COST EFFECTIVENESS ANALYSIS OF USING DIFFERENT MONITORING MODALITIES IN TREATING SEVERE TRAUMATIC BRAIN INJURY (CESTBI) IN NEURO-ICU, HUSM, KELANTAN

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ABSTRACT

Introduction: *There are two schools of thought in practicing neurotrauma monitoring for patients with severe traumatic brain injury (TBI); the application of the baseline neuro-monitoring (BNM) and the use of multiple modalities neurotrauma monitoring (M3) which is very expensive. The answer of which of the two monitoring systems is more efficient and worth doing should be sought.* ***Objective:*** *To determine the cost effectiveness analysis between BNM and M3 monitoring modalities in the management of severe TBI.* ***Methodology:*** *Sixty-two patients with severe TBI admitted to Neuro-ICU, USM who fulfilled the predetermined criteria were selected using systematic random sampling. The macro and micro costing were performed on each of patient. Barthel Index was used to measure physical performance as an outcome six months after discharge. The analyses used were the Independent t- test, ANCOVA, and Repeated Measure ANOVA.* ***Results:*** *The mean total equipment cost of M3 was significantly higher at p = 0.049 (mean difference of RM23.74) after controlling other variables. The mean difference in Barthel Index after six months was significance between the two groups (p = 0.031), patients that were treated with M3 had higher score [63.7 (SD 30.03)] compared to those who were treated with BNM [46.83 (SD 30.36)]. However, the cost-effectiveness ratio of using M3 was significantly lowered (p=0.031) with a mean of RM476.29 was needed to increase a unit improvement in mean Barthel Index compared to RM629.12 if we used BNM.* ***Conclusion:*** *Although M3 is more costly, the outcome ofpatients treated with M3 was better than that of BNM. Therefore we can conclude that the used of multiple neuro-monitoring was more cost effective than the use of only baseline neuro-monitoring in treating severe traumatic brain injury.*

INTRODUCTION

Management of severe traumatic brain injury may be very complex with interaction of multiple variables such as intracranial pressure (ICP), cerebral perfusion pressure (CPP), arterial carbon dioxide tension (PaCO2) and mean arterial pressure (MAP) (Ghajar *et al*, 1995, Matta & Menon, 1996). Even though the use of ICP monitoring has grown to become a standard technique in the management of severely head injured patients, the present of other modalities like Transcranial Doppler Ultrasonography, Jugular Venous Oximetery (White & Baker, 2002), Cerebral Oxygen Monitoring (Schell & Cole, 2000) and others has improved the final outcome of the patient with traumatic brain injury despite of the present of the skillful and expert personnel that guide the treatment toward the better quality of life of the patient. However, these will either directly or indirectly increase the total cost of the management of the patient

During this time, costs for medical and surgical supplies were greatest for persons with severe brain injuries and those who eventually spent longer time in the Neuro-Intensive Care Unit. Additionally, individuals with more severe injuries received the highest pharmacy bills (Mayer *et al.* (2003). There are many ways to assess the outcome of patient following severe traumatic brain injury (Whyte & Rosenthal, 1998). Apart from GOS and DRS, the Barthal Index scoring system also can be used to assess the outcome the patients with severe traumatic brain injury. There were two schools of thought in practicing neurotrauma monitoring for patient with severe traumatic brain injury in HUSM. Firstly, the application of the baseline neuro-monitoring (BNM) which is mainly focusing on ICP monitoring was believed to be efficient enough to assist in achieving the maximum outcome of the treatment. The other who uses multiple modalities monitoring (M3) like Transcranial Doppler Ultrasonography, Jugular Venous Oximetery and Cerebral Oxygen Monitoring on top of ICP monitoring, believes that BNM was not sufficient enough in detecting adverse brain condition that may result in poorer medical outcome and subsequently result in higher direct medical expenditures and indirect cost.The answer whether those M3 are worth doing or BNM is efficient enough in clinical management of patient with severe traumatic

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brain injury should be sought out in order a proper policy or policy adjustment could be made for the best accessibility and equity in the patient care.

METHODOLOGY

The study was conducted in Hospital Universiti Sains Malaysia (HUSM), Neoru-Intensive Care Unit (ICU), Kota Bharu, Kelantan from January 2003 till December 2003. It was a cost-effectiveness analysis study (prospective cohort). In this study, the costs of different monitoring in treating patients with severe traumatic brain injury play a major concern. Barthel Index was used as an outcome measurement because it was more comprehensive method and has been recommended as a standard measure of physical disability to those who had neurological deficit (Laura *et al*, 1998). It consists of the series of physical performance that need to be done by patients on admission and six months post discharge from neuro-ICU. The costs of the treatment were measured by using budget information for the financial year 2003 which consisted of recurrent cost and capital cost started from the day of admission till the patients were discharged from the neuro-ICU. Only the direct provider costs were calculated in this study. The indirect costs were presumed equal in both groups because the study was conducted at same place and using similar facilities. The patients who were sustained traumatic brain injury without any major orthopedic or surgical problems which GCS at 8 and below were recruited as sample of the study. Those who already had previous history of traumatic brain injury or organic brain injury and had underlying chronic medical illness like diabetes and hypertension were excluded in this study. The sample size was measured by using formula of different between two means and the patients were selected by using systematic random sampling. All the data that were obtained via macro and micro costing form as well as Barthel Index form were analyzed using SPSS version 10.0.

RESULT

There were 62 patients who sustained severe traumatic brain injury recruited in this study. Thirty-three of them were monitored by using multiple modalities of neuro-monitoring (M3 and thirty of them were put baseline neuro-monitoring (BNM) only. Majority of the cases were male (92.0%) and only 8.0% of them were female. Road traffic accident (RTA) was found to be the most common cause of brain injury followed by fall and fighting. Table 1 shows that only the mean Barthel index measured at six months post treatment was significantly difference between the two groups. Others parameters were found not to be significantly difference. Equipment cost plays a major role in this study. Each techniques of monitoring, either by using M3 or only BNM will reveal different costing value and this difference will give the result in choosing a better technique in managing the patients with severe traumatic brain injury. In this study, age and severity of illness which were level of consciousness presented by GSC and Marshall Index score were consider as cofounders. By using ANCOVA, the covariates were controlled and the means difference in equipment cost between the two groups was still significance at p equal to 0.049 (Table 2).

Table 1: Characteristic Of Respondents In Both Croups

Variables	*CROUP 1 (M3)* Mean (SD)	*CROUP 2 (BNM)* Mean (SD)	Mean Difference	[a] p value
Age (Year)	34.2 (20.15)	33.4 (18.86)	0.8	0.875
[b]GCS	6.6 (1.37)	6.0 (1.45)	0.6	0.101
[b] Marshall Index	2.8 (0.81)	3.1 (0.96)	0.3	0.259
[c]Barthel's Index	63.7 (30.03)	46.8 (30.36)	16.9	0.031
Length of stay (Days)	14.4 (6.61)	12.4 (6.13)	2.0	0.221

Note: [a] independent t test (equal variance was assumed), [b] Measure during admission, [c] Measure at 6 month

Table 2: ANCOVA To Determine The Mean Total Equipment Cost Differences When Age And Severity Of Illness; GSC And Marshall Index Were Controlled

Group of study	Mean' (SD)	p value	Adj. mean [b] (95%CI)	F stat (df)	p value
M3	109.9 (50.17)	0.040	108.9 (91.90-126.02)	(3.07,1)	0.049
BNM	86.2 (42.47)		87.2 (69.54-104.80)		

Note: [a] Independent t test

[b] Adjusting mean using ANCOVA (adjusting for age and severity of illness; GCS and Marshall Index)

According to result presented in Table 3, there was no significance changed in Barthel index at time of admission because all of them were ventilated. After six months post treatment in neuro-ICU, the mean Bathel index was significantly difference between the study groups.

Table 3: Repeated Measure ANOVA To Compare The Change Of Barthel Index Between Two Groups

Group	At Admission Mean (SD)	At six months Mean (SD)	F stat (df)	P value [a]
M3	0.00(0.0)	63.75 (30.03)	4.86 (1)	0.031
BNM	0.00 (0.0)	46.83 (30.36)		

Note: [a] Null hypothesis; The Barthel Index change is not different between two study groups Cost-effectiveness analysis was done to mean provider cost. The ratio of mean provider cost to mean Barthel index was calculated for each patient in both groups.

Table 4: Cost-Effectiveness Ratio Of Treating Severe Traumatic Brain Injury With Different Group Of Neuro-Monitoring Modalities

Group of Study	Provider Cost Per Patient (RM)	Barthel Index Change (Outcome)	Cost-Effective-ness Ratio (Cost / Outcome)	p value
	Mean (SD)	Mean (SD)		
M3	30,363.6 (23,405.15)	63.75 (30.03)	476.29	0.031
BNM	29,461.6 (18,835.30)	46.83 (30.36)	629.12	

Note: "independent t test

Table 4 shows that the cost-effectiveness ratio for patient who was treated with multiple neuro-monitoring is RM 476.29 per unit increase of mean Barthel index while in BNM group, the cost-effectiveness ratio is RM 629.12 per unit increase of mean Barthel index changed. The mean different of cost effectiveness ratio was significance between the two groups.

DISCUSSION

This study had shown that majority of the patients who had severe traumatic brain injury were male, only 8% of them were female. Most of them sustained injury through road traffic accident. Their characteristics (age, GCS score, Marshall Index score, length of stay and gender) were comparable in between the groups. It was purposely conducted to look at the provider cost in managing patient with severe traumatic brain injury. The statistical analysis (independent-t test) of mean provider costs showed that there were no significance differences in mean score of all categories of provider cost (building, operation and maintenance, salary, imaging, laboratory, drugs and consumables item) except for the mean equipment cost. Controlling the covariate factors was very important to ensure that the mean difference in equipment cost was not been influenced by others variables. Analysis of covariance (ANCOVA) revealed that after controlling the covariates, the difference in total mean equipment cost still remain significance. It showed that the cost of treating patient by using multiple neuro-monitoring (M3) was higher as compared to those who were only managed with baseline neuro-monitoring (BNM). Repeated Measure ANOVA shows that with the application of M3, the ability of the patients to recover from the neurological insult was higher than those who were only managed by using BNM only. The physical improvement was shown by the significance difference in Barthel Index six months post-treatment in Neuro-ICU. The cost of managing patient with severe traumatic brain injury was expensive.It was once again proven via this study that revealed the mean total provider cost of a patient that had been monitored by M3 and only BNM were RM30,363.6 and RM29,461.6 respectively and it was not significance difference in between study groups. However, the cost effectiveness ratio (ratio between provider cost and mean outcome) of treating severe traumatic brain injury was RM476.26 in M3 and RM629.12 if we use BNM and the difference of RM146.83 per patient was statistically significance ($p = 0.031$). This analysis presents for the first time evidence suggesting that the used of M3 for patient with severe traumatic brain injury offers a cost effective means of reducing the risk of complication and improving health performance especially in recovery from neurological deficit. Therefore the policy of treating severe traumatic brain injury needs to be revised so that the equity and accessibility of these modem and sophisticated facilities can be achieved. The protocols of neurological management in Neuro-ICU also need to be reviewed so that it can fit with the

current need. Detail financial assessments needed for the provider to make judgment in expanding this services.

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