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Prognostic Indicators in Moderate to Severe Traumatic Brain Injury

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Abstract: ***Introduction: TBI is emerging as a major health burden and problem affecting all countries. Classification based on severity, supplemented by neuro-imaging has significantly advanced our knowledge. Prognostic models are necessary to predict clinical outcome in cases of TBI. Aim of study: To identify and analyse strong predictors of outcome like GCS, Pupillary reactivity, CT characteristics, Demography and Comorbid conditions. Methodology: 200 TBI patients admitted and who fit into the moderate to severe head injury criteria were analysed. Conclusion: Based on these prognostic variables, probable outcome could be arrived at, thereby enabling us to take suitable decisions regarding the use of appropriate management techniques in order to achieve better outcome in these group of patients.***

Keywords: head injury, Prognosis, GCS, Trauma

1. Introduction

Traumatic brain injury (TBI) is emerging as a major health burden and socio-economic problem affecting all countries.[1] Classification based on clinical severity, supplemented by neuro-imaging has significantly advanced our knowledge and understanding of the mechanism involved in head injury, creating opportunities for effective intervention and treatment.

Prognostic models are necessary to predict clinical outcome in cases of TBI. They commonly use two or more criteria of patient data to predict outcome. Five possible predictors which had strong prognostic value were selected and a core prognostic group data base was arrived at.[2] Strongest predictors of outcome wereGlasgow Coma Scale (GCS), Pupillary reactivity, CT (Computerised Tomography) characteristics, Demography and Comorbid conditions.

2. Review of Literature

TBI is any damage to the brain from external forces in the form of rapid acceleration or deceleration, penetrating injuries or blast injuries that can result in temporary or permanent impairment of brain function with or without detectable structural damage.[3]

Points	Best Eye Opening	Best Verbal Response	Best Motor Response
6			Obeys commands
5		Oriented	Localizes to pain
4	Spontaneous	Confused	Withdraws to pain
3	To speech	Inappropriate	Flexion (decorticate)
2	To pain	Incomprehensible	Extension (decerebrate)
1	none	None	None

The most common cause of head injury is road accidents followed by falls. Birth trauma is the commonest cause in neonates.Mechanical forces that can cause head injuries can be classified as Static or Dynamic

Traumatic brain injury is classified usually on the basis of:
1) Severity 2) Mechanism 3) Anatomical feature of the injury and 4) Pathological features

Severity: It is classified into mild, moderate and severe.The most commonly used system is the Glasgow Coma Scale (GCS). Table 1. This scale is recommended for age ≥ 4 years. In childrenit differs from GCS in best verbal and motor response.

Mechanism: It can be divided into- Non penetrating and Penetrating head injury. Penetrating where the duramater is breached.In general,TBI is used to refer to non-penetrating injury.

Pathological Features: Pathologically it could be Extra axial – when it is outside the brain but within the skull, Extra axial lesions include – Sub Dural Hematoma,Extra Dural Hematoma,Sub Arachnoid Haemorrhage, Intraventricular haemorrhage.Intra axial – when it is within the brain tissue (hematomas). Focal – when it is confined to a specific area. Diffuse – when it is distributed in a general manner (e.g.: Diffuse Axonal Injury, concussion)

Clinical Assessment of Head Injury patient: To anticipate forthcoming sequelae and for successful management of head injury patients, a comprehensive neurological examination is the single most efficient factor in diagnostic evaluation.

The first and foremost is to assess respiration and ensure clear airway and oxygenation. After stabilizing respiratory and vascular status a complete history should be obtained regarding time and mode of injury, course of events following injury, duration and timing of loss of consciousness, drug intake, co-morbid conditions, associated seizures etc.

The state of consciousness is the single most important neurological examination and is recorded as per the GCS scale. Pupillary size, eye movements and optic nerve

function should be assessed. Motor examination, reflex examination and sensory examination should be done.An important part of examination in TBI is determination of brain death.CT scan is the preferred diagnostic modality to detect structural damage and detect developing or developed intra cranial haemorrhage.Currently, CT scan is advocated in all TBI patients with GCS of 14 or less and for patients with GCS 15, with presence of risk factors.[4]

As the pathology in TBI is a dynamic process, follow up CT scan is advised if there is clinical deterioration or if lesions were seen on initial CT scan. MRI studies are not useful in the acute or early phase as they do not provide any additional information for decision making.

3. Materials and Methods

The study is a prospective interventional study to highlight the importance of the five selected prognostic indicators on the outcome of the disease and to grade them accordingly.

The study is being conducted among inpatients in the Department of Neurosurgery at Government Coimbatore Medical College Hospital and who presented within 24 hours of their injury.

Methodology

Around 200 TBI patients admitted and who fit into the moderate to severe head injury criteria were analysed.200 TBI patients, more than 5 years of age admitted with GCS ≤ 13 are included. Patients on prolonged treatment, pregnant women, patients with bleeding disorders and hypertensive bleeds, patients brought dead, patients with third nerve damage caused by direct orbital trauma resulting in a dilated and/or a fixed pupil are excluded.

The study period was from July 2017 to August 2018. Prospectively collected, individual, patient data was used. At the end of the study the prognostic indicators were categorized based on their impact on outcome as most important, less important and least important. The criteria were then graded according to their outcome, by the Glasgow Outcome Scale (GOS) at 6 months. It was classified into 1) Favourable (good or moderate recovery) 2) Unfavourable (severe disability, vegetative, dead). The study was compared to the outcome obtained in the IMPACT study. [5]

Age

Value	Score
≤ 30	0
30-39	1
40-49	2
50-59	3
60-69	4
≥ 70	5

Pupillary Reaction

Both Pupils Reacting	0
One Pupil Reacting	2
No Pupils Reacting	4

CT Classification: (Marshall system)[6]

Diffuse injury I -no intra cranial pathology visualised on CT Scan

Diffuse injury II -cisterns present, with midline shift < 5 mm andfew lesion densities seen. No high or mixed densitylesion > 25 ml

Diffuse injury III -cisterns compressed or absent with midline shift0-5mm.No high or mixed density lesion > 25 ml

Diffuse injury IV -Midline shift > 5mm. No high or mixed density lesion> 25 ml

Evacuated mass lesion V -any surgically evacuated mass lesion. Non evacuated mass lesion VI - high or mixed density lesion > 25 ml notsurgically.

The Marshall's classification had limitations like wide differentiation between diffuse injuries and mass lesions and lack of specification on the type of mass lesion.

Using this chart sum scores was calculated for core (i.e. age, motor score, pupillary reaction) and the extended model (i.e. core + CT characteristics + hypotension + hypoxia). The 6-month outcome probability score was defined as 1 / (1+e-LP). Here LP is the linear predictor in logistic regression model.[7,8]

Marshall Classification

Age Category in Years	Unfavourable	%	Favourable	%
< 30	13	26%	37	74%
30 – 39	12	38.71%	19	61.29%
40 – 49	23	56.10%	18	43.90%
50 – 59	28	59.57%	19	40.43%
60 – 69	11	55%	9	45%
≥ - 70	9	81.82%	2	18.18%

Using the online prognostic calculator which is based on this formula, the predicted probability of mortality and unfavourable outcome for 6 months was arrived at.The outcome of this study was compared and validated with the IMPACT study.[9]

Score Chart for Predicting Outcome in Impact Study

4. Results

Based on the data collected the following statistics was arrived at.

	GRADE I	-2
	GRADE II	0
	GRADE III / IV	2
	GRADE V / VI	2
SAH	YES	2
	NO	0
EDH	YES	-2
	NO	0
HYPOXIA	YES/SUSPECTED	1
	NO	0
HYPOTENSION	YES/ SUSPECTED	1
	NO	0

Demographic profile
The demographic profile was: Male - 170 (85%) Female - 30 (15 %). Mode of injury:Road traffic accidents constituted the bulk of the cases. This was followed by self falls and assault. Road traffic accidents - 173 (86.5%) Self-fall - 23 (11.5%) Assault - 4 (2%).

25% of the cases were in the age group less than 30 years. 22.5% of cases were in the age group of 50 to 59. 21% of cases were in the age group of 40 to 49. 16 % of cases was in the age group of 30 to 39. 10% of cases was in the age group of 60 to 69. Only 5.5% cases were in the age group more than 70.

Glasgow Outcome Score (GOS)
Age wise GOS score: Though the total number of deaths was the highest in the 40 – 59 age group the highest percentage of death was in the above 70 years' group.

Age wise favourable and unfavourable outcome:

Severity of injury: The total number of patients with moderate injury was 90 and the number of patients with severe injury was 110. Moderate injury (GCS 9 – 12)- 90 (45%). Severe injury (GCS – 3 – 8)- 110 (55%)

In the GCS 3, GCS 4 and GCS 5 category the mortality in the study group was 100%.In the GCS 6 category the mortality was 66.67%.In the GCS 7 – 13 categories the mortality was 27.10%.

Pupillary Reactivity
Out of the 200 cases 103 cases had normal reaction of pupils to light, 75 cases had sluggish reaction to light and 22 cases had no reaction to light.The mortality in the group which had no reaction to light was 100%, whereas the mortality in the sluggishly reacting group and normally reacting group was 77.33% and 1.94%.Unequal pupils were seen in 25 cases, out of which 19 underwent surgery and 6 cases were treated conservatively. There were 2 deaths (10.53%), in the operated group and 5 deaths (83.33%) in the conservatively treated group.

CT Scan Detected Intracranial Lesion
Out of the 200 cases 16 cases presented with DAI (8%), SDH was present in 49cases (2 4.5%), 35 cases had EDH (17.5%), 31 cases presented with SAH (15.5%), 26 cases had haemorrhagic contusion (1 3%) and 43 cases had multiplelesions (21.5%) As per the Marshall's CT scan classification, 12 cases had grade I lesions (6%), 70 had grade II lesions (35%), 34 had grade III lesions (17%), 13 had grade IV lesions (6.5%) and 71 had grade V lesions (35.5%).

Status of Basal Cisterns
Out of the total 200 cases, 8 cases had obliteration of the basal cisterns (4%). 7 patients died (87. 5% mortality). 2 cases were associated with SDH (25%), 3 cases were associated with haemorrhagic contusion (3 7.5%) and 2 case was associatedwith SAH (25%) and one had multiple lesions (12.5%).

EDH and SDH
In a comparative study on mortality in patients with EDH and SDH, the number of patients with EDH was 36 and the mortality rate was 3 0.56% whereas for 69 cases of SDH the mortality rate was 5 3.62%. Hence SDH had a poor outcome.

Comorbid Conditions
Hypotension and hypoxia were considered and they were amenable to therapeutic modification.Of the 200 cases, 20 cases (10%) had hypotension and out of these cases 19 died (95%).8 cases (4%) had hypotension and hypoxia and all 8 died (100%)

Marshall's Class	Total Cases	%	Impact Study
GRADE I	12	6%	7%
GRADE II	70	35%	35%
G RADE III	34	17%	17%
G RADE IV	13	6.5%	4%
GRADE V	71	35.5%	28%

Predicted Probability of Mortality and Unfavourable Outcome
Using the prognostic calculator, the predicted probability ofmortality – core after 6 months was 25.02 %.The predicted probability of unfavourable outcome – core after 6 months was 36.77%. The predicted probability of mortality – core + CT after 6 months was 23.25%. The predicted probability of unfavourable outcome– core + CT after 6 months was 33.82%

Predicted probability of 6 month mortality core model	Predicted probability of 6 Month Unfavourable outcome core model	Predicted probability of 6 month Mortality core + C T model	Predicted probability of 6 Month Unfavourable outcome core + C T Model
25.02%	36.77%	23.25%	33.82%

Impact Study

Predicted probability of 6 month mortality core model	Predicted probability of 6 Month Unfavourable outcome core model	Predicted probability of 6 month Mortality core + C T model	Predicted probability of 6 Month Unfavourable outcome core + C T Model
28%	32%	26.50%	31.60%

5. Discussion

Prognostic models enable us to predict fairly accurately at the time of admission, as to what the outcome for a given injury might be10. Scores like the GCS help us to predict outcome only 24 hours following injury.[11,12]

Clinically, they help doctors as well as patients in decision making about the modality of treatment. They are also help

in research studies to compare outcomes in various patient's groups and in randomized controlled trials.[13]

When considering prognostic predictors, characters that can be reliably and easily determined within the initial few hours are chosen.[14] Subsequently five important predictors were chosen which had an importantbearing on patient outcome.[15]

They were:Glasgow Coma Scale, Demographics, Pupillary Size and Reaction, CT characteristics (Marshall Classification) and Comorbid Conditions (Hypotension, Hypoxia.

6. Conclusion

These prognostic indicators gave a reasonable discrimination among patients for good and poor outcome 6 months after traumatic brain injury.Patients who presented with GCS 5 and below had 100% mortality. Patients with dilated pupils and hypotension along with hypoxia also had a mortality rate of 100%.Patients with unequal pupils who underwent early surgery had a significant improvement in outcome compared to those who didn't undergo surgery.Patients above the age of 70 had 82% unfavourable outcome.Patients with multiple lesions along with mass effect and midline shift at the time of admission also had a poor prognosis.Based on these prognostic variables, probable outcome could be arrived at, thereby enabling us to take suitable decisions regarding the use of appropriate medical or surgical management techniques in order to achieve a better outcome in these group of patients.

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