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The Use of Motor Response (M Score) to Predict the Prognosis and Improve Treatment Outcomes in Patients with Severe Traumatic Brain Injury, Pranangklao Hospital, Nonthaburi Province

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Suriya Piyapadungkit, M.D.
Department of Surgery, Pranangklao Hospital, Nonthaburi, Thailand

Abstract This study aimed to use motor response of Glasgow Coma Scale (M score) for outcome prediction in patients with severe traumatic brain injury (TBI) in order to provide proper management leading to the better treatment outcomes. The scope of the study also included the role of intensive care unit (ICU) on the patients' survival. It was conducted as retrospective study among 214 severe TBI patients admitted at Pranangklao Hospital between October 2015 and September 2018. All patients had severe traumatic brain injury (GCS score 3-8 and M score of 1-5). Patients with moderate and mild TBI (M-score 6, GCS scores 9-12 and 13-15), multiple injuries with unstable hemodynamic (hypovolemic shock), spinal injury with paralytic extremities, or multiple fractures of extremities were excluded. The patients were divided into 2 groups: the M_1- M_3 group and the M_4-M_5 group. Both groups were admitted either in ICU or non-ICU depending on ICU beds status at admission time. It was found that the M_1-M_3 group had higher mortality than the M_4-M_5, (mortality rate of 88.1% vs. 26.9%). It was also revealed that ICU played an important role in reducing the mortality rate in both groups (ICU mortality of 81.0% vs. non-ICU mortality 95.2% in the M_1-M_3 group, and 11.9%, vs. 42.9 % in M_4-M_5, respectively, $p<0.01$). Thus, motor response (M score) should be used effectively for outcome prediction and selection of TBI patients with poor prognosis for intensive care; and ICU service could be necessary for the better survival. Patient with severe TBI, especially those with M score 4-5, should be admitted in ICU for better survival and better treatment outcomes. In conclusion, increasing the number of ICU beds to meet the patients need and selecting patients according to prognosis by using M score especially M_4-M_5 for ICU admission and proper management in case of limited ICU beds would decrease preventable deaths.

***Keywords*: severe traumatic brain injury, Glasgow coma scale, Glasgow outcome scale, motor response**

Introduction

Traumatic brain injury (TBI) remains an important health problem and a leading cause of death worldwide.[1-4] The most common cause of TBI is road traffic injuries.[5] In Thailand, road traffic injuries were among in the top five of common causes of death (15,000 cases/year or 22.3 per 100,000 population).[6] Road traffic injuries accounted for 46.5% of injuries. Of which, 51.2% of the cases were young people, and 86.6% of them were involved in motorcycle crashes.[7]

TBI is divided into 3 groups of severity by Glasgow Coma Scale (GCS) score: mild (GCS 13-15), moderate (GCS 9-12) and severe (GCS 3-8).[3,5,8-12] Severe TBI is one of the most serious health problems because of high mortality (50.0%: 1.5 million/year) and high morbidity (30.0%-70.0%)[1,3,4,8-14] depending on age, pupillary response, hypovolemic shock, hypothermia, hypoxia, degree of midline shift in CT scan, intensive care unit and management, brainstem reflex, motor response and GCS score.[4,10,15-23]

Plum F and Levy DE reported some patients with the potential for recovery received less treatment than they need and others with overwhelming and irreversible brain damage received good supportive care.[24] Intensive care unit (ICU) ICU admission and intensive management have been utilized to patients with severe TBI to improve outcomes and prevent secondary brain injuries.[1,3,5,8,19,25] From the data, severe TBI is a common problem and Thai Ministry of Public Health needs to reduce mortality and has policy to achieve the target.[7] Nevertheless, one of the limitation is the limited ICU beds for too many severe TBI patients, which lead to increase mortality.

The objectives of this study were to assess the use of motor response component (M score) of GCS as a tool to predict the prognosis and improve treatment outcomes in patients with severe TBI, and the role of ICU care in improving the patients' survival. It was expected that the study findings would be useful in reducing mortality and improving clinical recovery outcomes in TBI patients, as well as appropriately allocating resources and prioritizing treatment for the patients, leading to the proper management and the better treatment outcomes.

Material and Methods

This study was conducted as a retrospective analytic study among severe TBI patients admitted at Pranangklao Hospital between October 2015 and September 2018. The research proposal was reviewed and approved by the Pranangklao Hospital Ethic Committee. There were altogether 214 patients during the study period. All patients had severe traumatic brain injury (GCS score 3-8). Other patients with moderate TBI (M_6 and GCS score 9-12), mild TBI (GCS score 13-15), multiple injuries with unstable hemodynamic (hypovolemic shock), spinal injury with paralytic extremities, multiple fractures of extremities were excluded. The patients were divided into 2 groups by using motor response component of Glasgow Coma Scale: group M_1-M_3 and group M_4-M_5. All patients did not open their eyes (E_1) and had been intubated (V_t). The treatment outcomes of the 2 groups were analyzed and compared. Patients admitted either in ICU or non-ICU were randomized depending on ICU beds availability at the time of admission. The treatment results between ICU and non-ICU patients were also compared.

In Pranangklao Hospital, medical equipment and arrangement in ICU and non-ICU were as follow: ICU had volume respirator, patient:nurse ratio = 2:1, suitable

room temperature and more equipment (BP monitor, pulse oxymetry, arterial blood gas etc.) but non-ICU had a Bird's respirator, patients:nurse ratio = 8-10, warm to hot room temperature and limited number of BP monitors.

The study outcomes were measured by (1) mortality rate, (2) mechanical ventilator support time (duration of weaning or death), and (3) recovery status at the discharge time using Glasgow Outcome Scale which categorizes the treatment outcomes into 5 categories: (1) death, (2) persistent vegetative status, (3) severe disability, (4) moderate disability, and (5) low disability or good recovery.[26] Statistical analysis was performed by using mean, percentage for characteristics of the patients. Discrete data were compared by Chi-square test, and continuous quantitative variables by Student's t-test.

Results

There were 84 patients in the M_1- M_3 group and 130 in the M_4-M_5. Demographic characteristics, clinical data and treatment outcomes of the 2 groups were presented in Table 1. There were no significant differences of the 2 groups with regard to sex, age, admitted ward and waiting time to surgery (door to incision). However, the M_1-M_3 group had significantly more midline shift in CT scan than the M_4-M_5. In addition, the M_1- M_3 group had higher mortality than the M_4-M_5 group (mortality rate of 88.1% GOS 4,5 3.6 %, compared to mortality rate 26.9% GOS 4,5 60%, $p<0.01$); and longer ventilator-weaning time, $p<0.01$; lived shorter, $p<0.01$; and worse outcome, $p<0.01$ (Table 1).

Table 1 Demographic characteristics, clinical data and treatment outcomes of the 2 groups: M_1- M_3 and M_4-M_5

Charactetristics		Group M_1-M_3 (n=84) Number (%)	Group M_4-M_5 (n=130) Number (%)	p-value
Sex	male	68/84 (81.0%)	115/130 (88.5%)	
	female	16/84 (19.0%)	15/130 (11.5%)	
	Total	84/84 (100.0%)	130/130 (100.0%)	0.127
Age (year)		12-65	4-79	
	Mean±SD	32.79±12.81	34.04±18.44	0.587
Ward				
	ICU	42/84 (50.0%)	67/130 (51.5%)	
	non-ICU	42/84 (50.0%)	63/130 (48.5%)	
	Total	84/84 (100%)	130/130 (100%)	0.826
Mechanism of injury				
	Road traffic injuries	80/84 (95.24%)	126/130 (96.92%)	
	Gunshot wound	2/84 (2.38%)	1/130 (0.77%)	
	Falling	2/84 (2.38%)	3/130 (2.31%)	
CT-Scan				
	Epidural hematoma	11/84 (13.10%)	40/130 (30.77%)	
	Subdural hematoma	58/84 (69.04%)	57/130 (43.85%)	
	Others	15/84 (17.86%)	33/130 (25.38%)	

Table 1 Demographic characteristics, clinical data and treatment outcomes of the 2 groups: M_1- M_3 and M_4-M_5 (cont.)

Charactetristics	Group M_1-M_3 (n=84) Number (%)	Group M_4-M_5 (n=130) Number (%)	p-value
Midline shift (mm.)	0 -23.8	0 -24.5	
Mean±SD	8.32±7.02	4.16±5.47	<0.001
Surgery			
ICU	19/42 (45.24%)	35/67 (52.24%)	
Non-ICU	15/42 (35.71%)	28/63 (44.44%)	
Total	34/84 (40.48%)	63/130 (48.46%)	
Door to incision (hour)	1.5-50	1.5-96	
Mean±SD	8.18±10.01	9.75±14.01	0.563
Duration on mechanical ventilator (day)	4-180	1-62	
Mean±SD	38.10±51.68	11.49±14.17	<0.001
Living time before death (day)	1-56	1-37	
Mean ± SD	4.62±6.63	8.80±8.76	0.007
Clinical outcomes at discharge			
Good (GOS 4-5)	3/84 (3.6%)	78/130 (60%)	<0.001
Poor (GOS 2-3)	7/84 (8.33%)	17/130 (13.08%)	<0.001
Dead (GOS 1)	74/84 (88.1%)	35/130 (26.9%)	<0.001

Tables 2 and 3 compared outcomes of patients admitted in ICU and non-ICU among the M_1-M_3 group and the M_4-M_5 group, respectively. The data showed that there was no statistical difference in sex, age, and door to incision between the ICU and non-ICU patients in the M_1-M_3 group <p>0,05). Howev-

Table 2 Comparison of demographic and clinical characteristics of M_1-M_3 patients who were admitted in ICU and Non-ICU

Charactetristics		ICU (n=42) Number (%)	Non-ICU (n=42) Number (%)	p-value
Sex	Male	32/42 (76.2%)	36/42 (85.7%)	
	Female	10/42 (23.8%)	6/42 (14.3%)	
	Total	42/42 (100%)	42/42 (100%)	0.266
Age (year)		12-61	15-65	
Mean±SD		40.07±19.40	41.38±19.21	0.757
Surgery		19/42 (45.24%)	15/42 (35.71%)	
Door to incision (hour)		2-18	1.5-50	
Mean±SD		9.82±12.79	6.1±4.22	0.289

Table 2 Comparison of demographic and clinical characteristics of M_1-M_3 patients who were admitted in ICU and Non-ICU (cont.)

Charactetristics	ICU (n=42) Number (%)	Non-ICU (n=42) Number (%)	p-value
Mortality	34/42 (81.0%)	40/42 (95.2%)	0.043
Time to wean ventilator (day)	6-44 (n=8)	4-180 (n=2)	
Time to dead (day)	1-15	1-8	
Mean±SD	6.53±9.26	3.00±1.93	0.021

Table 3 Comparison of demographic and clinical characteristics of M_4-M_5 patients who were admitted in ICU and Non-ICU

Charactetristics		ICU (n=67) Number (%)	Non-ICU (n=63) Number (%)	p-value
Sex	Male	61/67 (91.0%)	54/63 (85.7%)	
	Female	6/67 (9.0%)	9/63 (14.3%)	
	Total	67/67 (100%)	63/63 (100%)	0.342
Age (year)		4-79	13-70	
Mean±SD		34.84±20.30	33.19±16.35	0.613
Surgery		36//67 (53.73%)	26/63 (41.27%)	
Door to incision (hour)		1.5-96	2-22	
Mean±SD		13.04±17.74	5.64±4.78	0.036
Mortality		8/67 (11.9%)	27/63 (42.9%)	<0.001
Time to wean ventilator (day)		1-62	1-40	
Mean±SD		13.98±15.65	7.29±10.13	0.026
Time to wean ventilator in 2 weeks (day)		1-13	1-14	
Mean ±SD		4.82±2.81	4.39±2.93	0.464
Time to dead (day)		1-26	1-15	
Mean ±SD		12.13±9.67	7.81±8.41	0.227

er, the ICU patients had lower mortality (81.0% vs. 95.2%), and longer survival (6.53 days vs. 3.00 days). Similar findings for sex and age were observed in the M_4-M_5 group. The ICU patients in this group were found to have significantly delayed surgery (13.04 hours vs. 5.64 hours), longer survival (12.13 hours vs. 7.81 hours) and lower mortality (11.9% vs. 42.9%), $p<0.05$. There was a hugh gap in the mortality between the M_1-M_3 and the M_4-M_5 groups, 11.9% compared to 81.0%, although the outcomes were significantly higher than that of the non-ICU patients.

Discussion

Glasgow Coma Scale (GCS) was developed in 1974 by Teasdale G and Jennett B, and was utilized worldwide.[27] GCS composed 3 component of Eye opening (E), Verbal response (V) and Motor response (M). The Glasgow Outcome Scale (GOS) first described in 1975 by Jennett B and Bond M used for evaluating outcomes after treatment is divided into 5categories: (1) death, (2) persistent vegetative states: minimal responsiveness, (3) severe disabilities: conscious but disabled; dependent on others for daily support, (4) moderate disability: disabled but independent; can work in sheltered setting, and (5) low disability or good recovery: resumption of normal life despite minor deficits.[26] GCS and GOS are used to evaluate severity and treatment outcomes worldwide.

Motor response (M score) alone can predict outcomes accurately equivalent to the full GCS but motor response has linear relationship to mortality while GCS does not have a linear relationship with mortality.[28-29] The better GCS and the better motor response (M score) provided the better GOS at 6-12 months.[30] This study revealed that the M_4-M_6 group had survival rate and outcomes superior to M_1-M_3 group. As well, the M_4-M_6 group had lower mortality, more rapid weaning of ventilator, long living time before dead (in other word, having more chance to survive), and had better GOS recovery outcomes. ICU also played the important role on the patients' survival.

Conclusion

Motor response (M score) is found to be an effective tool for predicting outcomes and sorting appropriate services for patients with severe TBI in order to reduce mortality rate, improve recovery outcomes, adjust mechanical ventilator support time, and prolong living time before death. As demonstrated in this study, patients in the M_4-M_5 group had better treatment outcomes than the M_1-M_3 group. Another significant finding in this study is the role of ICU services which are necessary for improving survival rate in patients with severe TBI, particularly those with M scores 4-5 (M_4-M_5) who should be admitted in ICU for better survival. It is recommended to increase the number of ICU beds to meet the patients need or select appropriate service that fit with patients' prognosis according to their M score. Proper management of ICU beds in medical facilities with limited ICU beds is also recommended in order to reduce preventable deaths.

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การศึกษานี้มีวัตถุประสงค์เพื่อใช้ motor response ใน Glasgow Coma Scale (M score) ทำนายผลการรักษาและคัดแยกผู้ป่วยที่มีพยากรณ์โรคดี-เลว กรณีบาดเจ็บสมองอย่างรุนแรงนำไปสู่การรักษาที่เหมาะสมเพื่อให้ได้ผลรักษาที่ดี การศึกษานี้ครอบคลุมถึงความสำคัญของหอผู้ป่วยหนักต่ออัตรารอดของผู้ป่วย เป็นการศึกษาย้อนหลังผู้ป่วยบาดเจ็บสมองอย่างรุนแรง (severe TBI) 214 ราย ที่รับไว้ในโรงพยาบาลพระนั่งเกล้าระหว่างเดือนตุลาคม 2558- กันยายน 2561 ผู้ป่วยทั้งหมดเป็นผู้ป่วยบาดเจ็บสมองอย่างรุนแรง (GCS score 3-8) ส่วนผู้ป่วยบาดเจ็บสมอง ปานกลางและบาดเจ็บเล็กน้อย (M score 6, GCS scores 9-12 และ 13-15) ผู้ป่วยบาดเจ็บหลายระบบจนเกิดภาวะความดันโลหิตต่ำ(hypovolemic shock) ผู้ป่วยบาดเจ็บไขสันหลังจนเป็นอัมพาต ผู้ป่วยแขนขาหักหลายท่อนไม่นับรวมในการศึกษานี้ แบ่งผู้ป่วยเป็น 2 กลุ่ม คือ กลุ่ม M1-M3 และกลุ่ม M4-M5 แต่ละกลุ่มรับไว้ทั้งในหอผู้ป่วยหนักและหอผู้ป่วยสามัญโดยไม่มีอคติขึ้นกับสภาวะเตียงที่มีในหอผู้ป่วยหนักขณะรับผู้ป่วยไว้ในโรงพยาบาล ผลการศึกษาพบว่า ผู้ป่วยกลุ่ม M1-M3 มีผลการรักษาต่ำกว่ากลุ่ม M4-M5 (อัตราตายร้อยละ 88.1, GOS 4-5 ร้อยละ 3.6 เทียบกับอัตราตายร้อยละ 26.9, GOS 4-5 ร้อยละ 60.0, $p<0.01$) ผู้ป่วยที่รักษาในหอผู้ป่วยหนักมีผลการตายต่ำกว่า (อัตราตายในหอผู้ป่วยหนักร้อยละ 81.0 เทียบกับหอผู้ป่วยสามัญ ร้อยละ 95.2, $p<0.01$ ในกลุ่ม M1-M3 และร้อยละ 11.9 เทียบกับร้อยละ 42.9 ในกลุ่ม M4-M5, $p<0.01$). ดังนั้น motor response (M score) สามารถใช้ทำนายผลการรักษาและคัดแยกผู้ป่วยที่พยากรณ์โรคดีกรณีบาดเจ็บสมองอย่างรุนแรงได้อย่างมีประสิทธิภาพ อีกทั้งหอผู้ป่วยหนักมีความจำเป็นต่ออัตรารอดของผู้ป่วย ซึ่งผู้ป่วยบาดเจ็บสมองอย่างรุนแรงโดยเฉพาะ M score 4-5 ควรได้รับการรักษาในหอผู้ป่วยหนักเพื่อเพิ่มอัตรารอดและได้ผลรักษาที่ดี การผลักดันให้เพิ่มปริมาณเตียงในหอผู้ป่วยหนักจนเพียงพอต่อปริมาณผู้ป่วยบาดเจ็บสมองอย่างรุนแรงหรือการคัดแยกผู้ป่วยตามพยากรณ์โรคโดยใช้ M score โดยเฉพาะ M4-M5 เพื่อวางแผนการรับเข้าหอผู้ป่วยหนักและวางแผนรักษาที่เหมาะสมในภาวะที่มีปริมาณเตียงในหอผู้ป่วยหนักจำกัด จะเป็นการลดการเสียชีวิตของผู้ป่วย

Keywords: severe traumatic brain injury, Glasgow coma scale, Glasgow outcome scale, motor response