THE ESTIMATED COST OF SURGICALLY MANAGED ISOLATED TRAUMATIC HEAD INJURY SECONDARY TO ROAD TRAFFIC ACCIDENTS

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DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF SURGERY (NEUROSURGERY)

SCHOOL OF MEDICAL SCIENCES

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- My parents and my family, whose love and support made this journey possible.

(II) Abstract

Background: Traumatic brain injury secondary to road traffic accidents occurs mainly in the younger age group in which injury related disability leads to long term impact on employment, economic and social consequences across the lifespan. This study was designed to assign a monetary cost (in terms of RM, *Ringgit Malaysia*) to surgically treated patients in isolated traumatic head injury up to one year post injury.

Methods: This costing study consisted of forty-nine patients. Relevant resource items were identified and valued using the direct measurement of costs method, cost accounting methods, standard unit costs method, fees, charges and/or market prices method. These values were than tabulated to generate the total costs for each patients, via a combination of macro-costing and micro-costing methods.

Results: The estimated annual cost for all patients was RM 1,471,919.80, with the mean cost per case of RM 30,039.18± 22,986.25 (CI, RM 4089.97-RM 81,007.04). The mean cost of care for per case of mild, moderate and severe head injury was RM 11,041.35± 10,936.88 (CI, RM 4,089.97-RM 33,816.72), RM 32,550± 20,998.76 (CI, RM 10,254.93-RM 69,167.03) and RM 36,917.86± 23,697.34 (CI, RM 4,457.49-RM 81,007.04) respectively. In Univariate Analysis, the following were associated with higher cost of care: severe head injury (***P***=0.001), sustaining 2 or more intracranial pathologies (***P***=0.01), having a poor Glasgow Outcome Scale (GOS, 1-3) (***P***=0.02), tracheostomised (***P***<0.001) and contracting pneumonia (***P***<0.001), while Logistic

Regression Analysis revealed that with increasing age, cost of care increases (b=RM591.60, ***P***=0.05).

Conclusion: The mean cost of treatment for this group of patients is high when compared to the per capita income of RM 37,900 in 2016. This generated value acts as a baseline cost for future estimation of treatment where adequate fundings should be channeled timely and appropriately to achieve better health care standards.

Keywords: Cost of care, Malaysia, Head injury, Road traffic accidents.

(III)Abstrak

Kecederaan otak disebabkan oleh kemalangan jalan raya berlaku terutamanya dalam kumpulan umur yang lebih muda di mana kecacatan berkaitan kecederaan membawa kepada kesan jangka panjang terhadap pekerjaan, ekonomi setempat dan kemerosotan sosial sepanjang hayat. Kajian ini direka untuk menjana kos rawatan (dari segi RM, Ringgit Malaysia) bagi pesakit yang dibelah setelah mengalami kecederaan otak sahaja yang disebabkan oleh kemalangan jalan raya.

Kajian ini merupakan kajian kos. Ia ini terdiri daripada empat puluh sembilan pesakit yang diikuti selama satu tahun selepas dimasukkan ke hospital. Para pesakit dibahagikan menurut jenis kecederaan otak serta tahap kecederaan mengikut *Glasgow Coma Scale (GCS)*. Butiran sumber yang berkaitan dikenalpasti dan dinilai daripada harga pasaran semasa menurut sumber yang dipergunakan. Kos dikira menggunakan kaedah pengukuran kos langsung dan kaedah perakaunan kos secara tidak langsung. Ini menjana jumlah kos bagi setiap pesakit, melalui gabungan kaedah makro-kos dan mikro-kos.

Anggaran kos tahunan untuk kesemua 49 pesakit adalah RM 1,471,919.80, dengan anggaran kos purata setiap kes RM 30,039.18 ± 22,986.25 (CI, RM 4089.97-RM 81,007.04). Kos purata penjagaan bagi setiap kes kecederaan ringan, sederhana dan teruk adalah RM 11,041.35 ± 10,936.88 (CI, RM 4,089.97-RM 33,816.72), RM 32,550 ± 20,998.76 (CI, RM 10,254.93-RM 69,167.03) dan RM 36,917.86 ± 23,697.34 (CI,

RM 4,457.49-RM 81,007.04) masing-masing. Dalam *Univariate Analysis*, kos yang lebih tinggi dikaitkan dengan: kecederaan kepala teruk (***P*** = 0.001), mempunyai 2 atau lebih jenis kecederaan otak (***P*** = 0.01), mempunyai *Glasgow Outcome Scale* yang rendah (GOS, 1-3) (***P*** = 0.02), telah menjalani pembedahan trakeostomi (***P*** <0.001) dan mempunyai jangkitan peparu (***P*** <0.001), manakala *Logistic Regresison* mendedahkan bahawa kos rawatan meningkat sebanyak RM 591 bagi setiap tahun peningkatan umur (b = RM591.60, ***P*** = 0.05).

Kesimpulanya, kos rawatan bagi golongan pesakit ini adalah tinggi. Isu ini merupakan salah satu beban kewangan di Malaysia yang tidak harus dipandang rendah kerana ia boleh menimbulkan kesan negatif terhadap taraf kesihatan dan taraf socioekonomi rakyat. Oleh itu, peruntukan yang secukupnya harus diberi di samping mengekalkan kestabilan institusi kewangan negara.

Kata kunci: Kos penjagaan, Malaysia, Kecederaan kepala, Kemalangan jalan raya

(IV)Introduction - literature review and rationale

i. Definition

Head injury is defined as blunt and/or penetrating injury to the head and/or brain due to an external force with temporary or permanent impairments to the brain function which may or may not result in underlying structural changes in the brain (1). Nearly 60% of head injuries are due to road traffic injuries in any part of the world, with the rest of 20–30% attributed to falls; 10% due to violence, and another 10% due to combination of work place and sports related injuries (2).

ii. Impact of Head Injury

Economic and health consequences of traumatic brain injury (TBI) secondary to road traffic accidents are known to be substantial. According to the Global Status Report on Road Safety 2015 published by World Health Organization (WHO) which included data from Malaysia and the other 179 countries reflecting 6.97 billion people or 97% of the world's population, up to 50 million people incur non-fatal injuries while a staggering 1.25 million deaths are as a result of road traffic accidents globally each year(3). In 2012, road traffic accident was the number one cause of death among people aged 15-29 years, the ninth leading cause of death across all age groups globally, and are predicted to become the seventh leading cause of death by 2030(3). In 2015, the global rate of road traffic deaths was at 17.4 per 100,000 populations, while the reported estimate rate was 24 per 100,000 populations for Malaysia(3). Health Facts 2016 published by the Planning Division of Health Informatics Centre of Ministry of Healthy(MoH) Malaysia reported that in 2015, ICD-10 : S00-T98, Injury and other consequences of external

causes was the fourth (7.54%) commonest cause of hospitalisation in MoH hospitals and Private hospitals in Malaysia(4). It was the 3rd commonest reason for emergency department visits at MoH hospitals contributing to 11.65% of the total of attendances(5). Meanwhile, ICD-10-CM : V00-Y99, external causes of morbidity was the fifth principal causes of death in the MoH hospitals(4). In the United States, the estimated burden of TBI on the US economy in 2010 was approximately $76.5 billion, outweighing costs for acute care and rehabilitation (6). Reports also indicate that in low- and middle-income countries, road traffic deaths and injuries were estimated to cause economic losses of up 5% of their respective Gross Domestic Product (GDP) compared to the estimated 3% of GDP lost to road traffic deaths and injuries globally(3).

The high incidence of traumatic brain injury in the early age group translates into long term disability. This is an adverse impact upon employment, economic and social consequences across the lifespan (7). The loss of life, the potential for life-long morbidity amongst survivors, and the social and financial implications towards patient's family circle makes this a pressing public health and medical problem.

Emphasis towards the primary, secondary and tertiary prevention of traumatic head injury especially those secondary to road traffic accidents are still far from satisfactory, whereas treatment in our government hospitals are heavily subsided obscuring the actual cost of treatment, especially when compared to the private medical health sectors.

iii.Rationale of study

Systematic review by Lu et al published in the Journal of Neurotrauma in 2013 revealed that a total of 28 publications worldwide were published regarding the economic impact of traumatic head injury since 2000 to August 2012 (8). Twenty-five percent of the articles focused on diagnostic strategies, 22% on injury prevention efforts, 11 % focused in cost effectiveness of surgical treatment while the rest looked into healthcare costs, and effectiveness of rehabilitations and other treatment strategies (8).

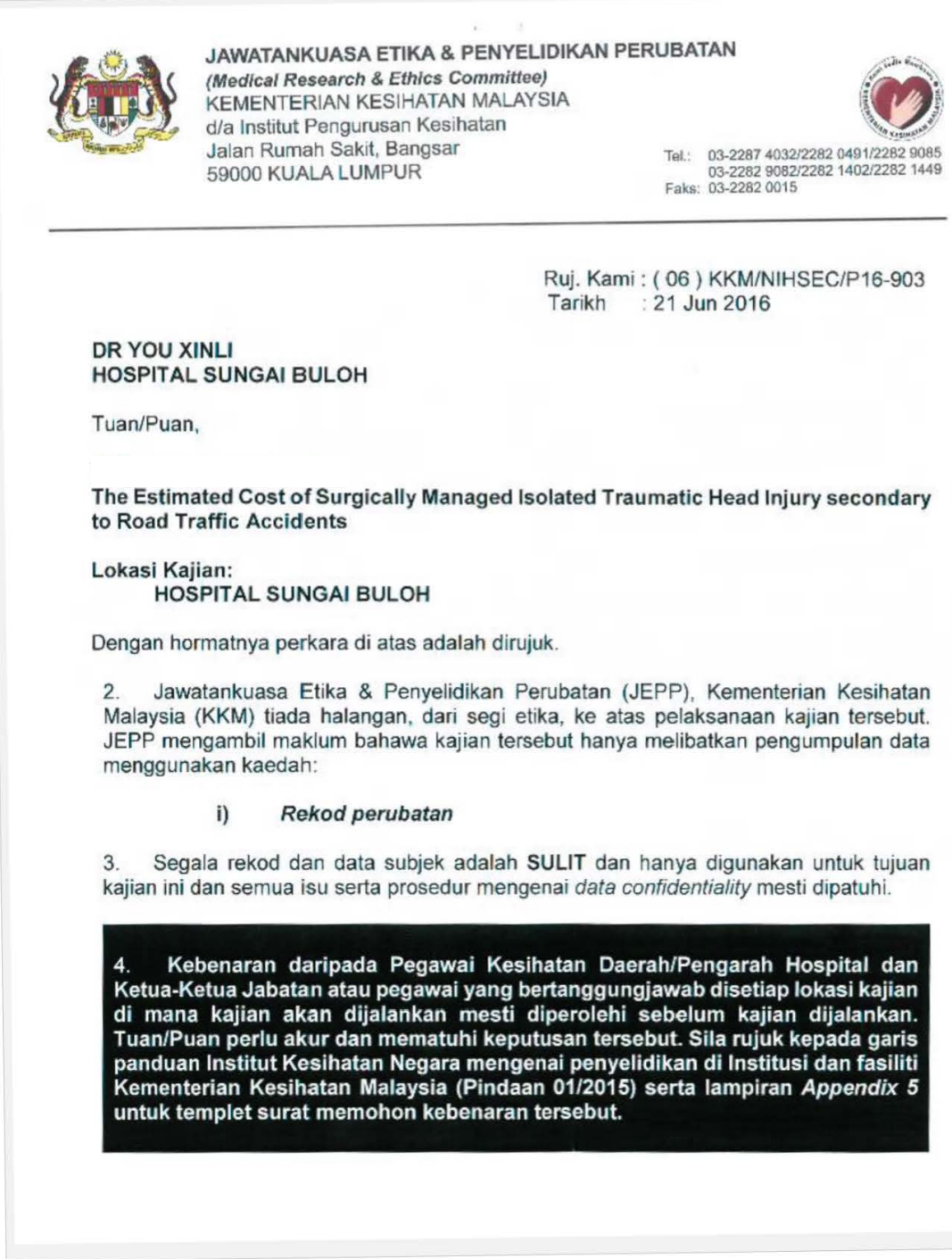
Up to now, there is no similar research regarding the cost of treatment for surgically managed isolated traumatic head injury in Malaysia. This knowledge gap of insufficient data and information regarding the cost of treatment for traumatic head injury restricts our total comprehension of its impact and magnitude towards our health care system and also towards our society.

This study was designed to focus on the monetary cost generated from the health care standpoint where it is aimed to tabulate the actual cost of surgically treated patients in traumatic head injury. Here, a total of forty-nine patients and their cost of treatment for traumatic brain injury needing surgical intervention secondary to road traffic accidents in the public hospital setting in Malaysia are presented and discussed.

(V) Approval of study protocol

Figure 1: Letter Of Approval Of Study Protocol

Study registration number: NMRR-16-969-28923 (IIR)
Letter of approval from Medical Research Ethics Committee Malaysia dated 21/June/2016



JAWATANKUASA ETIKA & PENYELIDIKAN PERUBATAN
(Medical Research & Ethics Committee)
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Ruj. Kami : (06) KKM/NIHSEC/P16-903
Tarikh : 21 Jun 2016

DR YOU XINLI
HOSPITAL SUNGAI BULOH

Tuan/Puan,

The Estimated Cost of Surgically Managed Isolated Traumatic Head Injury secondary to Road Traffic Accidents

Lokasi Kajian:
HOSPITAL SUNGAI BULOH

Dengan hormatnya perkara di atas adalah dirujuk.

2. Jawatankuasa Etika & Penyelidikan Perubatan (JEPP), Kementerian Kesihatan Malaysia (KKM) tiada halangan, dari segi etika, ke atas pelaksanaan kajian tersebut. JEPP mengambil maklum bahawa kajian tersebut hanya melibatkan pengumpulan data menggunakan kaedah:

i) ***Rekod perubatan***

3. Segala rekod dan data subjek adalah **SULIT** dan hanya digunakan untuk tujuan kajian ini dan semua isu serta prosedur mengenai *data confidentiality* mesti dipatuhi.

4. Kebenaran daripada Pegawai Kesihatan Daerah/Pengarah Hospital dan Ketua-Ketua Jabatan atau pegawai yang bertanggungjawab disetiap lokasi kajian di mana kajian akan dijalankan mesti diperolehi sebelum kajian dijalankan. Tuan/Puan perlu akur dan mematuhi keputusan tersebut. Sila rujuk kepada garis panduan Institut Kesihatan Negara mengenai penyelidikan di Institusi dan fasiliti Kementerian Kesihatan Malaysia (Pindaan 01/2015) serta lampiran *Appendix 5* untuk templet surat memohon kebenaran tersebut.

5. Adalah dimaklumkan bahawa kelulusan ini adalah sah sehingga **20 Jun 2017**. Tuan/Puan perlu menghantar perkara-perkara berikut kepada JEPP selepas mengikut kesesuaian. Borang-borang berkaitan boleh dimuat turun daripada laman web MREC (http://www.nih.gov.my/mrec).

I. Borang ***Continuing Review Form*** perlu dihantar ke JEPP selewat-lewatnya 2 bulan sebelum tamat tempoh kelulusan ini bagi memperbaharui kelulusan etika.
II. ***Study Final Report*** perlu dihantar ke JEPP pada penghujung kajian.
III. Mendapat kelulusan etika sekiranya terdapat pindaan ke atas sebarang dokumen kajian/ lokasi kajian/ penyelidik.

6. Sila ambil maklum bahawa sebarang urusan surat-menyurat berkaitan dengan penyelidikan ini haruslah dinyatakan nombor rujukan surat ini untuk melicinkan urusan yang berkaitan.

Sekian terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menurut perintah,

.....
(DATO' DR. CHANG KIAN MENG)
Pengerusi
Jawatankuasa Etika & Penyelidikan Perubatan
Kementerian Kesihatan Malaysia

(VI)Manuscript for submission

The Estimated Cost of Surgically Managed Isolated Traumatic Head Injury secondary to Road Traffic Accidents

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1. Abstract

Traumatic brain injury secondary to road traffic accidents occurs mainly in the younger age group in which injury related disability leads to long term impact on employment, economic and social consequences across the lifespan. This study was designed to assign a monetary cost (in terms of RM, *Ringgit Malaysia*) to surgically treated patients in isolated traumatic head injury up to one year post injury. This costing study consisted of forty-nine patients. Relevant resource items were identified and valued using the direct measurement of costs method, cost accounting methods, standard unit costs method, fees, charges and/or market prices method. These values were than tabulated to generate the total costs for each patients, via a combination of macro-costing and micro-costing methods. The estimated annual cost for all patients was RM 1,471,919.80, with the mean cost per case of RM 30,039.18± 22,986.25 (CI, RM 4089.97-RM 81,007.04). The mean cost of care for per case of mild, moderate and severe head injury was RM 11,041± 10,936.88 (CI, RM 4,089.97-RM 33,816.72) , RM 32,550± 20,998.76 (CI, RM 10,254.93-RM 69,167.03) and RM 36,917.86± 23,697.34 (CI, RM 4,457.49-RM 81,007.04) respectively. In Univariate Analysis, the following were associated with higher cost of care: severe head injury (***P***=0.001), sustaining 2 or more intracranial pathologies (***P***=0.01), having a poor Glasgow Outcome Scale (GOS, 1-3) (***P***=0.02), tracheostomised (***P***<0.001) and contracting pneumonia (***P***<0.001), while Logistic Regression Analysis revealed that with increasing age, cost of care increases (b=RM591.60, ***P***=0.05). In conclusion, the mean cost of treatment for this group of patients is high when compared to the per capita income of RM 37,900 in 2016. This

generated value acts as a baseline cost for future estimation of treatment where adequate fundings should be channeled timely and appropriately for delivery of best health care standards.

Keywords: Cost of care, Malaysia, Head injury, Road traffic accidents.

2. Introduction

1. Definition

Head injury is defined as blunt and/or penetrating injury to the head and/or brain due to an external force with temporary or permanent impairments to the brain function which may or may not result in underlying structural changes in the brain (1). Nearly 60% of head injuries are due to road traffic injuries in any part of the world, with the rest of 20–30% attributed to falls; 10% due to violence, and another 10% due to combination of work place and sports related injuries (2).

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1.25 million deaths are as a result of road traffic accidents globally each year(3). In 2012, road traffic accident was the number one cause of death among people aged 15-29 years, the ninth leading cause of death across all age groups globally, and are predicted to become the seventh leading cause of death by 2030(3). In 2015, the global rate of road traffic deaths was at 17.4 per 100,000 populations, while the reported estimate rate was 24 per 100,000 populations for Malaysia(3). Health Facts 2016 published by the Planning Division of Health Informatics Centre of Ministry of Healthy(MoH) Malaysia reported that in 2015, ICD-10 : S00-T98, Injury and other consequences of external causes was the fourth (7.54%) commonest cause of hospitalisation in MoH hospitals and Private hospitals in Malaysia(4). It was the 3rd commonest reason for emergency department visits at MoH hospitals contributing to 11.65% of the total of attendances(5). Meanwhile, ICD-10-CM : V00-Y99, external causes of morbidity was the fifth principal causes of death in the MoH hospitals(4). In the United States, the estimated burden of TBI on the US economy in 2010 was approximately $76.5 billion, outweighing costs for acute care and rehabilitation (6). Reports also indicate that in low- and middle-income countries, road traffic deaths and injuries were estimated to cause economic losses of up 5% of their respective Gross Domestic Product (GDP) compared to the estimated 3% of GDP lost to road traffic deaths and injuries globally(3).

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family circle makes this a pressing public health and medical problem. Emphasis towards the primary, secondary and tertiary prevention of traumatic head injury especially those secondary to road traffic accidents are still far from satisfactory, whereas treatment in our government hospitals are heavily subsided obscuring the actual cost of treatment, especially when compared to the private medical health sectors.

3. Rationale of study

Systematic review by Lu et al published in the Journal of Neurotrauma in 2013 revealed that a total of 28 publications worldwide were published regarding the economic impact of traumatic head injury since 2000 to August 2012 (8). Twenty-five percent of the articles focused on diagnostic strategies, 22% on injury prevention efforts, 11 % focused in cost effectiveness of surgical treatment while the rest looked into healthcare costs, and effectiveness of rehabilitations and other treatment strategies (8).

Up to now, there is no similar research regarding the cost of treatment for surgically managed isolated traumatic head injury in Malaysia. This gap of insufficient data and information regarding the cost of treatment for traumatic head injury restricts our total comprehension of its impact and magnitude towards our health care system and also towards our society.

3. Objectives

The objectives of the study were to determine the average cost of treatment for surgically managed isolated traumatic brain injury secondary to road traffic accidents in a publicly funded healthcare system in Malaysia and its related factors among surgically managed isolated traumatic brain injury patients secondary to road traffic accidents.

4. Methods

1. Participants

This study looked into all patients who were operated in a publicly funded hospital - Hospital Sungai Buloh (HSB), Selangor, Malaysia from 1st April 2015 to 1st April 2016. The inclusion criteria were patients between 16-60 years old, who fulfilled the ICD-10 code: S 06 (Intracranial Injury), had a clear history of motor vehicle accident and had injuries needing neurosurgical intervention. Patients with other system involvement or patients who did not have their post-operative care or notes recorded in HSB Hospital Information System (HIS) were excluded. A total of 1409 patients were identified but only 49 patients who fulfilled the criteria were selected. They were followed up until 1 year after admission and were stratified according to the severity of head injury and diagnosis of brain injury according to the ICD-10 codes. The severity of head injury according to Glasgow Coma Scale (GCS) is reported in Table 1 and the exact ICD-10 codes used are reported in Table 2.

Table 1: Severity of Head Injury : Glasgow Coma Scale	
Severity of Head Injury	**Glasgow Coma Scale (GCS)**
Mild	13-15
Moderate	9-12
Severe	3-8

Table 2: ICD codes for Diagnosis of Head Injury	
Diagnosis	**ICD - 10 Code and description**
Intracranial Injury	**S 06**
	S06.0 Concussion
	S06.2 Traumatic cerebral edema
	S06.3 Focal brain injury
	S06.4 Extradural hemorrhage
	S06.5 Traumatic subdural hemorrhage
	S06.6 Traumatic subarachnoid hemorrhage
	S06.7 Intracranial injury with prolonged coma
	S06.8 Other intracranial injuries
	S06.9 Intracranial injury, unspecified

2. Data Source

The study collected basic participant data - sociodemographic data, pre-morbid status, nature of road traffic accident, type of intracranial injury, treatment and surgical details, and discharge status up to 1 year post-admission. Identification of the resources used to deliver the services during admission, and follow-ups were noted. Measurement of resource utilisations and costs incurred were concurrently done. Source data were obtained from the HSB HIS system, intra-operative logs, land and surface area data

from Department of Engineering HSB, data from the HSB Revenue Department, HSB Finance Department of HSB, and HSB Financial reports - *Laporan Peruntukan dan Perbelanjaan Mengurus dan Pembangunan, JPKA Bil 3/2015, Bil 3/2016.*

3. Cost of treatment calculation

The focus of this study was to generate the cost of treatment in a publicly funded healthcare system. The estimated total cost of treatment (ETC) for each participant was calculated and reported. The estimated cost was generated using a combined approach of both micro-costing methods and macro-costing methods as reported by Fishman et al (9). Micro-costing methods were used for calculation of direct costs (DC) of surgical procedures (PC), cost of investigations (IC), and costs of hospitalisation (HC). Calculation of each surgical procedure included cost of usage of operating room (orc) which was assigned an hourly weight representing intensity of utilisation to cost and, individual operative costs (opc) which was generated via cost of item utilisation. Similar method was used for calculation of IC which included all the laboratory (labc) and radiological costs (radc). HC was a total of costs incurred during ICU stay (icuc), ward stay(wadc), clinic follow-ups (clinc) and medication costs (rxc). All the identified relevant resource items utilised were valued using the direct measurement of costs method, cost accounting methods, standard unit costs method, fees, charges and/or market prices method.

Top-down costing approach or macro-costing method were used for calculation of indirect costs (IDC). Indirect costs included all the predictor variables of overhead costs associated with building maintenance, labour charges, gas, water and electricity, fuel and transportation maintenance, etc,. which were not identified in the direct costs. The IDC per case is modelled as a function to the predictor variables as stated above. This sets the stage for efficient derivation of cost-per-case estimates where IDC unit cost was generated via the quantum of funding available for HSB maintenance, divided according to surface area involved by said activity and by the total of units of activity (patients load). Surface area calculations were done by the Engineering Department of HSB and is attached in the Appendix. Here, cost calculation excluded costs incurred by patients and family such as lost of income or out-of-pocket expenses or home care expenses.

The calculation of individual costs material for each patient was done via the following formulas (Table 4) with Microsoft® Excel for Mac (Version 15.15 151008). These were then totalled for each patient with IBM® SPSS® Statistics (Version 22, release 22.0.0.0, 64 bit version). The average per patient cost were estimated as mean by dividing the total costs by the total number of patients. Average cost of treatment was generated for patients dichotomised according to gender, severity of head injury and diagnosis.

Table 4: Formulas for Case Cost Calculation		
Formula		
1	*ETC = DC + IDC*	The ETC was computed from both direct (DC) and indirect costs (IDC) incurred during admission and up to 1 year post admission.
2	*DC = PC + IC +HC*	Direct costs were calculated via the micro-costing method, which is the total cost for cost of procedure(s)(PC), cost of investigations (IC) and costs of hospitalisation (HC).
	i) *PC = orc + opc*.	PC included total operating room costs (orc) and individual operative costs (opc). IC included all the laboratory (labc) and radiological costs (radc). HC was a total of costs incurred during ICU stay (icuc), ward stay(wadc), clinic follow-ups (clinc) and medication costs (rxc).
	i) IC = labc + radc	
	i) HC = icuc+wadc+clinc+rxc	
3	IDC = (Maintenance Funding$_{/year}$ x % of area involved) / total patient load$_{/year}$	

4. Statistical Method

Inferential statistical analysis was performed with the use of commercially available software IBM® SPSS® Statistics (Version 22, release 22.0.0.0, 64 bit version). Probability values < 0.05 were considered significant. Descriptive statistics, Univariate analysis and Logistic regressions were done to identify factors of high costs.

5. Results

1. Demographic data of the study

Forty-nine patients' data were analysed for demography, co-morbidities, nature of road traffic accident, type of intracranial injury, treatment details and discharge status 1 year post-admission.

There were 45 males and four female with age ranging from 18 to 54 years of age (mean age of 29.96 years). Forty-three participants had no significant co-morbids (87.8%) except two had hypertension, two had congenital heart disease, one had diabetes mellitus and one had history of ischemic heart disease. A total of 38 participants were motorcyclists (77.6%), seven were car passengers/drivers (14.3%), three were pedestrians(6.1%) and one was a cyclist (2%). Severity of head injury was graded according to the Glasgow Coma Scale (GCS) on presentation. GCS of 3 to 8 were considered severe head injury while 9 to 12 and 13 to 15 were moderate and mild