TELENEUROSURGERY: OUTCOME OF MILD HEAD INJURY PATIENTS MANAGED IN NON-NEUROSURGICAL CENTER IN THE STATE OF JOHOR

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

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ABSTRAK

Latar belakang: Perkembangan dunia teknologi yang semakin pesat telah mempengaruhi profesion penjagaan kesihatan dalam cara menguruskan kes-kes harian. Pelaksanaan teleneurosurgeri dalam menguruskan pesakit, telah menurunkan kadar pemindahan pesakit yang tidak perlu dari hospital daerah ke hospital yang mempunyai kemudahan neurosurgeri. Pesakit yang mengalami kecederaan kepala termasuk di dalam golongan pesakit yang menggunakan model pengurusan ini, dimana mereka di rawat di hospital daerah di bawah jagaan pakar pembedahan am. Semakin ramai pesakit yang dirawat menggunakan model ini, maka keberkesanan and keselamatan model pengurusan pesakit ini semakin mendapat persoalan. Kajian ini dijalankan bagi menilai pesakit yang mengalami kecederaan kepala ringan yang diuruskan di hospital daerah menggunakan kemudahan teleneurosurgeri.

Metadologi: Sebanyak tiga ratus dan lima puluh Sembilan pesakit telah dimasukkan ke dalam kajian ini. Purata umur pesakit adalah 45.39 tahun dengan majority pesakit lelaki sebanyak 77.2%. Kaum Melayu menjadi kontributor terbanyak dengan 60.45% daripada keseluruhan pesakit. Sebanyak 11(3.06%) orag pesakit delah digolongkan di dalam golongan yang tidak memuaskan dimana 10 (2.79%) daripada keseluruhan pesakit memerlukan perpindahan lambat ke unit neurosurgery. Didapati, tiada perubahan ketara dalam GOS (p=0.368) dalam golongan pesakit yang tidak memuaskan apabila perbandingan semasa 3 dan 6 bulan dibuat. Ujian statistik univariat menunjukkan bangsa Melayu (p=0.021) dan GCS semasa rujukan (p=0.024)

merupakan factor penting dalam menentukan hasil akhir pesakit. Walaubagaimanapun, keputusan ini disangkal apabila menggunakan analisis multivariat.

***Konklusi**:* Walau tiada factor yang signifikan selepas analisis multivariat. Kaum Melayu dan GCS semasa rujukan adalah dua factor yang berkemungkinan memberikan impak yang signifikan jika lebih banyak bilangan sampel dapat dikaji. Peratus kegagalan menggunakan model pengurusan tersebut adalah serendah 3.06%. Kajian yang lebih besar yang merangkumi lebih banyak pusat neurosurgeri adalah perlu untuk menangani had-had yang dihadapi dalam kajian ini.

ABSTRACT

Background: Technological advancement has influenced the way health care professions in managing cases. The implementation of teleneurosurgey been proven to reduce the rate of unnecessary transfer of patient from primary hospital to hospitals with neurosurgical services. Head injury patients are among those who were managed in the primary hospital under the care of general surgical unit (GSU), with the help of teleneurosurgery. As more head injury patients are managed utilizing this model of management, there are growing concerns regarding the safety and outcome of the patients with no immediate neurosurgical services. This study is to evaluate the outcome of patients with mild head injury which is managed in a non-neurosurgical centers with the help of teleneurosurgery.

Methods: This study was conducted in the period of 16 months from the month of June 2015 through September 2016, by recruiting samples from five primary hospitals utilizing teleneurosurgery for neurosurgical consultations in managing mild head injury cases in Johor state. Low risk mild head injury patients that undergone CT brain were referred to neurosurgical unit HSAJB and was managed remotely in the GSU. Two main outcomes were noted; favourable and unfavourable, with the unfavourable outcome was considered when the patient needs a delay transfer to NSU, death or discharge with a lower Glasgow Coma Scale (GCS) from admission. A follow up review of the Glasgow Outcome Scale (GOS) at 3 and 6 months was noted in the study.

Results: A total number of three 359 samples were recruited in this study with a total of 36 exclusion. Mean age of the patients were of 45.39 years old, with 77.2% of them were male. Malay ethnicity constitutes a majority of 60.45% of all the subjects. A total of 11(3.06%) patients had an unfavourable outcome with 10(2.79%) needing a delay transfer to NSU. There was no significant difference in GOS at 3 and 6 months for patient in the unfavourable group (p=0.368) on McNemar test. Unvariate analysis reveals Malay ethnicity (p=0.021) and referral GCS (p=0.024) are two important factors in determining patient's outcome. This finding was however not reproducible when using multivariate analysis.

Conclusion*:* Despite absence of identified factor on multivariate analysis that determines patient's outcome, Malay ethnicity and referral GCS are two possible important factors if larger sample was studied. The percentage of failure in utilizing this model of practice is relatively low, 3.06%. A prospective and multicentric model study with a bigger sample size is proposed in order to address the limitation encountered in this study.

Keywords*:* teleneurosurgery, neurosurgical unit, general surgical unit, delay transfer, mild head injury.

INTRODUCTION & LITERATURE REVIEW

Neurosurgical services are not widely available in all hospitals in Malaysia. As to overcome this shortage, neurosurgical services are provided at centrally located hospitals. Patients with neurosurgical related problems which present themselves to centers without neurosurgical services, need to be referred via telephone conversation without images or video conferencing technique (1). The emergence of telemedicine services in recent years has further improvised the neurosurgical services.

Teleradiology was established in the early 1990's utilizing the conventional personal computer. By utilizing teleradiology, transmitting valuable clinical data along with images within or between hospitals markedly enhances the quality of clinical communication (2, 3). The usage of teleradiology in neurosurgery is also known as teleneurosurgery. This data transferring technology in neurosurgery has led to reduce in cost management, improvement in managing neurosurgical referral, and inter-hospital communication between medical providers (2, 4).

Teleneurosurgery in Malaysia is the use of communication technologies to transfer medical information related to neurosurgery. This service was gradually introduced in Malaysia since 2006 (2). Patient suffering from traumatic head injury were being evaluated in hospitals with no neurosurgical services and are successfully managed in the primary hospital with the help of teleneurosurgery. In a recent local study by Risdhawati et.al (2), noted that 37% of transfer was avoided and patients were best kept in their primary hospitals by utilizing

teleneurosurgery. The swift advances in information technology exchange have also reshaped the way we practice medicine. With the help of teleneurosurgery, there is global scale communication and transmission of data which precludes unnecessary patients transfer (2, 5, 6), thus further reduces the costs for patients and medical providers.

Glasgow Coma Scale (GCS) has become the gold standard tool for assessment of patient with traumatic head injury since its landmark paper publication by Teasdale and Jennet more than 40 years ago (5, 7). With computerized tomography (CT) scans widely available nowadays, a combination of both GCS and CT scan findings should be taken into consideration in stratifying the severity of head injury and the treatment strategy (8).

Traumatic head injury could be divided into three categories; 1) mild head injury (GCS: 13-15), 2) moderate head injury (GCS: 9-12) and 3) severe head injury (GCS: 3-8) (9-11). The practice of managing head injury patient harboring a non-surgical lesion in the primary hospital under the care of general surgical unit (GSU) is considered as safe, economical and acceptable (5).

The outcome of patients which are managed in a non-neurosurgical center is largely unknown, due to lack of follow up (2) Severe head injury patients who are managed in non-neurosurgical centers were associated with a 26 % increase in mortality and a 2-15 fold increased in odd of death comparatively to those who are treated in neurosurgical centers (12). Yoram et al

had noted that, patient with intracranial bleed (ICB), can be safely managed in hospitals without neurosurgical unit (NSU)(13). As more patients are kept in the primary hospitals, without immediate neurosurgical services, there are growing concerns regarding the safety and outcome of these patients which are co-managed remotely with the centralized neurosurgical team via teleneurosurgery. This paper is to evaluate the outcome of patients with mild head injury which is managed in a non-neurosurgical center with the help of teleneurosurgery.

2. ETHICAL APPROVAL

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To

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5 Feb at 11:30 AM

Dear Dr MOHD SYAHIRAN BIN MOHD SIDEK (corresponding person) and Principal / Coordinating Investigator,

NMRR ID : NMRR-15-1895-25648

Research Title : Teleneurosurgery : Outcome of mild head injury patients managed in non-neurosurgical center in Johor state

Submission No: S1

RevisionNo : R1

With reference to the matter above, the Ministry of Health Medical Research Ethics Committee (MREC) has come to the following decision regarding the research submission as per the above NMRR ID.

'APPROVED, WITH EXEMPT REVIEW BY MREC CHAIRPERSON/ DEPUTY CHAIRPERSON'

The ethical approval letter will be e-mailed to you shortly. With the letter, you may commence your research PROVIDED permission is obtained from the respective Heads of Departments and Hospitals/ Institutes of the sites where your research will be conducted. Thank you for your patience throughout the process

Have a pleasant day!

Warmest Regards,

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TELENEUROSURGERY: OUTCOME OF MILD HEAD INJURY PATIENTS MANAGED IN NON-NEUROSURGICAL CENTER IN THE STATE OF JOHOR

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ABSTRACT

Background: Technological advancement has influenced the way health care professions in managing cases. The implementation of teleneurosurgey been has proven to reduce the rate of unnecessary transfer of patient from primary hospital to hospitals with neurosurgical services. Head injury patients are among those who were managed in the primary hospital under the care of general surgical unit (GSU), with the help of teleneurosurgery. As more head injury patients are managed utilizing this model of management, there are growing concerns regarding the safety and outcome of the patients with no immediate neurosurgical services. This study is to evaluate the outcome of patients with mild head injury who were managed in non-neurosurgical centers with the help of teleneurosurgery.

Methods: This study was conducted in the period of 16 months from the month of June 2015 through September 2016, by recruiting samples from five primary hospitals utilizing teleneurosurgery for neurosurgical consultations in managing mild head injury cases in Johor state. Low risk mild head injury patients that undergone CT brain were referred to neurosurgical (NSU) unit HSAJB and was managed remotely in the GSU. Two main outcomes were noted; favourable and unfavourable. Unfavourable outcome was considered when the patient needs a delay transfer to NSU, death, or discharge with a lower Glasgow Coma Scale (GCS) from admission. A follow up review of the Glasgow Outcome Scale (GOS) at 3 and 6 months was noted in the study.

Results: A total number of three 359 samples were recruited in this study with a total of 36 exclusion. Mean age of the patients were of 45.39 years old, with 77.2% of them were male. Malay ethnicity constitutes a majority of 60.45% of all the subjects. A total of 11(3.06%) patients had an unfavourable outcome with 10(2.79%) needing a delay transfer to NSU. There was no significant difference in GOS at 3 and 6 months for patient in the unfavourable group (p=0.368) on McNemar test. Unvariate analysis reveals Malay ethnicity (p=0.021) and referral GCS (p=0.024) are two important factors in determining patient's outcome. This finding was however not reproducible when using multivariate analysis.

Conclusion*:* Despite absence of identified factor on multivariate analysis that determines patient's outcome, Malay ethnicity and referral GCS are two possible important factors if larger sample was studied. The percentage of failure in utilizing this model of practice is relatively low, 3.06%. A prospective and multicentric model study with a bigger sample size is proposed in order to address the limitation encountered in this study.

Keywords*: teleneurosurgery, neurosurgical unit, general surgical unit, delay transfer, mild head injury.*

1. INTRODUCTION

Neurosurgical services are not widely available in all hospitals in Malaysia. As to overcome this shortage, neurosurgical services are provided at centrally located hospitals. Patients with neurosurgical related problems which present themselves to centers without neurosurgical services, need to be referred via telephone conversation without images or video conferencing technique (1). The emergence of telemedicine services in recent years has further improvised the neurosurgical services.

Since 2006, telemedicine in neurosurgery or teleneurosurgery has been widely used for transmission of clinical data and images throughout Malaysia (2). Many patient suffers from traumatic head injury were being evaluated in hospitals with no neurosurgical services and are successfully managed in the primary hospital with the help of teleneurosurgery. In a recent local study by Risdhawati et.al (2), noted that 37% of transfer was avoided and patients were best kept in their primary hospitals by utilizing teleneurosurgery. The swift advances in information technology exchange have also reshaped the way we practice medicine. With the help of teleneurosurgery, there is global scale communication and transmission of data which precludes unnecessary patients transfer (2, 5, 6), thus further reduces the costs for patients and medical providers.

Glasgow Coma Scale (GCS) has become the gold standard tool for assessment of patient with traumatic head injury since its landmark paper publication by Teasdale and Jennet more

than 40 years ago (5, 7). With computerized tomography (CT) scans widely available nowadays, a combination of both GCS and CT scan findings should be taken into consideration in stratifying the severity of head injury and the treatment strategy (8). Traumatic head injury could be divided into three categories; 1) mild head injury (GCS: 13-15), 2) moderate head injury (GCS: 9-12) and 3) severe head injury (GCS: 3-8) (9-11). The practice of managing head injury patient harboring a non-surgical lesion in the primary hospital under the care of general surgical unit (GSU) is considered as safe, economical and acceptable (5). The population of interest in this study were patients who suffer from mild head injury, which were kept in the primary hospital with remote consultation using the help of teleneurosurgery.

As more patients are kept in the primary hospitals, without immediate neurosurgical services, there are growing concerns regarding the safety and outcome of these patients which are co-managed remotely with the centralized neurosurgical team via teleneurosurgery. This paper is to evaluate the outcome of patients with mild head injury who was managed in a non-neurosurgical center with the help of teleneurosurgery.

2. METHODOLOGY

The study was a cross-sectional observational study which was conducted in the period of 16 months from the month of June 2015 through September 2016. The sample size of this study was calculated based on the previous study by Yoram Klein et.al (13). Based on the study quoting a 97% of good outcome (13) of mild head injury patient, with an expected 2% difference in proportion of the good outcome from the reference, the sample size calculated was two hundred and eighty samples.

A total of five peripheral hospitals without neurosurgical services in the state of Johor were enrolled in this study. The five hospitals includes; 1). Hospital Sultan Ismail (HSI), 2). Hospital Muar, 3). Hospital Segamat, 4). Hospital Kluang and 5). Hospital Batu Pahat . Head injury cases seen in these peripheral hospitals were referred to a central neurosurgical unit (NSU) for the state of Johor, which is located in Hospital Sultanah Aminah Johor Bahru (HSAJB). Subjects were identified using the database from the official Neurosurgery HSAJB department E-mail and teleconsultation. Both departmental E-mail and teleconsultation were considered as teleneurosurgery.

Patients with suspected blunt traumatic brain injury that meets the criteria based on Canadian CT Head Rule (11, 14) as portrayed in **Table 1** had an unenhanced computerized tomography (CT) of the head on presentation. The patients were attended by the general surgeon in the primary hospital. The decision for an immediate transfer of the patients to the NSU or to be managed in the primary hospital under the care of GSU was made after a phone consultation

between both parties. Clinical data and CT images were conveyed via teleneurosurgery. High risk patients were transferred to HSAJB under the care of NSU. Low risk patients who were not transferred, were admitted to the GSU in the primary hospital and neurological evaluation was performed by the surgical staff. A repeat CT scan was performed for patients with positive CT findings within 24 to 48 hours after admission or earlier in case of neurological deterioration. In case of neurological deterioration or worsening bleed, the patients were transferred to the NSU in HSAJB for further intervention or observation. Low risk traumatic brain injuries were defined as no intracranial bleed (ICB), solitary brain contusion <1cm in diameter, minimal subdural hematoma < 0.5cm in maximal width, small subarachnoid hemorrhage (SAH) and no signs of mass effect (13). The decision for placement of patients either to be kept in the primary hospital under GSU or to be transferred to NSU was based on the criteria mentioned above.

Table 1: Canadian CT Head Rule : Patients With Minor Head Injury With At Least One of the Following

A. High risk (for neurological intervention)

- **GCS score <15 at two hours after injury**
- **Suspected open or depressed skull fracture**
- **Any sign of basal skull fracture (haemotympanum, 'racoon' eyes, cerebrospinal fluid otorrhoea/rhinorrhoea, Battle's sign)**
- **Vomiting >two episodes**
- **Age >65 years**

B. Medium risk (for brain injury on CT)

- **Amnesia before impact >30 minutes**
- **Dangerous mechanism (pedestrian struck by motor vehicle, occupant ejected from motor vehicle, fall from height >three feet or five stairs)**

Inclusion criteria for this study were; 1) mild head injury with the Glasgow coma scale (GCS) $\geq$ 13 (9-11, 13) clear history of trauma, 3) age $\geq$18 years old, 4) the first referral must be within 24 hours of initial trauma, 5) patients were decided by the neurosurgical team to be managed in the primary hospital under the care of general surgical unit (GSU). Exclusion criteria includes; 1) incomplete referral; either clinical data or images, including poor image quality(2), 2) referral made after 24 hours of the initial trauma, 3) GCS $\leq$ 12, 4) other mode of referrals such as via multimedia messaging services (MMS) (2), 5) age $\leq$ 17 years old, 6) polytraumatized patients.

The primary end point of this study is to determine the outcome of the patient managed in GSU at the time of discharge. A favorable outcome was defined; by discharge from the primary hospital with the similar or a better GCS score from the initial presentation. An unfavorable outcome was considered if there was a need for a delayed transfer to NSU, discharge from the primary hospital with a lower GCS score comparatively to the initial presentation or death. Patients which were discharge either from GSU or NSU after a delayed transfer were seen in the neurosurgical clinic in 3 and 6 months' time. The condition of the patient during the follow up at 3 and 6 months' time (15) were recorded and the Glasgow Outcome Scale (GOS) (10, 16) was determined by the attending medical officer. Secondary endpoint of the study was to determine and compare the GOS at 3 and 6 months in the favorable and unfavorable group.

Age, sex, ethnicity, radiological diagnosis, GCS on admission and upon discharge, duration of stay and types of referral were collected to describe the variability of the study

population. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 22 software. Demographics were expressed in table form using mean and standard deviation (SD) for numerical variables and numbers and percentages for categorical variables. McNemar test was used in order to determine the difference in the GOS of both favorable and unfavorable group at 3 and 6 month. Outcome predictors were analyzed using univariate and multivariate logistic regression analysis as to give the crude and odd ratio. Statistical significance was considered when p was ≤ 0.05.

Study proposal was sent for approval from Malaysian Medical Research and Ethics Committee (MREC). A letter of approval of the study is shown as attached. [NMRR ID: NMRR-15-1895-25648].

3. RESULTS

Between the period of June 1, 2015 and September 30, 2016, 395 patients were referred to NSU HSAJB via teleneurosurgery with the GCS of $\geq$ 13. A total number of 359 (n) patients were enrolled in this study and 36 patients were excluded as it does not satisfy the inclusion and exclusion criteria. 5 patients were excluded as having polytrauma, 20 patients were excluded as they were late referral; > 24 hours after initial trauma, and the rest were because of incomplete referral with poor image quality.

Table 2 summarizes the demographics of the population studied. Out of 359 (n) patients, 277 (77.2%) were male and 82 (22.8%) were female. The population ranges from 18 to 88 years old with the mean (SD) of 45.39 (20.23). Malay comprises the majority of patients, with a total of 217 (60.45%) followed by Chinese, 91 (25.35%). The mode of referral for teleneurosurgery was almost equal between official departmental e-mail, 180(50.14%) and teleconference, 179 (49.84%). Hospital Muar leads the number of cases referred using teleneurosurgery, 105 (29.25%), followed by Hospital Batu Pahat, 98 (27.3%), Hospital Sultan Ismail, 83 (23.12%), Hospital Segamat, 38 (10.58) and Hospital Kluang, 35 (9.75%). Mean (SD) GCS on referral was 14.52 (0.72), with 234 (65.18%) of the population have a full GCS upon referral. Mean (SD) GCS upon discharge was 14.89 (0.78) with 1 reported death in this series. Radiologically, 115 (32.0%) of the population have sustained subdural hemorrhage (SDH), followed by no evidence if intracranial bleed (ICB); 96 (26.7%); hemorrhagic contusion; 63 (17.5%); subarachnoid

hemorrhage (SAH); 43 (12.0%), and extradural hemorrhage (EDH); 42 (11.7%). The mean (SD) duration of stay was 2.16 (1.19) days.

10 (2.79%) patients had a delay transfer to NSU HSAJB for further management. Out of the 10 delay transfer, 6 (60%) needed surgical intervention and 4 (40%) did not deemed any. The cases needing surgical intervention includes; 2 cases of EDH, 1 cases of SDH, 1 contusion case, and 2 newly developed EDH case on repeat CT brain with the initial CT shows SAH and another showing no ICB respectively. 1 death was recorded from the SDH case needing surgical intervention. Except for the 2 newly found EDH on repeat CT scan, all the operated cases were brought over to NSU HSAJB with the expansion of the initial ICB. The other 4 delay transfer cases also shows expansion of the initial ICB, otherwise was managed conservatively as having good GCS upon review.

Out of the study population (n=359), 348 (96.94%) patients have favorable outcome with 11 (3.06%) have unfavorable outcome. 10 out of the 11 unfavorable outcome was due to the need of a delay transfer, 1 of the patient was in the unfavorable group due to a lower documented GCS: 13 upon discharge comparatively to the admission GCS: 14. A total number of 319 (88.86%) and 311 (86.63%) of the population have a GOS of 5: good recovery, at 3 and 6 months respectively.

There were a total of 2 recorded deaths in the period of the study. 1 death was after transfer to NSU for surgical intervention of an acute SDH expansion. This was a case of a 34 years old man who was involved in a motor vehicle accident. He sustained mild head injury with