# ORIGINAL ARTICLE

# Paediatric asthma clinical pathway: Impact on cost and quality of care

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## ABSTRACT

**INTRODUCTION:** Uncontrolled asthma may cause an increase in healthcare utilisation, hospital admission and productivity loss. With the increasing burden of asthma in Malaysia, strategies aimed at reducing cost of care should be explored. **OBJECTIVE:** This study aims to determine if a clinical pathway (CPW) for inpatient paediatric asthma would reduce average length of stay (ALOS), improve asthma management and decrease cost.

**METHODS:** A quasi-experimental, pre-post study was used to evaluate the CPW effectiveness. Paediatric inpatients aged 5-18 years old, admitted for acute asthma exacerbation from September 2015 to April 2016 were prospectively recruited. Data from patients admitted from January-July 2015 were used as control. CPW training was carried out in August 2015 using standardised modules. Direct admission cost from the provider's prospective was calculated. Outcomes compared were differences in ALOS, discharge medication, readmission within 28 days of discharge and cost.

**RESULTS:** ALOS is 26 hours lower in the CPW group for severe exacerbations and underlying uncontrolled asthma (19.2 hours) which is clinically significant as patients have shorter hospital stay. More newly-diagnosed intermittent asthmatics were discharged with relievers in the CPW group (p-value 0.006). None of the patients in the CPW group had readmissions (p-value 0.16). Mean treatment cost for patients in the intervention group is higher at RM843.39 (SD ±48.99, versus RM779.21 SD±44.33).

**CONCLUSION:** This study found that management using a CPW may benefit asthmatic patients with uncontrolled asthma admitted with severe exacerbation. Further studies will be needed to explore CPW's impact on asthma management starting from the emergency department.

## INTRODUCTION

Asthma is a common chronic respiratory condition in childhood. Globally, the prevalence of asthma in children varies between countries, from 5.0% in Albania to 37.6% in Costa Rica.[1] The estimated prevalence of asthma in Malaysia in children aged 6-7 years is at 5.8% and 8.9% in children aged 13-14 years, similar to that in South Korea.[1]

The burden of asthma can be life long, thus justifying the importance of achieving good asthma control from childhood. Poorly controlled asthma leads to frequent hospitalisations, increased clinic visits, school absenteeism, and loss of productivity for carers due to acute exacerbations. Based on Asthma Insights and Reality in Asia Pacific (AIRIAP) Phase II study, 53.4% of patients less than 16 years old in Asia had uncontrolled asthma.[2]

Annual per patient direct costs for asthma management ranges from US\$108 for Malaysia to US\$1,001 for Hong Kong, where acute care accounted for 63% of total per patient direct costs in Malaysia, compared to 18% in Philippines and 89% in Hong Kong.[3] Optimal management of asthma can help control the disorder, thus enabling asthma patients to have better quality of life and avoid medical costs from clinic or emergency visits as well as hospitalisations.

Many guidelines are available as decision aids for asthma management. The Malaysian Clinical Practice Guidelines for the Management of Childhood Asthma that was revised in 2014, presents a consensus of evidence-based management in an effort to ensure optimum management. However, adherence to the guidelines remains a challenge. Highest reported barriers to the compliance to clinical practice guidelines (CPG) include insufficient time to consult CPGs and inconvenience of CPG retrieval during point of care.[4] Thus, the availability of decision-making aids in suitable formats would ensure timely, appropriate and effective management.

CPGs can be embedded in clinical pathways (CPW), that are detailed, structured, multidisciplinary care plans that contextualises evidence-based treatment options in the local context. Ultimately this will standardise the care given for a specific health problem in a specific population.[5] The CPW aims to link evidence to practice and optimise clinical outcomes whilst maximising clinical efficiency. Previous studies on paediatric asthma CPWs were heterogeneous, from the study setting, intervention design and measured outcomes. A 2014 systematic review found that hospital-based paediatric asthma CPWs may be effective in decreasing hospital stay, however, there is limited evidence on the reduction of cost and the number of readmissions.[6]

Majority of studies that utilised CPWs in the emergency department showed non-significant results in the measured outcomes.[7,8] On the other hand, Norton et al. showed lower hospitalisation rate and higher administration of oral corticosteroid in moderate to severe exacerbation and increased number of patients getting β2-agonists within an hour of presentation.[9] Studies in the hospital setting in the United States showed significant improvement in the average length of stay (ALOS), however, there were mixed findings on significant reduction in hospital cost and re-admission.[10-13] In terms of sustainability of outcomes, a three-year evaluation of an inpatient paediatric CPW found progressive reduction in ALOS and cost.[14] In contrast, a more recent study showed progressively decreasing ALOS with no significant fluctuation in cost over a similar implementation period.[13]

Since evidence showed an increase in asthma prevalence and its significant economic burden, strategies aimed at reducing cost of care should be explored and investigated, particularly in the context of Malaysian healthcare system.[3,15,16] Besides increasing conformity to guidelines, CPWs help in decision-making and also improve agreement between physicians about treatment options.[17]

This study aims to determine if a CPW developed and executed in the paediatric asthma inpatient management in Hospital Taiping would reduce the direct admission cost and improve selected outcome measures as proxies for quality of care, that includes ALOS, discharge medication prescribed for patients with newly-diagnosed asthma in accordance with the Malaysian CPG for the Management of Childhood Asthma Revised 2014 and readmission within 28 days of discharge.

## METHODS AND MATERIALS
### Study Design
A quasi-experimental, pre-post study design was used to evaluate the effectiveness of the CPW for inpatient management of asthma. All inpatients aged 5-18 years old, admitted from September 2015-April 2016 for acute exacerbation in the paediatric ward in Hospital Taiping were included in the study. For the pre-intervention group, retrospective data were collected from January until 31 July 2015 from medical records of patients admitted with asthma (Figure 1). Those with life-threatening asthma requiring ventilator support and intensive care, underlying chronic lung or heart disease, neurological impairment, history of prematurity and those who were transferred to/from other hospitals were excluded.

Sample size was calculated with the aim to lower hospital stay by eight hours (0.3 days).[14] With this aim, using a formula derived by Fleiss, with a power of 0.80 and alpha level of 0.05, the minimum sample size calculated was 150 per group.[18]

### Intervention Development
*Asthma Clinical Pathway*
The CPW was developed in 2014 by a team consisting of paediatric respiratory physicians from all over Malaysia and reviewed by external reviewers consisting of private paediatric respiratory physicians and general paediatricians. The CPW was pre-tested on 50 patients in Hospital Kuala Lumpur and the Universiti Kebangsaan Malaysia Medical Centre. Changes to the CPW were made according to the feedback from medical officers and nurses. A pilot study was then conducted in Hospital Raja Perempuan Zainab II and Hospital Tanah Merah among 17 cases and five cases respectively. Following that, the CPW was revised and pre-tested on five patients in Hospital Kuala Lumpur before implementation.

With the aim to ensure the best practice, the key feature of the CPW was a guided step-by-step inpatient clinical management of asthma from admission to discharge in the paediatric population above the age of five, in accordance with the Malaysian CPG for the Management of Childhood Asthma Revised 2014.[19] The CPW was incorporated into folders of all patients who were admitted for acute asthma exacerbation. It consists of sections on patient assessment, inpatient management and discharge, designed for use by doctors and nurses. The original copy was kept as patients' medical records while the carbon copy, with all identifiers blanked out, was kept in a research file for this study.

### Patient assessment section
The clerking sheet in the CPW provided a guide for comprehensive asthma history-taking, including evaluation of asthma control for those already diagnosed with asthma or evaluation of background asthma severity for newly-diagnosed patients, based on Global Initiative for Asthma (GINA) updated 2009 guidelines.[20] Parameters to assess clinical acute asthma severity based on GINA guidelines were presented in a table with checkboxes.

### Inpatient management section
Severity-based management of acute exacerbation as presented in the CPG algorithm was provided, with specific guides on oxygen supplementation, bronchodilator and systemic steroid dosages, frequency of vital signs observation and re-assessment time period.

Subsequent medical review sections provided guidelines for: 1) frequency of patient assessment; 2) bronchodilator frequency; 3) corticosteroid use if not previously ordered; 4) oxygen supplementation; and 5) consideration for discharge.

**Discharge checklist**
The last section of the CPW consisted of a discharge checklist that ensures education on asthma including assessment of inhaler technique and asthma action plan were given and all criteria for discharge were met.

*Asthma Training Modules*
In order to implement the CPW, a two-day course was conducted at the study site. The training modules were developed by consultant respiratory physicians, that included standardised lectures on asthma, briefing on CPW, pre- and post-quiz, hands-on sessions and role plays. A manual book was produced for distribution to participants.

Pre-testing of the training modules was conducted in a workshop from the 24-25 May 2014 at Hospital Raja Perempuan Zainab II (HRPZ II) with participants from all levels of healthcare providers including nurses, house officers, medical officers and specialists from HRPZ II, Hospital Gua Musang, Hospital Tumpat, Hospital Jeli, Hospital Kuala Krai, Hospital Machang and Hospital Tanah Merah. The effectiveness of the training was assessed using a pre- and post-workshop questionnaire. The modules did not require any amendments as it was well-accepted during the pilot study.

**Implementation of instruments**
*Study setting*
Hospital Taiping was chosen as the study site. It is the second largest hospital in the state of Perak, and acts as a reference hospital in the northern zone of Perak which consists of Kerian and Selama districts. It is a 608-bedded facility which had a total of 41,805 admissions in the year 2015. The paediatric department in the hospital has 71 beds, led by general paediatricians and had no paediatric respiratory physician.

*Implementation*
Prior to the implementation of the CPW, a training-of-trainer workshop was conducted in August 2015 using the training modules developed, attended by fifty healthcare providers consisting of paediatricians, medical officers, house officers and nurses who were involved in managing asthma patients. Patients admitted from 1-31 August 2015 were omitted from the study as it was considered the washout period. Inpatient management was carried out guided by the CPW document from September 2015 for a period of seven months. All patients diagnosed with asthma on admission would then have the CPW document in their patient folders. The research team also provided asthma action plan sheets which was completed and discussed with patients prior to discharge.

**Outcome measures**
*Quality of care*
The outcomes measured in this study were the ALOS in hours, proportion of patients with newly diagnosed persistent asthma who had been discharged with a controller medication, proportion of newly diagnosed intermittent asthma patients discharged with a reliever medication and proportion of re-admission within 28 days of discharge. These outcomes were selected as proxies of quality of care in the management of asthma in this study as they were easily measurable outcomes of the clinical processes related to the intervention.

Although asthma action plan and asthma education are also important in the management of asthma, they were not measured as outcomes in this study as all the patients who were in the CPW group were given both as part of the discharge checklist. Data on this could not be collected for the pre-intervention group as such details were often not documented in medical records.

Data collection was done using a standardised clinical record form for both groups. All data collected were verified by cross-checking with medical records by researchers. Parents of children in the CPW group were contacted by telephone one month after discharge from hospital to obtain data on readmission for asthma. Readmission for those in the pre-intervention group was determined by looking at hospital medical records.

*Cost*
We calculated cost using direct admission cost for inpatient management from the provider's prospective. This included daily general ward admission costs calculated based on ALOS, laboratory and radiology costs and costs of medication. Overhead costs and cost related to human resource utilised during admission were not included as activity-based costing was not done for this study.

Data on laboratory and radiology investigations done for each patient during admission were collected from the medical folders of patients and medication given during admission were obtained from prescription sheets. Discharge medication cost was calculated based on the drugs listed in the discharge summary for the duration specified.

Hospitalisation cost, diagnostics and laboratory unit costs were calculated using the Fees Order (Medical Cost of Services) 2014 from the Malaysian Federal Government Gazette. Acquisition price for drugs and consumables in 2014 was obtained from the Pharmacy Department of Hospital Taiping.

**Data Analysis**
Differences between the two groups in ALOS, discharge outcomes and cost per hospitalisation (including medication, laboratory and radiology costs) were compared.

Data were analysed using the IBM SPSS Statistics for Windows version 23 (IBM Corp, Armonk, NY). Chi-square test was used to compare categorical data (readmission within 28 days), and t-test was used to compare numerical data (proportion of newly diagnosed patients given appropriate medication and length of stay). All P values are 2-sided and are reported as significant if $p<0.05$.

Cost calculation was done using Microsoft Excel 2013 and bootstrapping was done using R statistical software[21] to report the mean cost of treatment and the 95% confidence intervals.

**Table I: Baseline Characteristics of Groups in the Study**

| Characteristic | Control (n=71) | CPW (n=67) | p-value |
|---|---|---|---|
| **Age (years)** | | | |
| Mean (SD) | 7.37 (1.82) | 7.75 (2.29) | 0.28 |
| | | | |
| **Sex (n, %)** | | | |
| Male | 44, 62% | 39, 58.2% | 0.65 |
| Female | 27, 38% | 28, 41.8% | 0.65 |
| | | | |
| **Ethnicity (n, %)** | | | |
| Malay | 62, 87.3% | 58, 86.6% | 0.57 |
| Indian | 6, 8.4% | 7, 8.5% | 0.73 |
| Chinese | 2, 2.8% | 2, 2.8% | 0.95 |
| Others | 1,1.5% | 0 | 1 |
| | | | |
| **Severity of acute asthma exacerbation (n, %)** | | | |
| Mild | 25, 36.6% | 22, 32.8% | 0.72 |
| Moderate | 41, 57.8% | 43, 64.2% | 0.50 |
| Severe | 4, 5.6% | 2, 3% | 0.44 |
| | | | |
| **Known asthma (n, %)** | 47, 66.2% | 43, 64.2% | 0.06 |
| Controlled | 18, 37% | 18, 41.9% | 0.73 |
| Partly controlled | 19, 43.5% | 11, 25.6% | 0.14 |
| Poorly controlled | 9, 19.6% | 14, 32.6% | 0.15 |
| | | | |
| **Newly diagnosed asthma (n, %)** | 24*, 33.8% | 24, 35.8% | 0.80 |
| Intermittent | 12, 54.2% | 14, 58.3% | 0.67 |
| Mild persistent | 8, 33.3% | 4, 16.7% | 0.15 |
| Moderate persistent | 3, 12.5% | 6, 25% | 0.30 |

*For 1 patient, there was insufficient information in the case notes to determine the underlying asthma severity

**Table II: Average Length of Stay (ALOS) in Hours Between Groups**

| | Control | | CPW | | |
|---|---|---|---|---|---|
| | n | Mean (SD) | n | Mean (SD) | p-value |
| **ALOS by severity (hours)** | | | | | |
| Mild | 25 | 42.0 (24.8) | 22 | 42.6 (17.9) | 0.46 |
| Moderate | 41 | 55.9 (26.9) | 43 | 64.1 (35.7) | 0.41 |
| Severe | 4 | 92.6 (53.3) | 2 | 66.6 (49.6) | 0.64 |
| | | | | | |
| **ALOS by early initiation of steroids (hours)** | | | | | |
| Yes | 59 | 52.7 (28.8) | 51 | 59.9 (34.5) | 0.29 |
| No | 12 | 54.6 (36.4) | 16 | 48.6 (23.7) | 0.85 |
| | | | | | |
| **ALOS by trigger pneumonia (hours)** | | | | | |
| Pneumonia | 30 | 54.2 (26.3) | 24 | 62.7 (30.8) | 0.29 |
| Others | 37 | 53.3 (33.3) | 40 | 54.8 (33.9) | 0.79 |
| | | | | | |
| **ALOS based on asthma control (hours)** | | | | | |
| Uncontrolled | 9 | 81.2 (41.7) | 14 | 62.0 (31.4) | 0.31 |
| Partly controlled | 19 | 53.7 (29.9) | 11 | 59.0 (36.4) | 0.78 |
| Controlled | 18 | 41.5 (26.0) | 18 | 44.5 (29.6) | 0.74 |

**Table III: Cost Comparison (in RM) Based on Known and Newly-diagnosed Asthma**

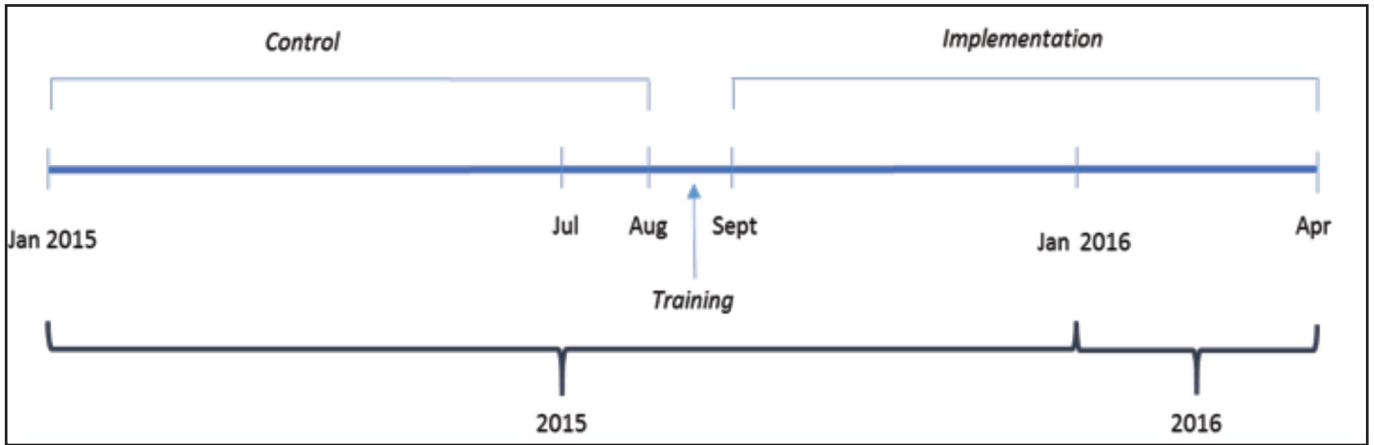| | Control | | | | Clinical Pathway | | | |
|---|---|---|---|---|---|---|---|---|
| | n | Mean | SD | 95% CI | n | Mean | SD | 95% CI |
| **Total cost by asthma category (RM)** | | | | | | | | |
| | | | | | | | | |
| **Known** | 47 | 802.74 | 60.77 | 692.38-929.74 | 43 | 800.84 | 59.84 | 687.84-922.58 |
| Controlled | 18 | 648.14 | 62.49 | 540.76-783.73 | 18 | 679.63 | 79.48 | 551.44-858.35 |
| Partly controlled | 19 | 810.92 | 94.62 | 650.75-1021.87 | 11 | 857.13 | 120.20 | 649.63-1112.29 |
| Uncontrolled | 9 | 1106.34 | 156.44 | 830.67-1437.54 | 14 | 895.65 | 107.68 | 694.69-1111.34 |
| | | | | | | | | |
| **Newly-diagnosed** | 24 | 731.27 | 53.81 | 626.99-837.56 | 24 | 915.34 | 81.44 | 764.88-1085.30 |
| Intermittent | 12 | 698.78 | 69.04 | 580.00-848.01 | 14 | 886.29 | 92.69 | 714.13-1073.97 |
| Mild persistent | 8 | 784.23 | 105.72 | 563.74-971.53 | 4 | 612.67 | 81.80 | 480.15-794.77 |
| Moderate persistent | 3 | 694.68 | 142.78 | 500.80-1046.89 | 6 | 1213.37 | 196.47 | 834.54-1573.72 |

**Fig. 1:** Timeline of Pre-implementation (Control) and Implementation Period.
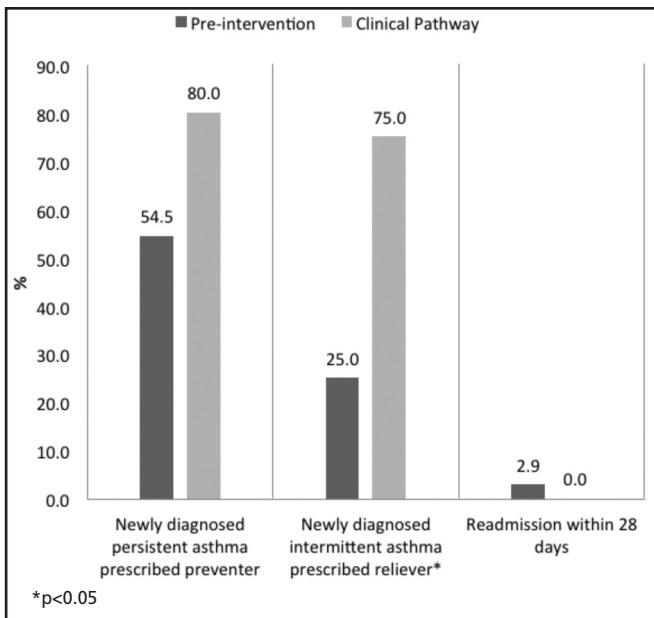


*p<0.05

**Fig. 2:** Comparison of Outcomes between Pre-intervention and Clinical Pathway Group.
Percentages refer to proportion of entire group, either pre-intervention (n=71) or clinical pathway (n=67)

## RESULTS

### Enrolment and Characteristics

The total patients included in the study were 138, with 67 in the CPW group. From the admission records, 152 patients were diagnosed with asthma. Fourteen patients were excluded as their final diagnosis was not asthma (five patients), CPW was not adopted (eight patients) or had life-threatening asthma (one patient).

The sociodemographic and background asthma characteristics of the patients in the study are summarised in Table I.

### Quality of care measures

Table II shows the average length of stay (ALOS) in the groups in hours. Although it was not statistically significant, the ALOS was shorter by 26 hours in the clinical pathway group for severe asthma exacerbation, which was clinically significant as patients spent one day less in the hospital. Similarly, the ALOS for patients with uncontrolled asthma was shorter by 19 hours in the CPW group.

Upon discharge, more patients in the CPW group with persistent asthma were prescribed a preventer and significantly more patients with newly-diagnosed intermittent asthma were given reliever medication (Figure 2). There were two cases (2.9%) in the pre-intervention group and none in the CPW group that had readmission within 28 days of discharge.

### Costing

The mean (SD) cost of treatment for patients in the CPW group was higher at RM843.39 (SD 48.99) versus RM779.21 (SD 44.33), however, the cost difference between the two groups was not statistically significant. The cost driver for both groups was relatively similar, with the main cost driver being the general admission cost that constituted 70% of the total. Twenty per cent of the cost was for diagnostic and laboratory tests, while the least percentage (7%) of cost came from medication provided.

The cost of treatment based on severity assessment of asthma on admission was similar for mild attacks, whereas in the CPW group, the cost was higher by RM97.18, with the mean cost of RM925.66 (SD 65.56) for treatment of moderate asthma; and lower by RM100.69, with the mean cost of RM1143.45 (SD 419.91) in the treatment for severe asthma attacks.

Table III shows the breakdown of the cost by asthma background. The higher cost for treating uncontrolled asthma cases for the pre-intervention group was due to the patients in the group having moderate and severe exacerbations compared to those in the clinical pathway who only had mild and moderate exacerbations.

## DISCUSSION

This study found no significant difference in the length of stay between patients treated using a CPW and the usual care. Our study revealed that the ALOS of paediatric asthma prior to the implementation of the CPW was 2.2 days. This is

consistent with studies from other countries.[22,23] Review of the available literature on the impact of a CPW in the management of inpatient asthma shows reduction in the ALOS for those with ALOS of more than 2.5 days in the control groups.[10,11,14] Stratified according to their asthma control, patients with uncontrolled asthma had a shorter length of stay by 19.2 hours in the CPW group which was clinically significant as these patients spent almost a day shorter in the ward. Poor control of asthma is associated with severe or more frequent acute exacerbations.[24,25] This in turn leads to a longer hospital stay.

Prescription and the use of appropriate drugs for asthma is an important factor in achieving good asthma control, which will in turn reduce exacerbations and visits to healthcare facilities. Our study found that a higher percentage of patients in the CPW group were given preventer and reliever medications for those newly diagnosed as persistent asthma and newly diagnosed intermittent asthma respectively. This is in line with the Malaysian CPG which states that all patients should be prescribed an intermittent short-acting β2-agonist to relieve symptoms in acute events and those with persistent asthma should be started on inhaled corticosteroids.[19] Inhaled corticosteroids are effective in the control of symptoms and improving peak expiratory flow.[26] Our findings were also similar to the findings of Kelly et al., with an increase in the prescription of controller medication in the CPW group.[10]

In our study, the cost driver for the hospital cost is the general admission cost which was directly related to the length of stay. The lower cost of hospital admission in uncontrolled asthma patients in the CPW group is due to shortened length of stay, which indicates that the CPW could be effective for this group. The higher cost in the CPW group for the treatment of newly-diagnosed asthma was due to better management in terms of higher prescription of appropriate drugs such as inhalers. A systematic review of the economic burden of asthma found that two studies showed an almost three-fold increase in cost with increasing disease severity.[27]

In the past, several studies looked at the impact of a CPW on the management of inpatient paediatric asthma. One of the earlier studies concluded that there was no significant difference in ALOS, cost of management and readmission rates between the intervention and pre-intervention groups.[28] The study, similar to ours was also a pre- and post-study but Kwan-Gett et al.'s study consists of patients who were more than two years old and data were collected from billing records. They defined readmission as readmission to the hospital within two weeks of discharge as compared to four weeks in our study.[28]

Kelly et al., looked at the ALOS, cost and admission to hospital or emergency within 72 hours of discharge which all showed statistically positive outcomes related to the use of a CPW. On top of that, they also looked at inpatient and discharge management of patients. Similar to our study, they found that using a CPW resulted in more patients being given controller medication and reliever medication upon discharge.[10]

McDowell et al., conducted a prospective controlled trial among children between the ages of 1-18 years old to look at the effect of an assessment-algorithm on ALOS, cost, relapse rate and adherence to their protocol.[11] In contrast to our study, they found that there was significant improvement in the ALOS and reduction in cost. Similar to our findings, there was no significant difference in readmission where hospital records were reviewed and a phone call was made to find out if any of the patients were readmitted. However, the duration that was looked at was within 72 hours of discharge.

A study in the United States concluded that the use of a CPW for inpatients aged two and above in paediatric asthma management reduced the ALOS, cost and overall use of nebulisers. More patients in the intervention group had less than 24 hours of stay in the hospital, thus reducing the overall cost of management. Patients were followed up by a phone call at two weeks post discharge to look at the outcomes, where three patients in each group had worsening symptoms with some requiring visits to a healthcare facility but none of the patients in both groups had readmission.[12] In contrast to our study, this study gave more authority to nursing staff to wean down bronchodilator therapy based on set guidelines which led to outcomes seen.

Wazeka et al., utilising a retrospective, non-randomised controlled trial over a period of four years among 2-18 year olds showed significant decreases in the ALOS and cost.[14] Readmission rate was also small at 0.02% within two weeks of discharge. Although a statistically significant reduction in ALOS was seen in the first year of implementation, no further reduction was seen in the following years. This study differs from ours and other preceding studies where not only does it involve a longer implementation period, but patients were also assigned to paediatric pulmonologists and patients admitted for intensive care were also included.

In 2008, Edwards & Fox found similar findings to the majority of previous studies in terms of reduction of ALOS. However, there was no significant difference in the proportion of patients given asthma education, prescription of proper discharge medication and readmission rates.[29] The study population is similar to preceding studies, inpatients admitted for asthma between the ages of 2-18 years old. The authors also acknowledged that the use of CPW in their study site was minimal, thus resulting in the outcomes seen.

Despite the non-significant findings from our study, it can be argued that CPW use was clinically useful as it resulted in improvement of patient management as evidenced by the increase of appropriate drug prescription for newly-diagnosed patients. The discharge checklist ensured that all aspects of asthma management were covered prior to discharge. Clinical usefulness in this sense refers to the benefit for patients in terms of receiving better care resulting from CPW use. The guided management of asthma patients during the intervention period ensured best practice as it was in accordance with the available evidence-based guidelines. In the long run, with patient compliance and trigger avoidance, better management of symptoms leads to good asthma control resulting in reduced exacerbations and fewer admissions, and inevitably better quality of life.

Original Article

There are several limitations to this study. There was a low number of cases in the study, with an average of 10 asthma admissions per month. The small sample size did not have enough statistical power; thus, the results have to be interpreted with care. A study over a longer period might have recruited more patients. However, extension of this study was not possible due to time and financial constraints. Our study looked at readmission within 28 days of discharge, in line with the service quality indicator in Malaysia. For the pre-intervention group, data were collected retrospectively. The readmission data were based on hospital records; therefore, primary care visits and visits to other healthcare facilities could have been missed. Although data collection from phone calls could have been done, it was prone to recall bias as it was done later in the year as compared to when the admission took place. The same problem was not seen in the CPW group as the patients were contacted via phone within one month of discharge.

In asthma management, GINA guidelines suggest early institution of systemic steroids to facilitate faster recovery.[20] It is acknowledged that early systemic steroid use is a possible indicator for quality of care. However, it is beyond the scope of this study as the CPW focussed on inpatient management of asthma, and management at the emergency department prior to admission was not dictated by the CPW.

Lastly, although best effort was done to consider the most comprehensive cost data for estimation of cost calculation, it was not possible to include overhead costs due to data unavailability; and cost related to human resources that were utilised during the implementation of the CPW was not included as it was labour intensive. Activity-based costing could have provided a better estimation of the cost of asthma admission.

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