners in Pakistan. Int J Tuberc Lung Dis. 2004; 8: 414–417.

10. Salama AA, Mohammed AA, El Okda el SE, et al. Quality of care of Egyptian asthmatic children: clinicians adherence to asthma guidelines. Ital J Pediatr. 2010: 21; 36: 33.

11. Yeh KW, Chiang LC, Chen SH, et al. Survey of the clinical practice of physicians in the management of asthma in Taiwan. Asian Pac J Allergy Immunol. 2006; 24: 1– 8.

12. Adult tobacco use information. National Center for Health Statistics, Centers for Disease Control and Prevention (CDC), 2017. https://www.cdc.gov/nchs/nhis/tobacco/tobacco_glossary.htm

13. Lai CKW, Guia TS, Kim YY, Kuo SH, Mukhopadhyay A, Soriano J, Trung PL, Zhong NS, Zainudin N, Zainudin BMZ. Asthma control in the Asia-Pacific region: the asthma insights and reality in Asia-Pacific study. Journal of allergy and clinical immunology 2003; 111:263.268.

14. Zainudin BM, Lai CKW, Soriano JB, Jia-Horng W, Guia TS, Asthma Insights and Reality in Asia-Pacific (AIRIAP) Steering Committee. Asthma control in adults in Asia-Pacific. Respirology 2005; 10:579-586.

15. Nathan RA, Thompson PJ, Price D, Fabbri LM, Salvi S, Gonzalez-Diaz S, Maspero JF, Cantu M, Fish JE, Murphy K. Taking aim at asthma around the world: Global results of the Asthma Insight and Management Survey in the Asia Pacific Region, Latin America, Europe, Canada, and the United States. The Journal of Allergy and Clinical Immunology 2015; 3:734-742.

16. Cheong KH, Ngiam NJ, Morgan GG, Pek PP, Tan BYQ, Lai JW, Koh JM, Ong MEH, Ho AFW. Acute health impacts of the Southeast Asian transboundary haze problem – a review. Int J Environ Res Public Health 2019; 16: 3286.

17. Pavagadhi S, Betha R, Venkatesan S, Balasubramaniam R, Hande MP. Physicochemical and toxicological characteristics of urban aerosols during a recent Indonesian biomass burning episode. Environ Sci Pollut Res 2013; 20: 2569 -2568.

18. Ming CR, Ban AYL, Abdul Hamid MF, T. Latif M., Mohammad N, Hassan T. Annual Southeast Asia haze increases respiratory admissions: A 2-year large single institution experience. Respirology 2018; 23: 914-920.

19. Chew F.T., Ooi B.C., Hui J.K., Saharom R., Goh D.Y., Lee B.W. Singapore's haze and acute asthma in children. Lancet (London, England) 1995;346:1427. doi: 10.1016/S0140-6736(95)92443-4.

20. Kelly AM, Kerr D, Powell C. Is severity assessment after one hour of treatment better for predicting the need for admission in acute asthma? Respir Med 2004; 98: 777-781.

21. Wilson MM, Irwin RS, Connolly AE, et al. A prospective evaluation of the 1-hour decision point for admission versus discharge in acute asthma. J Intensive Care Med 2003; 18:275-285.

22. Grunfeld A, Fitzgerald J. Discharge considerations for adult asthmatic patients treated in emergency departments. Can Respir J 1996; 3: 322-327.

23. Melani AS, Bonavia M, Cilenti V, et al. Inhaler mishandling remains common in real life and is associated with reduced disease control. Respir Med. 2011; 105: 930– 938.

24. World Health Organization. Malaysian health system review. Health Systems in Transition 2012;2:1.