

Activity-based Costing of Common Caries Treatments Among Paediatric Patients

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ABSTRACT

Background: Activity-based costing (ABC) is a micro-costing method. Despite being an accurate tool for cost calculation, ABC system is rarely applied in the dental fraternity as it is complex to be conducted. Data gathered through ABC is beneficial in bridging the gap between policy makers who emphasise on cost saving and the practitioners who emphasise on quality of treatment.

Aim: To conduct an ABC of common treatments for caries management among paediatric patients at Hospital Canselor Tuanku Muhriz (HCTM), Malaysia.

Methods: ABC was conducted through a clinical pathway to lay out the routine activities of dental caries management among paediatric patients, and to gather information about the equipment, instruments and consumables used, personnel involved, and the time spent for each procedure. Then, these resources were assigned into different categories namely equipment more than RM 500.00, instruments less than RM 500.00, consumables and staff salary. Finally, cost drivers were determined by calculating the amount of resources used and the time spent.

Results: Based on the clinical pathway conducted, there were 10 common treatments for caries management for paediatric patients. The common treatments involved were fissure sealant, glass ionomer cement (GIC) restoration for primary teeth, composite resin (CR) restoration for primary teeth, CR restoration for permanent teeth, strip crown restoration, stainless steel crown (SSC) restoration, pulpotomy, pulpectomy, extraction and scaling. The price range of treatment ranged from RM 60.00 to RM 450.00. Pulpotomy had the highest cost, whereas extraction of teeth had the lowest cost.

Conclusion: Study on costing is important to reduce the gap between the demand in dental treatment and the limited resources available to perform the treatment. ABC is deemed to

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be appropriate to be used in this study as dental treatments are largely procedure-based and this costing method produces a more precise and transparent data. The outcome of this data provides a tool for other hospitals to be used as a standardised approach for treating these patients and subsequently improve the quality of dental care given.

Keyword: activity-based costing, paediatric, clinical pathway

BACKGROUND

Samuelson in 1976 described economics as “the study of how men and society choose with or without the use of money to employ scarce productive resources to produce goods and services over time and distribute them for consumption, now and in the future, among various people and groups in society”¹. Health economics on the other hand is defined as “a branch of economics concerned with issues related to scarcity in the allocation of health and healthcare”².

The Law of Scarcity is one of the fundamental areas in economics, and its implications can have a drastic impact on the ways a society produces its goods and services. In finance, the term “scarcity” refers to the idea that an economic system cannot possibly produce all the goods/services that consumers want. The combined effects of unlimited wants and limited resources such as people, time, facilities, equipment and knowledge create a reduction in the availability of goods and services. In health services, needs appear to be infinite while resources are limited. For example, people may have wants on their medical or dental services, however, the means to pay for such services are limited. Another example of limited resource is the limited number of physicians or dentist and other resources such as equipment and facilities³. Economic data aids decision

makers to make rational judgement to effectively utilise the limited resources. This data provides guidelines on how the resources should be used⁴. Hence, economic evaluation studies are important in allocation of available resources, providing valuable information for policy leaders and decision making process among clinicians⁵.

One way how costing can be conducted is through activity-based costing (ABC). This tool was developed in the field of manufacturing in the 1970's and 1980's as an attempt to improve efficiency and cost control. ABC is a micro-costing method. The concept of ABC is that production of service consumes activities, and these activities consume resources. Hence, while performing ABC, a cost is assigned to each activity to calculate the total cost⁶. ABC is known to be a more accurate and transparent calculation compared to the traditional step-down method⁷. As for dental treatments, ABC is a better cost calculation method compared to the traditional step-down method because dental treatments are largely procedure-based, and resources consumed may not be reflected accurately if the step-down method is used⁸.

As explained by Goldberg and Kosinksi, ABC can be done in 4 steps⁶. First is developing an activity map where all activities related to the procedure are outlined. Second, an activity

analysis is done. Here, the resources used in each activity are listed. The next step involves assigning cost categories. The resources listed in the previous step are assigned to its respective categories namely equipment, instruments, labour and consumables. Lastly, the cost drivers for each resource and the number of resources used are determined. For example, for employee cost driver, the time taken for a procedure to be done is calculated. On the other hand, for material cost driver, the number of items used is calculated. Once these four steps are completed, a cost allocation rate is conducted by proportioning the annual cost of a resource and the number of times the resources are used over the time period⁶.

Despite being an accurate tool for cost calculation, ABC system is rarely applied in the dental fraternity. This is due to several reasons such as being unaware of the importance of evidence-based practices in assessing cost-effectiveness of treatment, difficulty in acquiring accounting information in healthcare services, lack of interest of finding the true cost of treatments due to the highly subsidised price for treatment, and inability to conduct costing due to lack of knowledge and experience. In our knowledge, there has not been any published papers regarding ABC of caries management among paediatric patients. Thus, this study was conducted. This data would be beneficial in bridging the gap between policy makers who emphasise on cost saving and practitioners who emphasise on quality of treatment. Hence, the aim of this paper was to conduct ABC of common treatments for caries management among paediatric patients at Hospital Canselor Tuanku Muhriz (HCTM), Malaysia.

METHOD

Ethics approval

All methods carried out in accordance with guidelines and regulations by the Declaration of Helsinki. This study was conducted after obtaining approval from the Ethical Committee, National University of Malaysia (UKM PPI/111/8/JEP-2020-675). Informed consent was waived by the Ethical Committee, National University of Malaysia as it did not involve any human subject.

Costing method

In this study, ABC was used. A clinical pathway was conducted to lay out the routine activities of dental caries management among paediatric patients, to analyse each activity, and to gather information about the equipment, the instruments and consumables used, personnel involved, and the time spent for each procedure to produce a clinical pathway for each of these procedures. Once the activity analysis was completed, the resources were assigned into different categories namely equipment more than RM 500.00, instruments less than RM 500.00 as well as consumables and staff salary. Finally, the cost drivers were determined. This expert panel discussion was conducted separately among the paediatric dental specialists (three members) and dental nurses (three members) working at HCTM to lay out the activity map of dental procedures done. Table 1 shows an example of ABC based on fissure sealant treatment.

Table 1 Example of activity-based costing for treatment of fissure sealant

Activity Map	Activity Analysis	Cost Category	Cost Driver
Prophylaxis	Handpiece	Equipment	Number of items used
	Cutting unit	Equipment	Number of items used
	Slow speed handpiece	Equipment	Number of items used
	Pumice	Consumable	Amount of items used
	Polishing brush	Consumable	Number of items used
	Glove	Consumable	Number of items used
	Mask	Consumable	Number of items used
	Mouth mirror	Consumable	Number of items used
	Probe	Equipment	Number of items used
	Tweezer	Equipment	Number of items used
	Paediatric dental specialist	Personnel	Time taken
	Dental staff nurse	Personnel	Time taken
	Dental surgery assistant	Personnel	Time taken
Application of fissure sealant	Light cure	Equipment	Number of items used
	Flowable fissure sealant	Consumable	Amount of items used
	Etchant	Consumable	Amount of items used
	Gauze	Consumable	Number of items used
	Cotton roll	Consumable	Number of items used
	Microbrush	Consumable	Number of items used
	Dappen glass	Instrument	Number of items used
	Excavator	Instrument	Number of items used
	Paediatric dental specialist	Personnel	Time taken
	Dental staff nurse	Personnel	Time taken
	Dental surgery assistant	Personnel	Time taken

Cost Calculation

We calculated the provider cost by estimating capital (dental equipment more than RM 500.00) and recurrent cost (staff salary, instruments less than RM 500.00 and consumables). For dental equipment worth more than RM 500.00, a life span of 5 years was determined with an annual discount rate of 5%. Hence, an annualization factor of 4.329 was used to calculate the cost of equipment⁴. After the annualization, the cost was divided by an average number of patients seen in a year. The emolument cost included salaries, bonuses, and allowances to personnel involved in each activity within the scope of the study, applied according to the time ratio of the activity. The total gross income of individual health personnel was divided by 10,560 minutes to arrive at an emolument cost per minute based on an

assumption that the total day of work is 22 days per month for 8 hours per day.

The cost of consumables was the total cost of all purchases of medication and non-medication (e.g., dental filling material, disposable gloves, masks, and other items used for the activities related to this treatment). During the clinical pathway, the amount of consumables used was discussed, and the cost was then proportionated according to the amount used. For costing purposes, consumables also included the use of instruments worth less than RM 500.00, apportioned by the average number of patients seen a year. Figure 1 shows the flowchart of conducting ABC and the costing and evaluation method used. The cost calculation of instruments worth less and more than RM 500.00, emolument, and consumables is shown in Table 2.

Table 2 Cost calculation based on activity-based costing

Cost of equipment / instruments worth at least RM 500		
Equipment	Cost per unit (RM)	Annuitized cost in RM (divided by 4.32)
Cutting unit	33,800.00	7824.07
High speed contra angle	650.00	150.46
Light cure unit	1,500.00	347.22
Amalgamator	1,800.00	416.67
Rubber dam set	2,450.00	567.13
Slow speed handpiece	600.00	138.89

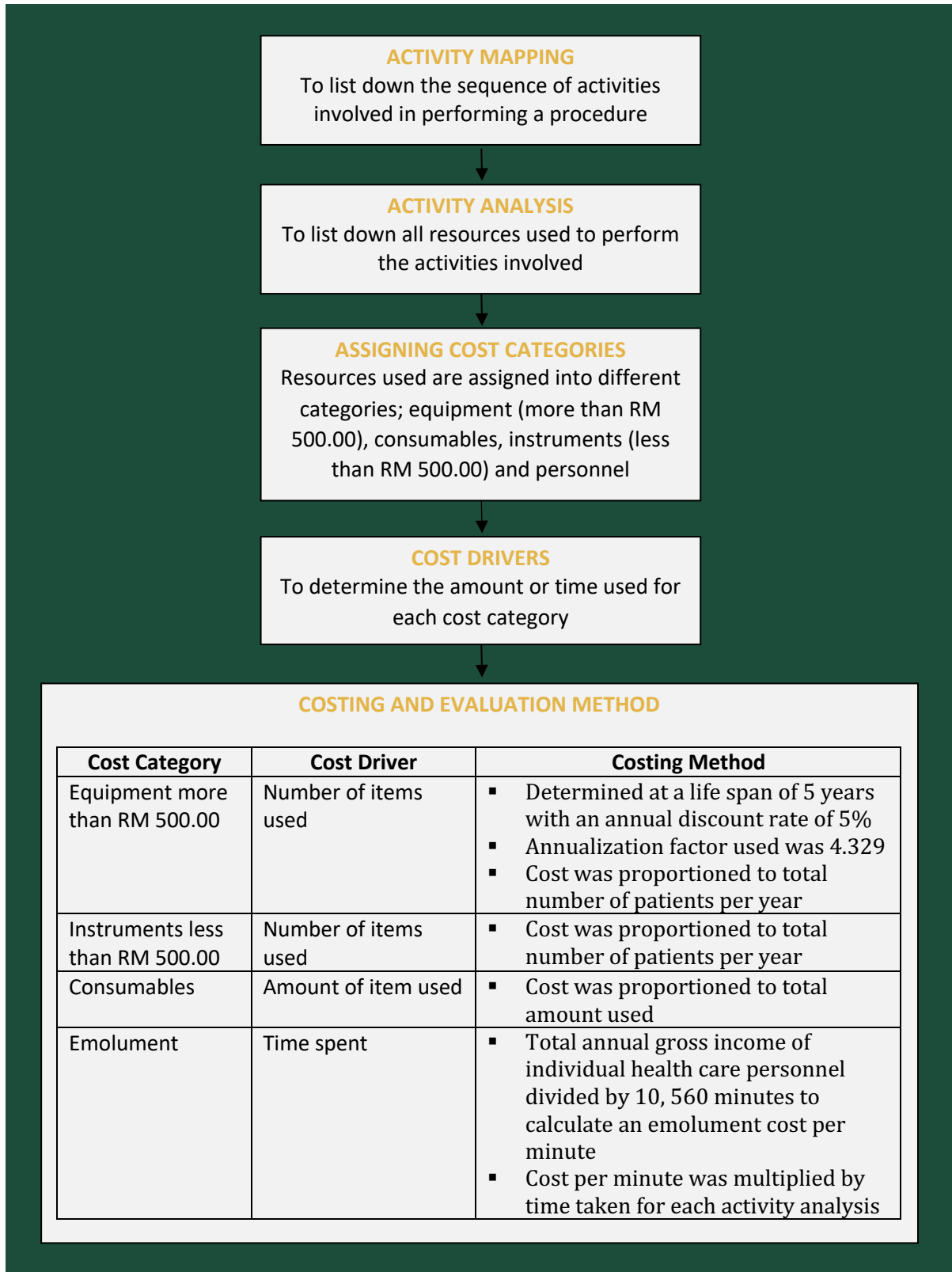
Staff cost per minute of procedure		
Personnel	Total emolument a year (RM)	Pay per minute (RM)
Paediatric dental specialist	183,228.00	1.44
Dental staff nurse	58,260.00	0.46
Dental surgery assistant	41,652.00	0.33

Cost of consumables used		
Consumables	Unit	Cost per unit (RM)
Flowable fissure sealant	Syringe	170.00
Etchant	Syringe	127.00
Bonding agent	Bottle	287.00
Packable composite resin	Syringe	85.00
GIC capsule	Pack	511.50
Dentin conditioner	Bottle	94.90
Pumice	Box	28.00
Prophylaxis paste	Box	48.00
Gauze	Pack	4.50
Cotton roll	Pack	22.00
Microbrush	Pack	45.00
Vaseline	Box	26.00
Floss	Roll	11.00
Rubber dam	Box	52.00
Celluloid strip	Box	34.00
Soflex disc	Unit	64.00
Strip crown	Box	1 348.98
Stainless steel crown	Box	1843.90
Normal saline	Bottle	6.50
Chlorhexidine mouthwash	Bottle	18.20
Vitapex	Syringe	145.00
Paper point	Box	29.00
Ferric sulphate	Syringe	278.00
Surgicel	Box	650.00
Local anaesthesia	Box	182.00
10cc syringe	Box	40.00
Branula	Box	156.00
LA needle	Box	72.00
Mineral trioxide aggregate	Sachet	200.00
Glove	Box	130.00
Mask	Box	31.28
Syrup Paracetamol	Bottle	2.50

Cost of dental instruments worth less than RM 500

Instruments	Unit	Cost per unit (RM)
Mouth mirror	Piece	40.00
Dental probe	Piece	30.00
Tweezer	Piece	48.00
Excavator	Piece	79.00
Plastic instrument	Piece	57.00
Mandrel	Piece	36.00
Ball burnisher	Piece	60.00
Dappen glass	Piece	24.00
Adam pleyer	Piece	335.00
Crown scissor	Piece	403.00
Root canal treatment file	Box	25.00
Extraction forceps	Piece	290.00
Elevator	Piece	480.00
Scaler tip	Piece	360.00
Local anaesthesia syringe	Box	206.00
Polishing brush / rubber cup	Piece	1.20
Diamond bur	Piece	0.90
Polishing bur	Piece	0.95
Bite block	Piece	40.00
Suture scissor	Piece	420.00

Figure 1 Flowchart of conducting ABC and costing and evaluation method used



Data collection instrument and cost analysis

A form for recording actual equipment, consumables, staff and time taken for each procedure was tabulated. We used Microsoft Excel 2020 (Microsoft, Redmont WA USA) to calculate cost.

RESULTS

Based on the clinical pathway conducted among the different personnel, in total there

were 10 common dental treatments identified. The common treatments involved were fissure sealant, glass ionomer cement (GIC) restoration, composite resin (CR) restoration for primary teeth, CR restoration for permanent teeth, strip crown restoration, stainless steel crown (SSC) restoration, pulpotomy, pulpectomy, extraction and scaling. ABC of these treatments is shown in Table 3. The cost was rounded to two decimal points.

Table 3 Activity-based costing of common caries treatments among paediatric patients

No	Treatment	Total equipment cost (RM)	Total consumables and instruments cost (RM)	Time taken (minutes)	Emolument cost (RM)	Total cost (RM)
1.	Fissure sealant	141.01	37.96	5	11.17	190.14
2.	GIC restoration	139.85	28.96	7	15.64	184.45
3.	CR restoration (primary teeth)	150.46	49.02	10	22.34	221.83
4.	CR restoration (permanent teeth)	150.46	53.27	15	33.52	237.24
5.	Strip crown	141.01	66.66	10	22.34	230.02
6.	Stainless steel crown	139.85	72.88	10	22.34	235.08
7.	Pulpotomy	142.36	247.96	12	26.81	417.13
8.	Pulpectomy	142.36	78.42	15	33.51	254.30
9.	Extraction	-	52.23	5	11.17	63.40
10.	Scaling	135.22	8.00	10	22.34	165.54

DISCUSSION

Based on the Law of Scarcity, there is always an infinite demand in healthcare sector, however, the resources available are limited. The limited resources can be due to a limited financial budget by the policy maker. Despite the limited budget, quality of treatment given should not be jeopardised. To provide quality treatment with limited sources, there must be a depth of knowledge on costs. A cost calculation can be an effective tool in bridging the gap between policy makers who emphasise on cost saving and practitioners who emphasise on quality of treatment.

An attempt to reduce cost should be based on an increase in efficiency, not in a decrease in quality of treatment. ABC is known to be the most precise form of cost calculation. This is because of the detailed process of data gathering and processing instead of the traditional step-down method that depends on the production volume. In the step-down method, the total cost is divided by the number of patients to get an average cost per patient. Using this method, one cannot estimate the cost of different procedures. As for dental treatments, ABC seems to be the best method for cost calculation as it is purely procedure-based. Using ABC, we can estimate the cost of each treatment by estimating the number of equipment, instruments and consumables used and the time taken for each treatment. In this study, we managed to gather all information using a clinical pathway and then calculated the cost based on the information obtained.

Implementing ABC in the healthcare system has its own advantages. Firstly, since ABC is known to be an accurate cost calculation

method, it can be a useful tool for policy makers in determining the charges of treatment incurred on patients. Instead of setting a price range using the step-down method, which is less precise, having an evident-based cost accounting data will be good for fees determination. This data is vital for the policy makers to use in future planning and budgeting of hospitals in terms of efficient allocation of health care resources to decide on the future fees to avoid a huge clinical burden. This also allows the policy makers to revamp the current charges based on evident-based costing especially if the present charges are under charged. As far as for dental charges in HCTM, there had not been any changes for the past 10 years or so. With a severely lower charge of fees compared to the original cost, a heavy financial burden is absorbed by the policy maker of HCTM. Secondly, another advantage of implementing ABC in the healthcare system is that the method also has an impact in the effectiveness of treatment. Since ABC is done in a standardised and detailed manner, this helps practitioners to analyse the expenses in detail and to implement improvisations that increase efficiency and quality of treatment. This helps to reduce cost by decreasing unnecessary expenses. Besides that, in Malaysia where implementation of dental insurance is in the rise, these data will be useful for insurance companies to set their insurance policy of dental treatment based on evidence-based costing.

ABC can be done using various methods such as using existing clinical guidelines⁹, interview, observation, and by conducting a clinical pathway to lay out the routine practices performed¹⁰. In this study, clinical pathway was used to determine the ABC. A

clinical pathway is defined as “an integrated management plans that display goals for patients, and provide the sequence and timing of actions necessary to achieve such goals”¹¹. Clinical pathway is important in patient management as it reduces variations in providing treatment, and this has been proven to reduce the time spent and cost of treatment while maintaining the quality of treatment¹². This is important to reduce the scarcity of resources available. For example, in this study, we standardised the activity and medicament used of each treatment. By doing this, we could reduce the cost by 1) buying materials in bulk, which are generally cheaper 2) avoid wastage by having to discard expired consumables. This occurs when there are variations among different practitioners who use different consumables. When certain consumables are less used, it ends up getting expired and needed to be discarded. The clinical pathway has also shown to improve intra- and inter-department communication, improve patient outcomes, promote patient safety and increase patient satisfaction¹³.

In our best of interest, this study was the most comprehensive study regarding the cost calculation of common dental treatments among paediatric patients. For dental management of different treatments of caries for paediatric patients in HCTM, the cost ranged from RM 60.00 to RM 450.00. Pulpotomy had the most expensive cost. This was due to the medicament used in pulpotomy procedure which ranged far higher than any other consumables used in other treatment modalities. Furthermore, pulp therapy is a technique sensitive procedure, thus a longer time is needed to complete the treatment. On the other hand, extraction had the cheapest unit cost. This is

because it consumes less consumables and instruments and does not require any equipment unlike other treatments. On top of that, lesser time is required to extract teeth.

This study had its own limitations. For cost calculation of this study, we calculated the cost of treatment purely based on the activities done during the treatment. We did not include and pre-treatment or post-treatment costs. For example, pre-treatment costs include cost of dental examination and radiographs taken. For post-treatment, cost such as autoclaving the instruments was not calculated. Besides that, in this study, we did not calculate indirect costs such as utility cost.

CONCLUSION

The study on costing is important to reduce the gap between the demand in dental treatments and the limited resources available to perform the treatments. In this study, ABC of common dental treatments for caries management in paediatric patients was conducted to find out the actual cost of these treatments. ABC is a micro-costing method and was deemed to be appropriate to be used in this study as dental treatments are largely procedure-based, and this costing method would produce a more precise and transparent data. A clinical pathway via an expert panel discussion was used to produce this ABC. The outcome of this clinical pathway provided a tool to be used by other hospitals as a standardised approach for treating these patients and to subsequently improve the quality of dental care given

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ETHICAL APPROVAL

This study was conducted after obtaining approval from the Ethical Committee, National University of Malaysia (UKM PPI/111/8/JEP-2020-675).

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There was no funding involved in this study.

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