

Outcome of Moderate and Severe Traumatic Brain Injury Amongst the Elderly in Singapore

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Abstract

Introduction: In line with other established protocols, our unit has instituted a standardised protocol for the management of moderate and severe traumatic brain injury since 1996 in our neurointensive care unit. **Materials and Methods:** We reviewed the outcomes, at 6 months' post-injury, in an elderly group aged ≥ 64 years (73.86 ± 8.0 years) and compared them to a younger group aged 20 to 40 years (29.2 ± 5.7 years) in a cohort of 324 patients. Outcome was dichotomised as favourable (mild and moderate disability but independent; Glasgow Outcome Score [GOS] 4 and 5), unfavourable (severe disability and persistent vegetative state; GOS 2 and 3) and death (GOS 1). **Results:** In the elderly group, the mortality (55.4%) was slightly more than double that of the younger group (20.9%); 21.5% had an unfavourable outcome (14.2% in the younger group) and only 23% had a favourable outcome (compared to 64.9% in the younger group). The final outcomes were significantly worse in all levels in the elderly group. This was in spite of data showing that the mechanism of injury was of a higher impact in the younger group, with a higher incidence of polytrauma and cervical spine injury. On admission, the mean Glasgow Coma Score (GCS) was 8.3 ± 3.91 for the elderly group and 8.59 ± 4.05 for the younger group ($P = 0.763$). Computed tomography scan showed that the elderly had a higher incidence of mass lesions (extradural haematoma and subdural haematoma) and traumatic subarachnoid haemorrhage. A subgroup (29.2%) of elderly patients had no surgical intervention based on poor clinical/neurological status, premorbid functional status and pre-existing medical conditions, with their family's consent. The GCS of ≤ 8 , on admission, was significant ($P < 0.001$) in predicting mortality in the elderly. In the elderly group, the female gender had a higher mortality rate (70.4%) than the males (44.7%) ($P = 0.19$). **Conclusion:** Age must be considered an independent factor in outcome prediction in the elderly with moderate and severe traumatic brain injury. A more conservative approach in the management of an elderly patient with severe head injury may be reasonable given its dismal outcomes after careful dialogue with the relatives.

Ann Acad Med Singapore 2004;33:63-7

Key words: Geriatric, Glasgow Outcome Score, Glasgow Coma Score, Moderate and severe traumatic brain injury

Introduction

Trauma remains the fifth most common cause of death in Singapore; it contributed 6.7% of mortality in 2001.¹ Head injury contributes to a significant proportion of patients who die from trauma.²

The management of severe and moderate traumatic brain injuries (TBIs) is very labour-intensive and costly for the

institution and the families involved. Many who survive have a protracted hospital stay requiring multi-disciplinary rehabilitative and supportive care, thus resulting in multiplied financial and emotional burden to the families.² This is especially true for the elderly with TBI.^{3,4}

Many studies⁵⁻¹⁶ have noted that the elderly have much poorer outcomes at all levels, even with comparable Glasgow

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Coma Scores (GCS) on admission. They have lower impact injuries and lower rates of multiple injuries, but with more severe computed tomography (CT) scan findings (mass lesions, subarachnoid haemorrhage [SAH] and midline shift).^{8,17,18} Age has been cited as a significant risk factor for poor outcome in several studies, either alone or in combination with GCS. Some authors have suggested a critical age threshold for worsening prognosis at 55 to 60 years of age.^{8-10,19,20} Several theories have been suggested, but these are still open to speculation and need further studies.^{5,8,11,21}

In Singapore, as with the rest of the world, the population is greying, with 7.4% of the population aged >65 years old in 2001.¹ Elderly patients, with their comorbidities and increasing physical frailties, are at significant risk from TBIs. A standardised protocol, aimed at maintaining an adequate cerebral perfusion pressure (CPP) comparable to existing published guidelines for the management of moderate and severe TBI, was implemented in our neurointensive care unit in 1996.²²

While this protocol has shown its relative efficacy in improving outcomes,²² there is no specific study in the local context which analyses its efficacy in the elderly population. We, therefore, decided to review elderly patients with TBI and their outcomes as compared to younger (aged 20 to 40 years old) patients managed on a standardised protocol.

Materials and Methods

We retrospectively reviewed all consecutive patients with severe TBI, for the period August 1999 to July 2001, from our prospectively maintained database of TBI patients admitted to our institution. As all patients required intubation and artificial ventilation or close neurological monitoring, they were managed in the neurosurgical intensive care unit (NICU). Of the 324 patients, 65 (20.1%) were aged ≥ 64 years and 148 (45.7%) were aged between 20 to 40 years old. They were admitted to the NICU according to established criteria for moderate and severe head injury, and were managed on a standardised, incremental protocol centred on a multi-modality monitoring system based on maintenance of adequate CPP and aggressive detection and treatment of secondary insults (such as hypotension, hypoxia, hyperpyrexia and hypoglycaemia).²² This is in accordance with the guidelines of the Brain Trauma Foundation.²³

Data collected included patient demographics, clinical findings on admission (including the post-resuscitative GCS, pupillary signs, presence of multiple and cervical spine injuries, ingestion of alcohol and mechanism of injury) and CT scan findings graded using the classification suggested by Marshall et al.^{24,25} Surgical interventions, including intracranial pressure (ICP) monitor insertion, craniotomy for mass lesions and the use of phenobarbitone coma protocols for raised ICPs according to existing criteria, were also collected. The multi-modality monitoring of physiological parameters in these patients include continuous electrocardiograph, invasive intra-arterial pressure, continuous pulse oximetry, continuous transduced central

venous pressure, CPP, hourly urine output and core temperature. The data were continuously entered automatically into a clinical information system (CIS; Hewlett-Packard Carevue 9000, Philips Medical System). ICP monitoring was via a strain gauge device previously described.²² Specific treatment targets for ICP and CPP, as well as guidelines for conventional intensive care unit management regarding nutrition, infection surveillance, deep vein thrombosis (DVT) prophylaxis and ventilatory protocols, were followed.

Outcome was assessed at 6 months post-injury using the Glasgow Outcome Scale (GOS).²⁶ However, for the purposes of analysis, we dichotomised the outcomes into 3 categories: death (GOS 1), unfavourable (GOS 2 and 3) and favourable (GOS 4 and 5). Clinical findings, as well as CT scan and radiological findings, and surgical interventions were correlated to outcome in both age groups.

All statistical analyses were carried out using SPSS (version 11.0) Association between outcome and categorical variables in both groups were assessed using chi-square or Fisher's exact test. Statistical significance was assumed if $P < 0.05$.

Results

Of the 65 patients aged ≥ 64 years old, 38 were male and 27 were female (range, 64 to 96 years; 73.86 ± 8 years). The ratio of males to females was 1.4:1. In the younger cohort, aged 20 to 40 years, the mean age was 29.2 ± 5.7 years ($P < 0.05$), with a ratio of males to females of 6.78:1 (Table 1).

The mechanism of injury between the 2 groups was very different, which was also seen in other studies. The elderly group had injuries of a much lower impact: falls (mainly domestic) accounted for up to 73.8% of injuries, and 21.5% involved vehicular accidents or were pedestrians. In the young age group, 54.7% were vehicular accidents in nature, the majority of whom were drivers or motorcyclists; 37.8% were due to fall from heights of several metres in height, a significant number from industrial accidents ($P < 0.05$). The rate of multiple injuries was much higher in the young age group, 31.1% ($P < 0.05$), accompanied by a cervical spine injury rate of 11.5%. In contrast, the elderly had a multiple injury rate of 12.3% and cervical spine injury rate of only 1.5%.

CT scan findings, based on the classification system of Marshall et al,²⁴ were more severe in the elderly group, with 86.2% exhibiting mass lesion compared to 60.8% in the young cohort ($P < 0.05$). The elderly had a 32.3% incidence of SAH on CT scan which was comparable to the young, which had 37.8%.

The mean GCS on admission, in the elderly was 8.3 (SD, 3.91) and 8.59 (SD, 4.05) in the young ($P = 0.763$). The distribution of patients, when grouped under GCS ≤ 8 , GCS 9 to 12 and GCS 13 to 15, was also quite comparable in both groups. A GCS of ≤ 8 on admission was statistically significant ($P < 0.05$) in the elderly group in predicting mortality; in the young age group, it was also significant ($P < 0.05$).

The mortality rate for the elderly was 55.4% compared to

Table 1. Patient Demographics and Prognostic Variables in Two Age Groups

Characteristics	20 to 40 years old (n = 148)	≥ 64 years old (n = 65)	P value
Mean age	29.22 ± 5.69	73.86 ± 8.04	<0.05
Male:Female	6.78:1	1.4 : 1	<0.05
GCS on admission			
≤8	88 (59.5%)	36 (55.4%)	0.763
>8	60 (40.5%)	28 (43.1%)	
Mechanism of injury			
Falls	56 (37.8%)	48 (73.8%)	<0.05
Vehicular/pedestrian	81 (54.7%)	14 (21.5%)	
Alcohol influence/presence	17 (11.5%)	3 (4.6%)	0.219
Pupillary abnormalities	35 (23.6%)	14 (21.5%)	0.571
Mass lesion on CT scan	90 (60.8%)	56 (86.2%)	<0.05
Presence of traumatic SAH	55 (37.2%)	21 (32.3%)	0.621
Injury rate			
Multiple	46 (31.1%)	8 (12.3%)	
Cervical spine	17 (11.5%)	1 (1.5%)	<0.05
Surgical intervention rate	63 (42.6%)	23 (35.4%)	0.268
Outcome			
1 (death)	31 (20.9%)	36 (55.4)*	<0.05
2 (poor outcome)	21 (14.2%)	14 (21.5%)*	
3 (good outcome)	96 (64.9%)	15 (23.1%)*	

CT: computed tomography, GCS: Glasgow Coma Score, SAH: subarachnoid haemorrhage

* One patient had missing outcome data.

Table 2. Outcomes According to GCS Groups

Variable	20-40 years old (n = 148)			≥64 years old (n = 65)*			P value
	Death	Poor outcome	Good outcome	Death	Poor outcome	Good outcome	
GCS							
≤8	30/88 (34.1%)	18/88 (20.5%)	40/88 (45.5%)	26/36 (72.2%)	4/36 (11.1%)	6/36 (16.7%)	<0.05
>8	1/60 (1.7%)	3/60 (5%)	56/60 (93.3%)	9/28 (32.1%)	9/28 (32.1%)	10/28 (35.7%)	<0.05
P value	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	

GCS: Glasgow Coma Score

* One patient had missing outcome data.

20.9% ($P < 0.05$) in the young age group (Table 1). The poor outcome was 21.5% in the elderly group compared to the young age group at 14.2%. The good outcome rate of the elderly was about half that of the young: 23% compared to 64.9%.

When the GCS on admission was taken into account, the trend of poorer outcomes at all levels in the elderly group, compared to the young, was still evident ($P = 0.000$). The poor outcome rate in those admitted with GCS ≤8 in the elderly group was lower than the younger group, due probably to the fact that most of the patients had died (Table 2).

Nineteen (29.2%) patients in the elderly group were deemed not suitable for neurosurgical intervention after re-assessment by the neurosurgeons and consultation with their families. Nevertheless, they were given supportive treatment under the

protocol aimed at minimising secondary insults (such as preventing hypotension, hypoxia, hyperglycaemia and hyperpyrexia). The majority (78%) of these cases had a GCS of 3 to 5 on admission, with CT scan findings of skull fractures with large subdural haematomas, extradural haematomas and/or SAH. There was 1 case each with the following: haemodynamic instability due to intra-abdominal bleeding requiring laparotomy, coagulopathy due to warfarin therapy, positive human immunodeficiency virus status, carcinoma of the breast and poor premorbid functional status. About 50% of patients were aged >75 years old and 57.1% were females. Of the 19 patients, 18 died and 1 survived in a vegetative state. When these 19 patients were excluded, the “true” mortality rate in the elderly group was still substantial at 40%, which was still nearly twice that of the younger group.

The female mortality rate in the elderly group was 70.4%

compared to the male mortality rate of 44.7% ($P=0.019$). This gender difference was not seen in the young age group ($P=0.232$).

Correlation with other factors in our database, including pupillary signs, incidence of hypoxia and hypotension, did not reveal any significant differences between both age groups which could account for the differences in outcome in the 2 age groups.

Discussion

Head injury accounts for a significant proportion of neurosurgical conditions afflicting the elderly.²⁷ The effects of a head injury are disproportionately more severe in the elderly. For a given severity of head injury, more elderly patients require admission, neurosurgical care²⁸ and longer hospital stay.⁷

The epidemiological profile of our local population appears to be similar to those in the West.^{2,11,15,17} Men appear to be more commonly afflicted, though this gender difference is more marked in younger patients (Table 1). The elderly group generally tends to have injuries of a lower impact, such as those sustained in falls. This may be due to frailties associated with advanced age, such as poor eyesight, impaired balance, postural hypotension and cerebrovascular accidents. As such, these patients seem to have less associated multiple injuries or accompanying cervical injuries. Vollmer et al⁸ concluded that multiple injuries do not seem to be a major determinant of death in head injury patients in any age group from the Traumatic Coma Data Bank study. This was echoed by Baltas et al²⁹ and Baxt and Moody.³⁰ Elderly patients with moderate and severe head injury tend to have a higher incidence of traumatic intracranial haemorrhage. This is especially so if the patient presented with coma ($GCS \leq 8$); only 16.7% had a favourable outcome compared to 43.8% who had good outcomes if the presenting GCS was ≥ 8 .

An increasing incidence of intracerebral haematoma with age has been noted in other studies, and is associated with decreasing chances of survival.⁸ Some studies have suggested that the presence of traumatic SAH on initial CT scan is also an adverse prognostic factor.³¹⁻³⁴ A 2-fold increase in mortality was noted in the group with subarachnoid blood in the United States Trauma Coma Bank study,¹¹ and it was postulated that the presence of subarachnoid blood appeared to predict an abnormal ICP. The presence of subarachnoid blood may represent major vessel injury with its attendant problems of vasospasm and tissue ischaemia. This adverse prognostic effect was also noted in patients with acute subdural haematomas.³⁵

In this review, the trend of poor outcome noted in elderly with closed head injury is in line with that found in other studies.⁵⁻¹⁶ Some studies have even suggested that age can be considered an adverse risk factor in head injury. The threshold has been suggested to be between 55 to 60 years of age. The poor outcome rates quoted in other studies on closed head

injury in the elderly ranged from 46% to 78%, and age has been identified as a strong prognostic indicator.³⁶

Although elderly patients have a much higher incidence of pre-existing systemic disease, this factor has been discounted as a predictor of poor outcome in other studies.^{2,5}

Nineteen patients did not have any neurosurgical intervention which included ICP monitoring, but were still managed on the protocol. The factors which persuaded us not to perform invasive cranial procedures include poor anaesthetic risk from pre-existing premorbid disease states, coagulopathy or a very poor neurological condition at presentation ($GCS 3$). While it may be argued that this group of patients may theoretically confound our results, we think that that would be highly unlikely as they represent patients with a very poor risk-to-benefit ratio for surgical intervention and/or survival. Nevertheless, even when this group of patients was disregarded, the mortality was still 40%; this is twice that of the younger group.

It is as yet unclear why the elderly have a greater propensity to develop a haematoma after an apparently trivial injury. Certainly, cerebral atrophy with a change in the viscoelastic properties of the brain, alterations in the mechanical properties of the bridging veins and stress placed on the venous structures secondary to cerebral atrophy may all contribute. Other systemic factors, including higher mean blood pressure, increased vascular rigidity and alterations in haemostatic mechanisms, may result in the development of larger haematomas, as would the greater potential volume of the subdural space following brain atrophy.

Overall, despite recent advances in the management of moderate and severe TBI, the mortality figures of the elderly remain dismal. While current results compare favourably with previous reports,³⁰⁻³⁸ the fact remains that only 1 in 5 is expected to have a favourable outcome, with most having a $GCS > 8$ on admission. The poor prognosis for elderly patients with severe TBI ($GCS \leq 8$), with traumatic intracranial haemorrhage on CT scan, has important ethical consequences.

How far should we pursue intensive and surgical management in this age group? A nihilistic approach may deprive a small group of patients who may benefit from aggressive treatment. Perhaps an individualised approach may be more appropriate. Obviously, patients who have a poor premorbid condition, poor GCS and massive traumatic intracranial haemorrhage may lead the surgeon towards a more conservative approach, while patients who have a good premorbid state and $GCS > 8$ may require a more aggressive approach.

Conclusion

The elderly with head injury needs to be reassessed by neurosurgeons after initial resuscitation. In cases when the presenting GCS is poor and the patient has significant comorbidities, counselling and discussions of the potential outcomes with their families should be done before further therapies are instituted. In our centre, the data in this study can

be used when counselling the patients' families, as there are no previous local data. This will help in the judicious use of the limited resources available, as well as to reduce the emotional and financial burdens to the families concerned.

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