

ORIGINAL ARTICLE

ESTIMATION OF COST OF DIAGNOSTIC LABORATORY SERVICES USING ACTIVITY BASED COSTING (ABC) FOR IMPLEMENTATION OF MALAYSIA DIAGNOSIS RELATED GROUP (MY-DRG®) IN A TEACHING HOSPITAL

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ABSTRACT

The Malaysia Diagnosis Related Group (MY-DRG®), established since 2002, is a patient classification system that stratifies disease severity and categories patients into iso-resource groups. Casemix can be used to estimate costs per episode of care and as a provider payment tool in health services. Casemix has also been used to enhance quality and improve the efficiency of health services. Hence, estimation cost per DRG is important especially in developing countries where costing data are still scarce. We embarked on a study to determine the costs of the diagnostics laboratory services for each MY-DRG® based on the severity of illnesses. Most costing studies for diagnostic laboratory services usually focus on the cost of consumables and equipment alone and employed the step-down costing method. Very few studies applied Activity-Based Costing (ABC) method to estimate the costs for diagnostic laboratory services. This study was done with the purpose of developing the diagnostics laboratory cost using the ABC method. All medical cases discharged from UKM Medical Centre (UKMMC) in 2011 grouped into MY-DRG® were included in this study. In 2011, a total of 2.7 million diagnostic laboratory investigations were carried out in the Department of Diagnostic Laboratory Services in UKMMC. ABC was conducted from January to December 2013 in all units of the department. Cost of 242 types of diagnostic laboratory services were collected using a costing format. Out of 25,754 cases, 16,173 (62.8%) cases were from the medical discipline. After trimming using L3H3 method, 15,387 cases were included in the study. Most of the cases were on severity level one (44.6%), followed by severity level two (32.3%) and severity level three (23.1%). The highest diagnostic laboratory service weight was for Lymphoma & Chronic Leukemia, severity level III (C-4-11-III) with the value of 5.9609. Information on seven cost components was collected from each procedure: human resources, consumables, equipment, reagents, administration, maintenance and utilities. The results revealed that, the biggest cost component for human resources was in Molecular Genetic Unit (89.6%), consumables (34.8%) from Tissue Culture Unit, equipment (11.2%) and reagents (68.1%) from Specialized Haemostasis Unit. In conclusion, the accurate and reliable cost of the diagnostic laboratory services can be determined using ABC. Top management of the department should be able to use the output of the study to take appropriate steps to reduce unnecessary wastages of resources in the various units of the services.

Keywords: Activity Based Costing, Cost calculation and weights, Diagnostics Laboratory services, Casemix

INTRODUCTION

Casemix system is a system that classifies patients based on the series of treatments received. The concept of this system aims to facilitate the process of monitoring patients, and the estimated cost of treatment by combining patients who have the same clinical feature into one homogeneous cluster named as Diagnosis Related Group (DRG). There are two main components in this system, namely patient classification system and cost analysis. Under patient classification there are two main components; diagnosis coding and procedure coding based on International Classification of Diseases 10th edition (ICD 10) and ICD 9 Clinical Modification (ICD 9-CM). In the cost analysis part there are two common costing method: Step-Down costing and Activity Based Costing (ABC). Step-down costing is also known as top down costing or macro costing. In other terms, gross costing may also be used to describe step-down in determining a unit cost. In certain circumstances, step-down

costing is applicable to be used in a situation where data on specific services are inadequate¹. ABC is a costing technique that allows organizations to determine the actual costs associated with their services based on the resources they consumed and quantitatively all the cost and performance of activities, resources and cost items, e.g. procedures, investigation, laboratory tests, drugs, etc. ABC was introduced in the United States as a tool to measure the costs of various products in the manufacturing sector, service industry and in the 90's presented to the healthcare industry and rarely utilised in the field of health²⁻⁵. This study employs the ABC method, which is being carried out for the first time in UKMMC. Findings from previous studies indicated that many industries use the ABC method with positive outcome⁶⁻¹³. The ABC is the accurate method to find out information in respect of the cost compared to other traditional methods⁹.

Universiti Kebangsaan Malaysia Medical Centre (UKMMC) is the first teaching hospital that has implemented casemix system in Malaysia. This system was officially launched on the 15th of July 2002. In the implementation of casemix system in this university hospital, MY-DRG® grouper is being used. Based on this grouper there are 22 types of CMG GROUP (Table 1). Casemix data that has been encoded includes 22 groups of Casemix Main Groups (CMG). CMG are the first level of classifications labeled with alphabet (A to Z). Generally, it is equivalent to chapters in ICD-10 and corresponds to body systems and payment package.

Table 1: Lists of Casemix Main Groups (CMG)

Description	Code CMG
Central nervous system groups	G
Eye and adnexa groups	H
Ear, nose, mouth and throat groups	U
Respiratory system groups	J
Cardiovascular system groups	I
Digestive system groups	K
Hepatobiliary and pancreatic system groups	B
Musculoskeletal system and connective tissue groups	M
Skin, subcutaneous tissue and breast groups	L
Endocrine system, nutrition and metabolism groups	E
Nephro urinary system groups	N
Male reproductive system groups	V
Female reproductive system groups	W
Deliveries groups	O
Newborn and neonates groups	P
Haemopoietic and immune system groups	D
Myeloproliferative system and neoplasm groups	C
Infectious and parasitic diseases groups	A
Mental health and behavioral groups	F
Substance abuse and dependence groups	T
Injuries, poisoning and toxic effects of drug groups	S
Factors influencing health status and other contacts with health services groups	Z

Based on MY-DRG® statistics, a total of 25,754 inpatient cases have been coded for the year 2011. From the total number, 16,173 (62.8%) inpatients were from Medical department, 5,117 (19.9%) inpatients were from Surgical, whereas for the Obstetrics and Gynecology (O&G) department, there were a total of 4,014 (15.6%) cases and only 450 (1.8%) cases in Pediatric. Since the establishment of UKMMC, no studies was conducted on the cost of diagnostic laboratory service. As a result, it is difficult for the management to determine the exact resources used, and components involved. In addition, the current charge rates are not based on cost of services.

The rate for diagnostic laboratory services in the Department of Diagnostic Laboratory Services is quite low and not at par with the facilities and expertise available in UKMMC. Most analyses on costing in hospitals are focused on step-down costing only. The examination cost which involves the total cost on a current patient undergoing an examination is minimal and not done in a systematic way¹⁴. The Ministry of Health in Malaysia is aware of the constant increase in costing. However, it is challenging to gather information on the estimated medical expenditure for each patient, as there are no studies conducted on the detailed costing in this field¹⁵. Thus this study aim to do an economic evaluation to determines cost and diagnostic laboratory service weights using ABC in implementation in MY-DRG®. Service weight is important for determining the prices of payment services¹⁶.

METHODOLOGY

Sample Selection

This is an economic evaluation study to determine and estimate the actual cost of diagnostic laboratory service in UKMMC. The duration of this research spanned from February 2012 until January 2013, and it was approved by the Ethics and Research Committee, Faculty of Medicine, UKM in February 2012 (UKM 1.5.3.5/244/SPP/FF-058-2012). All cases in the casemix MY-DRG® systems that underwent diagnostic laboratory services in the Department of Diagnostic Laboratory Services were chosen to be analyzed in this study. This study involves the collection of patient's data from 3 main sources:

- 1) Data from casemix MY-DRG® system
Data was trimmed using the Low One Third and High One Third (L3H3) method to remove the cases of outliers^{17,18}.
- 2) Patient Medical Records

3) Integrated Laboratory Management System (ILMS)

The universal sampling method was employed in this study, whereby all services offered in the year 2011 for all diagnostic laboratory services conducted in the department were included as the research sample. This study examined 242 diagnostic laboratory services offered in the year 2011 (Table 2).

Calculation of Cost

An Activity - Based Costing Form (ABC) was used to collect the cost of every diagnostic laboratory services carried out in each unit. There were 2.7 million investigations undertaken at all units in the Department of Diagnostic Laboratory Service in 2011. Cost was estimated using the calculation model below:

$$\text{Total cost} = \text{Cost of human resource} + \text{Cost of consumable} + \text{Cost of reagent} + \text{Cost of equipment} + \text{Cost of administrative} + \text{Cost of maintenance} + \text{Cost of utility}$$

Table 2: Number of diagnostic laboratory services Performed on all Units in the Department of Diagnostic Laboratory Services in 2011

No.	Unit	Number of diagnostic laboratory services performed on all Units
1	Chemical Pathology	90
2	Haematology	19
3	Cytogenetic	3
4	Cytopatology	5
5	Virology Serology	45
6	Immunology Serology	13
7	Bacteriology	18
8	Tissue Culture	6
9	Mycology	11
10	Molecular Genetic	4
11	Molecular Biology	6
12	Specialized Haemostasis	10
13	Histopatology	12
Total		242

Types of Cost

There were two types of cost used in this study; direct cost and overhead cost. Components of each type of cost are as below;

i. Direct costs:

- Human resource:** The cost of each work process for each diagnostic laboratory services with the number of staff involved, grade, years of service and the time period of performing the work.
- Consumables:** The cost of all consumables used during the diagnostic laboratory services such as plain tubes, slides, petri dish, cuvette etc.
- Reagents:** The cost of all materials, reagents used during the testing laboratory diagnostics such as Buffer PH 6.8 Methylene, Formaldehyde concentrated 40%, Acid Hydrochloric etc.
- Equipment:** The cost of the equipment used in the performance of diagnostic laboratory services includes the cost of equipment and the purchase of equipment. The cost of depreciation and replacement costs are also taken into account for the year of more than 5 years and above¹⁹.

ii. Overhead cost:

- Administrative:** Assessed based on the cost of employment of staff in the hospital. Administrative costs also include the cost of staff involved indirectly in diagnostic laboratory services.
- Maintenance:** Maintenance costs are costs involved in terms of maintenance of electrical, mechanical, civil, biomedical, solid waste management and other maintenance services.
- Utility:** These costs include the cost of the use of electricity, water, telephone and facsimile in the year.

Service Weights from average cost per episode

The calculation of service weight was done using the average diagnostic laboratory services cost for each MY-DRG® group as the numerator and the

average aggregate cost of all MY-DRG® groups as the denominator.

Statistical Analyses

All data included in this study administered through the use of the (IBM SPSS version 20), whereby the significant level utilised in this study is $p < 0.05$. All calculation of cost was done using Ringgit Malaysia (RM).

RESULTS

This study revealed, there were a total number of 13,773 cases requested for diagnostic laboratory services. L3H3 method was employed to remove the cases of outliers as a perfect fit in the casemix system. The total patients' charges of all the investigations was RM331,834 while the cost imputed using ABC method was RM1,173,685. This shows that UKMMC was only charging 28.3% of the total cost of diagnostic laboratory investigations on the patients.

Data analysis on calculation of diagnostic laboratory service weights showed that from the top 20 highest service weights among the diagnostic laboratory services, the service weight was the highest for MY-DRG® group C-4-11-III (Lymphoma & Chronic Leukemia) where the service weight was recorded as 5.9609. The lowest service weight was MY-DRG® group M-4-16-II (Connective Tissue Diseases) where the service weight was 1.6896. Details on the top 20 MY-DRG® group with highest service weight is illustrates in the Table 3.

Findings from this study also showed that the highest severity level III (severe) was the highest average cost per episode (RM1, 702.93) among diagnostic laboratory, followed by severity level II (RM1, 630.87) and severity level I (RM1, 325.49), respectively. Out of these 22 CMGs group in the current system employed by this hospital, the highest diagnostic laboratory cost was involving CMG (J-Respiratory system groups) with the total average cost per episode was of RM1, 551.18.

Direct Cost

Findings from this study showed that among 4 components under direct cost, 9 units showed a higher cost involving human resource cost. Among the unit with a higher human resource cost was Molecular Genetic Unit, Virology Serology Unit and Haemostasis Unit. Findings also showed that, there were no units with consumable cost as the highest cost. There were three units with reagent cost as the higher cost; Specialized Haemostasis Unit, Biology Molecule Unit, and Tissue Culture Unit. Similarly with consumable cost, there were no units showed a higher direct cost for equipment. Table 4 shows the percentage of component costs by unit in the department of diagnostic laboratory services

Overhead cost

Findings from this study also revealed that, component cost for overhead cost i.e. administrative maintenance and utility were the lowest among other cost (Table 4). The highest cost was only 5.8 involving administrative cost from Clinical Pathology Unit. However this amount is considered low compared to the other direct cost components.

DISCUSSIONS

One of the biggest challenges in the health and medical service is to identify the real cost of the procedure that was duly offered. Therefore, the use of the correct method of cost calculation should be determined²⁰. Most studies involving estimation of costs for diagnostic laboratory services or radiology procedures usually focuses on the cost of consumables and equipment as well as focusing on step- down costing or traditional costing method only². Lack of accurate costing information in hospital services make it necessary to change from the traditional costing system to Activity-Based Costing (ABC)²⁰. Very few studies employed ABC methods to estimate the costs for diagnostic laboratory services. Analysis from this study showed prior the implementation of ABC the total cost imposed on inpatients in this hospital was RM331, 834.33 and grossly increased to RM1, 173,685.15. The results reveal that available rates for inpatient hospital charges for diagnostic laboratory tests are 28.3% lower than the actual cost.

Table 3: Lists of the 20 highest Diagnostic Laboratory Service Weight among Groups MY- DRG®

No.	MY- DRG®	Severity	Description	Average cost (RM) per episode	Service Weight
1	C-4-11-III	Severe	Lymphoma & Chronic Leukemia	3804.28	5.9609
2	C-4-10-III	Severe	Acute Leukemia	3332.05	5.2209
3	M-4-16-III	Severe	Connective Tissue Diseases	2075.41	3.2519
4	A-4-10-III	Severe	Septicemia	1929.80	3.0238
5	A-4-10-II	Moderate	Septicemia	1825.78	2.8608
6	J-4-15-III	Severe	Respiratory Infections & Inflammations	1823.37	2.8570
7	J-4-16-III	Severe	Simple Pneumonia & Pertussis	1668.40	2.6142
8	J-4-15-II	Moderate	Respiratory Infections & Inflammations	1573.46	2.4654
9	C-4-11-II	Moderate	Lymphoma & Chronic Leukemia	1493.38	2.3400
10	J-4-21-III	Severe	Respiratory System Signs, Symptoms & Other Disorders	1365.19	2.1391
11	E-4-10-III	Severe	Diabetes And Nutritional & Other Metabolic Diseases	1335.63	2.0928
12	I-4-10-III	Severe	Acute Myocardial Infarction	1333.47	2.0894
13	J-4-15-I	Mild	Respiratory Infections & Inflammations	1325.49	2.0769
14	D-4-13-III	Severe	Respiratory Infections & Inflammations	1300.90	2.0384
15	I-4-12-III	Severe	Heart Failure	1188.09	1.8616
16	I-4-19-III	Severe	Cardiac Arrhythmia & Conduction Diseases	1144.00	1.7925
17	K-4-17-III	Severe	Gastroenteritis & Abdominal Pain	1143.02	1.7910
18	G-4-22-III	Severe	Seizure	1117.82	1.7515
19	G-4-14-III	Severe	Cerebrovascular Accident With Infarction	1103.71	1.7294
20	N-4-10-III	Severe	Renal & Urinary Tract Neoplasm & Kidney Failure	1089.40	1.7070

Table 4: Cost Components by Units in the Department of Diagnostic Laboratory Services

The Percentage of Component Costs													
	<i>CP^a</i>	<i>Hae^b</i>	<i>Cytog^c</i>	<i>Cytopa^d</i>	<i>VS^e</i>	<i>IS^f</i>	<i>Bakte^g</i>	<i>T C^h</i>	<i>Mycoⁱ</i>	<i>MB^j</i>	<i>M G^k</i>	<i>SH^l</i>	<i>Histo^m</i>
Human Resource	61.4	28.5	62.0	80.3	87.0	66.6	58.0	16.5	45.8	25.6	89.5	20.0	60.0
Consumable	1.3	3.1	5.2	3.2	1.7	0.1	26.0	34.8	29.3	20.7	0.1	0.2	2.0
Reagent	29.3	67.0	7.2	14.3	10.0	31.1	12.4	46.9	22.3	51.2	2.1	68.0	27.4
Equipment	0	0.1	25.2	0.8	0.1	0.5	0.6	0	0.3	1.3	7.8	11.0	8.8
Administrative	5.8	1.0	0.2	1.1	0.9	1.2	2.2	1.3	1.7	0.9	0.3	0.5	1.3
Maintenance	1.4	0.2	0.1	0.3	0.2	0.3	0.5	0.3	0.4	0.2	0.1	0.2	0.3
Utility	0.8	0.1	0.1	0.2	0.1	0.2	0.3	0.2	0.2	0.1	0.1	0.1	0.2
Total (%)	100	100	100	100	100	100	100	100	100	100	100	100	100
<i>a Chemical Pathology</i>			<i>e Virology Serology</i>			<i>i Mycology</i>			<i>j Molecular Biology</i>				
<i>b Haematology</i>			<i>f Immunology Serology</i>			<i>k Molecular Genetic</i>							
<i>c Cytogenetic</i>			<i>g Bacteriology</i>			<i>l Specialized Haemostasis</i>							
<i>d Cytopatology</i>			<i>h Tissue Culture</i>			<i>m</i>			<i>Histopathology</i>				

The service weight is important because the top management of UKMMC and researchers would be able to identify the distribution of budget and cost that should rightfully be allocated. Another study to develop service weight. of pharmaceutical services found almost similar results. The study

found that the group MY-DRG® C-4-11-III (Lymphoma and Leukemia Chronic, severity level-severe) has the highest with the service weight of 11.8 for pharmaceuticals services²¹. Out of the 22 CMGs group in the current system employed by this hospital, the highest diagnostic laboratory cost was

involving CMG (J-Respiratory system groups) with the average cost per episode of RM1,551. The respiratory system group (CMG -J) also has the highest number cases (2006 cases; 13%) in the MY-DRG® database. In Germany, DRG system has been introduced, which aims to distribute and allocate appropriate resources available for the calculation of the average cost per case of the hospital. Further research also explains that the DRG system will be used to determine the price or service weights. The price could be described directly if the average cost of long-stay wards per DRG acquired and the amount for each DRG as well be obtained by the group. The same survey, also conducted in England and France as one more way to set prices is to develop service weights for each DRG where it clearly shows the relationship in the treatment of patients per episode, and using the resources used²².

The results showed ABC method could be equally important providing knowledge of the activities carried out and can provide accurate cost calculation and component costs. The findings of this study finally revealed that the ABC method provide in-depth knowledge on the activities conducted and accurate costing can be identified based on each costing component. In addition, the percentage of the components involved and the highest percentile can be identified. The accuracy of methods ABC system depends criticality on each costing component. The more precise definition of costs, activities, products and cost drivers, the more accurate are the costing¹⁰. This study also provides in-depth information on the types and amount of resources used. By doing this, resources that require proper costing can be monitored to ensure that the quality of services are not jeopardised and this method is also beneficial in organising data as mentioned^{23,24}. The calculation in this study suggests that in 9 out of 13 unit, the components of human resources is the highest, as in an example for Molecular Genetics Unit (89.6%). This is because the process of working on these units require more experience staff to carry out time consuming procedures. The human resource component obtained through ABC can add value to the costing information of the diagnostic laboratory.

By using the ABC method it was found that the cost of the human resource is one of the cost components that are the largest from the total overall cost in Kashani Hospital and the findings also suggest that the cost of equipment and consumable materials at the laboratory is a significant contributor to the capital cost. However, the study failed to mention the percentage of the cost component^{6,7}.

Nevertheless, their research did not specify the type of the component and therefore, difficult to discuss this study. The researchers found that the presence of useful information about the activities can reduce and avoid waste because all information about of resources could be seen from the activities carried out³. The above finding is consistent with the study by a researcher who looked at resource utilisation and estimated cost that is accurately measurable through the calculation of the cost of every Computed Tomography (CT) procedures³. Likewise, the cost of chest X-ray via the ABC method in the Radiology Department, and it is found that the total cost for an X-ray chest is RM5.65 where the cost of the consumables, is higher as 76.8% of the total cost belonged to the X-ray film alone. The survey results also revealed the capacity of unused resources in various departments. Results from earlier studies have indicated that ABC method can reduce the wastage rate. A study of the cost of blood transfusions, where the model ABC used to evaluate the cost of blood transfusions available to provide information on the estimated cost of the blood of the latest and management can process assessment and provide encouragement to reduce waste by optimising the use of blood¹¹.

Hospitalized patients are associated with greater diagnostic laboratory services resource utilization. To date, cost allocation problems of diagnostic laboratory services still exist throughout all types of private and public sector in healthcare organizations. With this research, modifications can be made to reduce the cost of human resource in every procedure performed. ABC method of the hospital management will find a cost that is not directly accurate and applicable for improving analysis and decision-making on revenue and costs²⁵. The results of the study found that the percentage of the cost components for the overhead costs are low. In another study, it was concluded that the higher the overhead cost, the facility usage are not used to the maximum as this indirect cost is highly related to the use of the service¹².

From these data, the management in UKMMC can manage the budget more systematically and the costing data can be used to measure to wastages. On the other although the ABC method is complicated and involves high cost to be implemented, it still benefits a range of activities where costing can be improved and helps the management to make appropriate decisions^{12, 26,27}.

LIMITATION OF STUDY

During this study, some limitations have to be faced. The use of ABC is very new and re-assigned most of the forms are incomplete though itemized statement given to the staff of the unit involved. For the calculation of the cost of equipment, including equipment used for reagent rental. Therefore, some of the cost components are excluded and only the cost of major equipment and the purchase only. For component equipment maintenance costs are difficult to obtain since the Department of Building Management, UKMMC cannot provide the right value equipment for the maintenance since the cost are of a combined on the overall maintenance costs for every department.

CONCLUSION

The results reveal that available rates for inpatient hospital charges for diagnostic laboratory tests are 28.3% lower than the actual cost. Findings from this study also showed that the highest diagnostic laboratory service weights was MY-DRG® group C-4-11-III (Lymphoma & Chronic Leukemia) where the service weight was recorded as 5.9609. It was found that, 9 out of 13 units shows the components of human resources is the highest. The results showed the ABC method can be equally important in providing knowledge of the activities carried out and can provide accurate cost calculation and component costs. Implementation of ABC in healthcare institutions required not only changes by calculation procedures, may also change the way of their organizations' functioning. This information can be used to guide health care providers or specialists to make informed decisions regarding the use of appropriate investigations in order to reduce wastages of resources and support efforts for UKMMC to enhance service efficiency in managing their patients.

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