How Much Does Management of an Asthma-Related Event Cost in a Malaysian Suburban Hospital?

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ABSTRACT

Background: Patients with asthma need long-term management to maintain optimal control. In addition to routine maintenance, urgent visits and hospitalizations may be required, as these patients are prone to acute exacerbations. The aim of this study was to estimate the costs of maintenance and acute exacerbation management in patients with asthma in a suburban public hospital in Malaysia.

Methods: An activity-based microcosting approach was applied to estimate the unit cost of events from the hospital’s perspective. First, activities and resources that were involved in each cost center were identified and valued against a suitable form of unit. Thereafter, the mean cost of each resource per event was calculated by dividing the product of the quantity of the resource used and the unit cost of the resource by the number of events. The mean cost per event was the sum of the cost of resources for all cost centers involved. The costs were expressed in 2014 US dollars ($) and Malaysian Ringgit (RM).

Results: Data were collected from 15 maintenance, 20 acute exacerbation, and 50 hospitalization events. The mean (± SD) cost of maintenance management was $48.04 (± 10.10); RM154.68 (± 32.52). The cost of acute exacerbation management in the Emergency Department was $13.50 (± 2.21), RM43.46 (± 7.10); and in the medical ward, the cost was $552.13 (± 303.41), RM1777.86 (± 976.98), per hospitalization event. Conclusion: The microcosting of management of asthma-related events provides more accurate estimates that could be used in local economic studies. However, its possible limited generalizability to other types of health care settings in Malaysia needs to be kept in mind.

Keywords: asthma, cost, exacerbation, microcosting.

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Asthma is a chronic respiratory disease that requires long-term management to maintain optimal control. Routine follow-up at the outpatient clinic is very much dependent on patients’ asthma control status; that is, those who have poor asthma control will require more frequent clinic visits compared with those with good asthma control. Nevertheless, patients with asthma are prone to acute asthma exacerbations regardless of their asthma control status [1]. According to the National Health Morbidity Survey Malaysia 2006, among the surveyed patients with asthma (prevalence rate 4.5%), 19.7% and 10.1% of the patients reported visits to the Emergency Department (ED) and the hospital, respectively, in the past 12 months [2]. Up-to-date data were not available, but these numbers are expected to have increased with growing urbanization in this country in the past decade. In the Malaysian health care system, when an acute exacerbation cannot be managed by the patients themselves, an urgent visit to the ED with possible hospitalization becomes necessary. Hence, asthma is ranked as one of the most expensive chronic diseases in the world [3], as it requires high utilization of public health care resources. Information on resource utilization is important to the health care provider [4] for health care budget planning, and yet there is very little information on the costs of asthma management in this country.

One method considered the gold standard for measuring health care resource utilization in terms of cost is the activity-based bottom-up microcosting approach [5]. This approach provides highly precise cost estimates, whereby it identifies each component of resource use and values it by using the bottom-up approach to obtain patient-level unit costs. Activity-based costing is a common variant of the bottom-up microcosting method. The key point of activity-based costing is to identify all activities that are the cost drivers in a cost center/resource. Previous asthma costing studies in Malaysia [6] did not report the cost per hospitalization for asthma and also did not describe their costing methods adequately enough to help assess the precision of the cost estimates, and different costing methods yielded different estimates [7,8], thus affecting the precision or the accuracy of the measured costs [9]. The current study aimed to use the activity-based costing of the bottom-up microcosting approach to measure the costs incurred in a suburban public hospital in Malaysia.

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for a maintenance visit, an urgent visit to the ED, and hospital-
ization for asthma, from the hospital’s perspective. In Malaysia,
the major health care provider is the Ministry of Health Malaysia,
which is also the major health care payer under the universal
health care system. It is thus appropriate to estimate the cost of
managing these events from a public hospital perspective in this
study. A glossary of terms used in this article is provided in
Appendix 1.

Methods

General

This observational study was conducted in a 548-bed suburban
hospital in the state of Perak, Malaysia, during the month of
October 2015. A minimum of 15 observations were made on
patients over the age of 18 years visiting the respiratory clinic
(which is held once a month) at the Physician’s Clinic (PC),
Outpatient Pharmacy (OP), Ambulatory Pharmacy (AP), and ED.
A sample size of 15 units of each activity was arbitrarily chosen
because it was assumed that there would not be much difference
in the duration of completing one unit of activity compared with
another. However, 50 in-patient asthma cases (January to Sep-
tember 2015) were identified from the diagnosis written in the
census book of four adult general medical wards. Thereafter,
these records were retrieved from the Medical Records Unit of the
hospital. The 50-record sample was chosen because a greater
variability in the hospitalization costs was expected; admissions
for asthma exacerbation could have many reasons, such as a
treatment compliance issue or respiratory infection. These rea-
sions could affect the duration of stay, the need of diagnostic
tests, and prescription of drugs, among factors that contribute to
variability in hospitalization costs.

Briefly, the study population from the PC cost center, nebuliz-
ing activity, and ward were patients with asthma. However,
patients without asthma were also included as part of the study
population from the OP, AP, and ED cost centers. It was assumed
that the resources used for asthma and non-asthma cases in
these cost centers would be similar. This assumption was made
because all patients were treated equally (using the same resour-
ces, including the time spent by personnel) in the pharmacy and
in the treatment room of the ED. The overall methodology of this
study is summarized in Figure 1. The cost analysis was per-
formed by using Microsoft Excel 2007 (Microsoft Corp., Redmond,
WA). All costs were expressed as mean (SD) and were adjusted to
2014 US dollars ($1 = Malaysian Ringgit 3.22) [10,11]. This study
was approved by the Medical Research Ethics Committee of the
Ministry of Health Malaysia (NMR-12-372-11920).

Cost Centers, Activities, and Resources Involved

The “cost center” is where the resources are utilized. For main-
tenance management of asthma, the cost centers are the PC and
the OP, and the cost centers for acute management of asthma in
the ED are the green-zone section of the ED and the AP. For
reasons of data feasibility and accessibility, only the green-zone
(non-life-threatening) section of the ED was used in this study.
The medical ward is the cost center for hospitalization for
asthma. Details of the activities involved in each cost center
and the resources for each activity are provided in Appendix 2.

Quantity Measurement

The time spent to complete one unit of activity (rather than the
activity itself) for each activity (except prepacking) by the person-
nel was measured. For example, the time spent to complete the
registration for one patient was measured instead of the time
spent on working at the registration counter. This method avoids
the assumption that the personnel will work at the counter at all
times. This assumption is biased, given that the personnel will
have their downtime; moreover, the clinic may not run the whole
day. Therefore, the time taken to complete one unit of activity
was measured by summing the total duration (end time minus
start time) of every predetailed task; this provided a collective
description of the activity performed by the personnel per
patient. All activities except nebulizing were continuously
observed by an external observer—that is, “the external observer
maintains the attention on the subject and continuously records
the time taken to perform one or multiple tasks, implying that
the action of recording is triggered by an action performed by the

Figure 1 – The study flowchart.
subject" [12]. The consequent inevitable risk of the Hawthorne effect was minimal, as none of the observed personnel, except for the Head of Department, was informed about the observation. The details of the timed tasks for each activity are shown in Appendix 3.

The time spent by personnel in the PC cost center was only measured if the personnel were attending to adult patients with asthma. The respiratory clinic was held only once a month, and given the time constraint, all observations in the PC cost center were made on the clinic day. The time spent by the personnel in the OP, AP, and ED was measured regardless of the type of patient the personnel were attending to. An observation on the time spent by the personnel was considered “complete” if the activity was observed from the beginning to the end, as detailed in the tasks list. Consecutive observations were made among the conveniently sampled personnel in these cost centers. However, nurses were not observed for their time spent during treatment activities in the PC and the ED because they normally do not attend to the patient for the whole duration of the treatment. Nurses are more likely to be on standby mode to provide assistance, as needed. Hence their time spent per event in the treatment room was assumed to be the same as that of the doctors.

The time spent by personnel on nebulization was unobservable because there were no patients in need of nebulization during the time of data collection. The Head of Medical Assistants of the ED was interviewed instead to get an expert opinion on the time spent per nebulization. It was noted that each nebulization performed by patients was supervised by the personnel until the inhalation of the nebulizing solution was completed and that the rate of completion depended on the rate of inhalation. On a normal rate of inhalation, a patient takes around 10 to 15 minutes to complete one unit of nebulizing activity. The median of this time range was used as the usual time spent by the personnel per nebulizing activity. Time for administration of intravenous hydrocortisone as part of the management of acute exacerbation was arbitrarily chosen as 5 minutes. The total time spent on the nebulization activity (including intravenous administration) per patient visit was obtained from the nebulization therapy record book, including retrospective cross-sectional data for 7 days (20 asthma exacerbation records) from September to October. Hence, the total time spent for 20 events was the sum of the product of the median time and the units of nebulization activity per event.

A total of 15 and 20 observations were made during the cost measurement of maintenance and acute management in the ED, respectively, but no patient demographic data were considered to avoid the Hawthorne effect. The demographics and characteristics of the personnel that were observed for their time spent are detailed in Table 1. In total, 50 hospital admission records were reviewed; there were four records that belonged to one patient, so the total number of patients was 47. Mean patient age during admission was 40 years (± 18.1 years). Among the 47 patients, 60% were females. Prior to the admission resulting from acute exacerbation of bronchial asthma, six patients (13%) had ≥ 2 co-morbidities, and three (6%) had a single co-morbidity; most of the patients had diabetes mellitus and hypertension. Mean length of hospital stay was 3.4 days (± 1.6 days). Half (52%) of these events were diagnosed as asthma exacerbation caused by upper respiratory tract infection, and 24 events (48%) were diagnosed as asthma exacerbation caused by lower respiratory tract infection.

**Value of the Resources**

The resources measured in the above were valued in several ways to obtain the unit costs of resources, as detailed in Appendix 4.

**Mean Cost per Event**

Briefly, the mean cost of each resource per event was calculated by dividing the product of the quantity of the resource used and the unit cost of the resource by the number of visits or events (Appendix 5). The mean (± SD) cost per event was therefore the sum of the cost of resources for all cost centers involved in an event.

**Statistical Analysis**

To check for the precision of the small-sampled measured cost estimates, an analysis of coefficient of variation (CV) was performed to measure the dispersion of the cost estimates around the mean value. CV is the ratio of the SD to the mean, and it indicates how large the SD is in relative to the mean [13]. Costs have exponential (skewed) distributions; the standard deviation in exponential distribution is equal to the mean, hence its CV equals 1 [14]. Therefore, the dispersion is considered as low variation (more precise) if CV is < 1 or high variation (less precise) if CV is > 1.

**Results**

A total of 15 and 20 observations were made during the cost measurement of maintenance and acute management in the ED, respectively, but no patient demographic data were considered to avoid the Hawthorne effect. The demographics and characteristics of the personnel that were observed for their time spent are detailed in Table 1. In total, 50 hospital admission records were reviewed; there were four records that belonged to one patient, so the total number of patients was 47. Mean patient age during admission was 40 years (± 18.1 years). Among the 47 patients, 60% were females. Prior to the admission resulting from acute exacerbation of bronchial asthma, six patients (13%) had ≥ 2 co-morbidities, and three (6%) had a single co-morbidity; most of the patients had diabetes mellitus and hypertension. Mean length of hospital stay was 3.4 days (± 1.6 days). Half (52%) of these events were diagnosed as asthma exacerbation caused by upper respiratory tract infection, and 24 events (48%) were diagnosed as asthma exacerbation caused by lower respiratory tract infection.
(63%) to the total cost of maintenance management, followed by the time spent by health care personnel (32%). Conversely, the latter had the largest share (52%) of the total cost of acute management in the ED, and drugs comprised 24%, followed by consumables used in nebulization therapy (17%). Diagnostic/laboratory tests were the largest component (44%), followed by ward (30%) and treatment (19%) components in the cost of hospitalization. Fixed assets, maintenance, and consumables contributed the least to each cost. Overall, the cost per hospitalization was 11 and 41 times higher than the costs for maintenance and acute managements, respectively. The calculated CV was <1 for each of the estimated mean cost per event.

### Discussion

This study measured the costs of maintenance and acute managements per patient by using a bottom-up microcosting approach. Although this method yields a highly precise cost estimate, it is time consuming, labor intensive, and expensive. For that reason, this study had a short duration and only targeted a small sample of the population to measure the specific cost estimates associated with asthma. Furthermore, this study did not aim to measure the economic burden of asthma in a suburban hospital setting, for which a longer study duration and a bigger sample size would be necessary. Nevertheless, the latter had the largest component (44%), followed by ward (30%) and treatment (19%) components in the cost of hospitalization. Fixed assets, maintenance, and consumables contributed the least to each cost. Overall, the cost per hospitalization was 11 and 41 times higher than the costs for maintenance and acute managements, respectively. The calculated CV was <1 for each of the estimated mean cost per event.

As found by Stanford et al. [15], the cost of hospitalization is higher than the cost of acute management. This is also parallel to the systematic review findings by Bahadori et al., whereby hospitalization (excluding medication) may be regarded as one of the two largest direct cost components associated with asthma [3]. Most importantly, the cost of hospitalization alone exceeded the total health expenditure per capita for 2014 in Malaysia (= $456) [16] by about 17%. In view of respiratory disease being the second principal cause of hospitalization in public hospitals [17], applying cost-effective strategies, such as integrated care among health care professionals [18] provided to patients with poor asthma control, can lead to more efficient resource allocation in a health care setting.

The other largest cost component of asthma, as reported by Bahadori et al., is medication (drugs) [3]. Indeed, this component was also the largest component in the cost of maintenance management in the current study. This is not surprising as the existing maintenance medications that are currently procured and provided by the Ministry of Health Malaysia are innovator products (e.g., Symbicort® and Seretide®), which have high acquisition costs. Such medications are not administered or prescribed during treatment of acute exacerbations in this hospital, which explains the low drug cost in acute management.

Similar to the local findings by Chan et al., the cost of acute management is the lowest among the three types of costs [6]. Although it is more expensive than the measured cost in the current study, this could be attributed to 1) higher acquisition costs of drugs in a university-affiliated teaching hospital (borne by the Ministry of Education Malaysia) than in a public hospital borne by the major health care provider, the Ministry of Health Malaysia; and 2) different valuation methods of the cost of consultation (the method used in Chan et al.’s study was not specified). These same reasons also explain the higher cost of maintenance management in Chan et al.’s study compared with the current study, in addition to the fact that the study by Chan et al. had also involved the cost of alternative therapies. Chan et al. reported that higher cost of maintenance management compared with the cost of hospitalization, which is contrary to the findings in the current study. However, this difference could not be explained because the components involved in the cost of hospitalization were not detailed in that study.

In addition to obtaining an accurate cost estimate, another advantage of using this costing method is the ability to recognize which cost component makes the highest or the lowest

| Demographics and characteristics of personnel involved in time spent measurement. |
|-----------------------------------------------|-------------------------------|-----------------------------------------------|-----------------------------------------------|
| activity observed                              | Number observed / Number of potential samples | Mean years of working experience in the activity observed | Total duration observed (minutes) |
| Maintenance Management                         | Number observed / Number of potential samples | Mean years of working experience in the activity observed | Total duration observed (minutes) |
| Physician’s Clinic                             | Number observed / Number of potential samples | Mean years of working experience in the activity observed | Total duration observed (minutes) |
| Medical officer                               | 2/2                                           | 1/2                                           | 2.5                                           | 196                                           |
| House officer                                 | 2/2                                           | 2/2                                           | 1.2                                           | 212                                           |
| Nurse                                         | 2/3                                           | 2/2                                           | 6                                              | 77                                            |
| Supporting staff                              | 2/2                                           | 0/2                                           | 10                                            | 85                                            |
| Outpatient Pharmacy                           | Number observed / Number of potential samples | Mean years of working experience in the activity observed | Total duration observed (minutes) |
| Pharmacist                                    | 4/10                                          | 4/4                                           | 2.6                                           | 84                                            |
| Provisionally registered pharmacist            | 1/4                                           | 1/1                                           | 0.25                                          | 368                                           |
| Pharmacist assistant                          | 4/12                                          | 3/4                                           | 0.96                                          | 73                                            |
| Acute Management                              | Number observed / Number of potential samples | Mean years of working experience in the activity observed | Total duration observed (minutes) |
| Emergency Department                          | Number observed / Number of potential samples | Mean years of working experience in the activity observed | Total duration observed (minutes) |
| Medical officer                               | 1/1                                           | 0/1                                           | 2                                              | 95                                            |
| House officer                                 | 1/3                                           | 1/1                                           | 1                                              | 77                                            |
| Medical assistant                             | 3/3                                           | 0/3                                           | 5.7                                           | 130                                           |
| Supporting staff                              | 3/4                                           | 2/3                                           | 1.5                                           | 108                                           |
| Ambulatory Pharmacy                           | Number observed / Number of potential samples | Mean years of working experience in the activity observed | Total duration observed (minutes) |
| Pharmacist                                    | 1/1                                           | 1/1                                           | 0.7                                           | 54                                            |
| Pharmacist assistant                          | 1/1                                           | 1/1                                           | 1.5                                           | 36                                            |

* This is the median value; mean value was not taken because of the extreme skewness in the data range.
Table 2 – Calculation of the mean (±SD) costs per asthma-related event.

<table>
<thead>
<tr>
<th>Fixed assets</th>
<th>Maintenance of the building/room</th>
<th>Drugs</th>
<th>Personnels</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervision</td>
<td>$2,243.36 (± 32.52)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td>$2,216.97 (± 32.43)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$4,460.33 (± 65.96)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusions

By using the activity-based microcosting method, mean (± SD) costs obtained were as follows: $48.04 (± 10.10)/RM154.68 (± 32.52) per maintenance visit; $13.50 (± 2.21)/RM43.46 (± 7.10) per ED visit; and $552.13 (± 303.41)/RM1,777.86 (± 976.98) per hospitalization. At the current time, these results provide the best available local estimates that could be used in local economic studies from the perspective of the Ministry of Health Malaysia. However, these findings have to be applied cautiously because of their limited generalizability to other types of health care settings in Malaysia. Future studies should focus on addressing the limitations of the current study and explore a more efficient method for costing asthma-related events.

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Supplemental Materials

Supplemental material accompanying this article can be found in the online version as a hyperlink at http://dx.doi.org/10.1016/
REFERENCES


