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Review of Cerebral Protection Effect on the Outcomes of Severe Traumatic Brain Injured Patients in Bauchi, Nigeria

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Abstract

Introduction: As a cause of disability, severe traumatic brain injury (TBI) is a leading cause worldwide. The management of cerebral protection (CP) might play an outcome role in the patient. CP in optimize cerebral metabolism and subsequent agitation, prevent diffusion barriers from being compromised, and protect the brain from any additional insults secondary brain injury. The aim of this study was to analyze short term Glasgow Outcome Scale (GOS) in patients after CP at the intensive care unit (ICU) discharge and a month after ICU discharge. They are factors associated to the favourable outcome.

Methodology: This is a prospective cohort study that ran from February 2021 to January 2022. After ICU discharge and 1 month after ICU, shorter term outcomes of patients were evaluated discharge using GOS. GOS 4 and 5 was defined as favourable outcome.

We adopted Generalized Estimation Equation (GEE), to conduct bivariate GEE and multivariate GEE then. Thie equations enable the evaluation of the factors associated with favorable outcomes at ICU discharge and one month later.

Result: twenty-seven severe TBI patients who were admitted to ICU within 24 hours of (GOS of 8 and below) were recruited into the study and received CP management. At ICU discharge, the proportion of death was 17% and 0% at one month after ICU discharge. At ICU discharge the proportion of favorable outcomes was 26.1%, and 61.1% after 1 month post discharge.

We evaluated age, measured as odds ratio (OR) = 0.96 (95% CI: 0.94, 0.99; P =.001) among other factors. Duration of CP (OR = 0.41; 95% CI: 0.20, 0.84; P = 0.014) and hyperosmolar therapy (OR =0.41; 95% CI 0.21, 0.83; P = 0.013). The study shows significant association.

Conclusion: Younger age group, longer duration of CP and absence of hyperosmolar therapy is associated with favourable outcome. We recommend further clinical trials to assess the long-term outcome of CP.

Keywords: Traumatic brain injury; cerebral protection; Glasgow Coma Scale; Glasgow Outcome Scale

Introduction

According to reports head injuries trigger 1% of adult deaths while they cause 15% of all deaths in individuals between 15 to 45 years [1]. The demographic group faces significant mortality risks because of this condition. Headspace analysis of hospitalization outcomes show that brain injury inpatient mortality rates exist between 2.6% and 6.5% throughout European and US medical literature [2]. Hospital death rates after brain injuries depend largely on which system patients use to get referrals and admit them to facilities. The extent of disability throughout someone's lifetime rises with the level of trauma to their brain during an incident. The European hospital admission statistics show that every year 262 patients per 100,000 individuals need hospital care. The overall severe traumatic brain injuries (TBI) recorded number 10% when analyzing these medical cases. The definition of severe traumatic head injury applies when a post-resuscitation Glasgow Coma Score remains at or below 8 points [3]. Those who manage to survive traumatic brain injury develop various cognitive, emotional and neurological impairments [4, 5]. Severe head injuries experience different outcome rates among patients whose clinical situations are expected to be similar to each other. Study sites in both US and UK markets show such death rate heterogeneity that ranges between 15% and above 50% [6].

Critical care unit admission cases due to traumatic brain injuries (TBI) represents the second most common reason for hospitalizations as reported by the sixth leading cause of death in healthcare facilities [7]. A patient with severe traumatic brain injury (TBI) needs admission to a neurocritical unit that patients with intensive care unit capabilities to receive cerebral protection modalities. The process of cerebral protection requires healthcare providers to perform intubation and ventilate patients to safeguard their airway and preserve oxygen levels while lowering carbon dioxide concentrations. Patients need proper blood volume management combined with optimal sedation and pain control together with fever prevention and control of cerebral perfusion pressure for brain protection against additional harm and secondary brain injury [8]. The Brain Trauma Foundation has outlined guidelines that medical staff use to perform cerebral protection therapy [9]. Information in the guidelines remains vague because it provides numerous potential options which lead to variable cerebral protection implementation between different locations worldwide. The selection of medication alongside therapy choices belong to medical staff headed by neurosurgeons and neuro-anaesthesiologists who determine these procedures.

Several patient-specific conditions including TBI severity (mild, moderate, or severe) and injury type (blunt or penetrating) alongside individual characteristics steer the post-traumatic brain-injured neurological condition [10]. Medical professionals rely on the Glasgow Outcome Scale (GOS) to examine TBI-related patient outcomes because it remains the primary measurement instrument for this purpose. The functional capacity assessment through this test assigns ratings to patients from 1 to 5. Traumatic brain injury outcomes fall into two groups according to the Glasgow Outcome Scale: unfavourable results range from GOS 1 to GOS 3 but favourable results exist between GOS 4 to GOS 5.

A positive clinical outcome in TBI patients involves obtaining autonomy in their neurological functions after sustaining a traumatic brain injury. Wilson and colleagues [11] confirmed that the GOS can be evaluated through standard procedures documented in writing to achieve both practicality and consistency.

The variable practices of local physicians hinders full avoidance of unfavourable Glasgow outcome scale (GOS) results even though cerebral protection remains an effective method. However, there is currently no local data available regarding cerebral protection outcomes or favourable characteristics. This research evaluated severe traumatic brain injury (TBI) outcomes after cerebral protection and established the traits linked to positive results at the intensive care unit discharge and one month after discharge.

Materials and Method

A total of 27 patients with severe traumatic brain injury GCS ≤ 8 were included in the research after fulfilling admission criteria for ICU which included age between 18 and 65. This study omitted patients with cerebrovascular injuries and tumours or malignancies and other critical traumatic injuries in different body areas.

Researchers obtained participation consent from family members of recruited research participants and approval for the study was obtained from the Ethic and Research Committee of our institution with approval number, ATBUTH/REC/00572023.

Patients with severe traumatic brain injury underwent cerebral protection care at the intensive care unit following their direct admission between February to July 2024. Medical staff at the Brain Traumatic Foundation applied their cerebral protection therapy guidelines [12]. The treatment of patients with surgical lesions involved both surgical procedures and post-operative commencement of cerebral protection therapy. The patients with no surgical lesions received cerebral protection therapy starting immediately when they arrived at the ICU. No variations existed in tube cuff status or ventilator settings such as intermittent positive pressure ventilation applied to all patients. He received both intravenous fentanyl at a range of 0.5 mcg/kg/h-1 mcg/kg/h and intravenous propofol at 0.5 mg/kg/h-4 mg/kg/h. All patients received cardiovascular support through intravenous noradrenaline when necessary to maintain mean arterial pressure at 80 mmHg as the standard set pressure. Additional treatments administered to patients included hypothermia-related procedures along with barbiturate coma therapy according to evaluations performed by the neurosurgeon and anaesthetist. Intensive Care Unit personnel conducted ongoing tracking of blood pressure, Oxygen Saturation levels and Mean Arterial Pressure together with pupillary responses for all ICU patients. The Glasgow Outcome Score (GOS) was used to evaluate patient results at ICU discharge and afterward one month when patients left ICU.

Results

A total of twenty-seven patients were recruited for the study, while only 20 patients had a one-month follow-up after ICU discharge. Seven patients died during admission. The median age of our study population is 27.4 years, with a male preponderance that constituted 70.4% of the study population (Table 1).

Variables	*Number of patients (n=27)*	*Percent (%)*
Age (years)		
< 30	14	51.9
>30	13	48.1
Gender		
Male	19	70.4
Female	8	29.6

Table 1: Demographic profile of the patients.

Most of the study participants had surgical intervention (70.3%), which varied from the craniotomy and craniectomy with cloth evacuation to external ventricular drainage (Table 2).

Ninety-eight percent of patients who had surgical intervention commenced cerebral protection therapy immediately after the procedure, while only 6 patients (32%) commenced cerebral protection therapy after 1 hour of surgical intervention (Table 3). The duration of the cerebral protection therapy lasted for more than 72 hours in 11 patients (41%).

Variables	*Number of patients (n=27)*	*Percent (%)*
GCS (post-resuscitation)		
3	2	7.4
4	4	14.8
5	2	7.4
6	6	22.2
7	5	18.5
8	8	29.6
CT findings		
Acute EDH	8	29.6
Acute SDH	9	33.3
Brain Contusion	21	77.8
Brain Edema	12	44.4
SAH	16	59.3
Surgical procedure		
Yes	19	70.3
Type of procedure		
Craniotomy & clot evacuation	10	37
Craniectomy +/- clot evacuation	7	26
EVD	2	7
NB: GCS- Glasgow coma score, EDH-extradural hematoma, SDH-subdural hematoma, SAH-subarachnoid hemorrhage, EVD- external ventricular drainage.		

Table 2: Clinical profile of the severe TBI patients.

Parameters	*Total number of patients, n= 27 (%)*
Commencement	
Non-surgical	
< 3 hours	1(59)
>3 hours	7 (41)
Surgical	
Immediate	13 (68)
>1 hour	6 (32)
Duration	
< 72 hours	16 (59)
>72 hours	11 (41)

Table 3: Commencement and Duration of Cerebral Protection.

Seven patients (26%) died during intensive care admission. Favourable outcome was recorded in 41%, and 59% had favourable outcomes after discharge at the intensive care unit. Patients who were discharged from the intensive care unit were followed up for one month. Seven patients had unfavourable outcomes, and favourable outcomes were seen in thirteen patients (65%).

Glasgow Outcome Score (GOS)	*Number of patients (%)*
ICU Discharge, n=27	
GOS 1-3	16 (59)
GOS 4-5	11 (41)
1 Month post ICU Discharge, n=20	
GOS 1-3	7 (35)
GOS 4-5	13 (65)

Table 4: Glasgow Outcome Score at ICU discharge and 1 Month post-ICU discharge.

Parameters	*Bivariate OR (95% CI)*	*P-value*	*Multivariate OR (95% CI)*	*P-value*
Age (years)	0.969	0.015	0.961	0.004
	(0.945, 0.994)		(0.936, 0.988)	
Gender				
Male	1			
Female	1.222	0.755		
	(0.357, 4.181)			
GCS	1.437	0.001		
	(1.145, 1.803)			
Commencement of CP				
Non-surgical				
< 3 hours	1			
>3 hours	0.597	0.181		
	(0.281, 1.271)			
Surgical				
Immediate	1			
>1 hour	0.597	0.181		
	(0.281, 1.271)			
Duration of CP				
< 72 hours	0.420	0.010	0.410	0.014
	(0.217, 0.812)		(0.200, 0.838)	
>72 hours	1			
Surgical intervention				
Yes	0.599	0.193		
	(0.277, 1.296)			
No	1			

Table 5: Determinant of favourable outcomes at ICU discharge and 1-month post-ICU discharge.

Discussion

The Brain Trauma Foundation provides diverse guidelines about cerebral protection measures which serve severe traumatic brain injury patients through medical treatments and surgical procedures as well as layered monitoring systems [8]. Clinical practice accepts lowering intracranial pressure as per guidelines for secondary brain injury prevention because this technique reduces patient morbidity and mortality [3]. Most patients in our investigation demonstrated a median age of 26.4 years while research findings sup-

port that younger groups show specific trends of damage [13]. Male patients represented a larger patient count according to Frost et al.'s meta-analysis regarding TBI prevalence in developing nations [14].

Our developing nation location shares a common challenge with other developing nations when patients experience delays because of scarce tertiary medical facilities located away from rural areas during early cerebral protection window after the trauma.

The examined mortality rate reached 26% at ICU discharge beyond what developed nations typically experience at 18% [15]. The difference in mortality rates between our study period and other nations could stem from both the reduced duration of research along with delayed protection measures for the brain and late patient entries and environmental factors in our facilities. Fifty-nine percent of patients displayed unfavourable outcomes at ICU discharge but this percentage improved to 65% during month one after ICU release while the rate of unfavorable outcomes reduced to 35%. The research results matched results from the studies conducted by Arabin et al. [16] and Timofeev et al. [17].

Among the factors evaluated were; age of the patient, Glasgow coma score at admission, cerebral protection initiation time, cerebral protection duration, hyperosmolar therapy, hypothermia and surgical intervention. Age showed a strong association with outcomes, older age group from the study had unfavourable outcomes and this has been found in a study by Hukkelhoven et al. Physiological changes has been attributed to the likely reasons for unfavourable outcomes associated with age [19]. Also, older population have metabolic challenges and poor cardiac reserves which possibly explain unfavourable outcomes in older population [19].

The multivariate analysis on Glasgow coma score did not show any association with the outcome after cerebral protection. Hyperosmolar therapy in this study was associated with unfavourable outcomes while in contrast to this finding, Roquilly et al found out that the hyperosmolar therapy showed no statistically significant outcomes compared to those who did not receive hyperosmolar therapy [20]. Longer duration of cerebral protection improves the outcomes of patients with severe traumatic brain injuries in this study and this finding was similar to study by Mustafa et al. [21]. Randomized controlled trials study will be appropriate to substantiate further the findings in this study.

Conclusion

This study concluded that younger age group, longer duration of cerebral protection and absence of hyperosmolar therapy is associated with favourable outcome. We recommend further clinical trials, preferably multicenter randomized controlled trials to assess the long-term outcome of cerebral protection.

Research into cerebral protection effects with severe traumatic brain injury advances rapidly to improve the patient prognosis. The effectiveness of pharmacological agents, hypothermia, and stem cell therapy for secondary injury prevention remains unclear because further research is required to convert laboratory findings into clinical practice. Since TBI has intricate, pathophysiology combined with diverse patient reactions, treatment approaches should be customized to achieve optimal results. Further research must concentrate on improving brain protection methods for traumatic brain injury patients by refining treatment methods and creating more exact therapeutic solutions.

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Conflict of interest

The authors declared that they have no conflict of interest.

Compliance with Ethical Standards

Ethical approval was obtained from the Ethic and Research Committee of Abubakar Tafawa Balewa University Teaching Hospital Bauchi and ethical standard was followed throughout the research.

Informed Consent

Informed consent was obtained from the patient relatives that were responsible as care givers for the patient recruited in the study.

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Statements and Declaration

The Authors declared no financial interest or non-financial interest related to this research.

Author's Contribution

Olabisi O. Ogunleye: Conceptualization, literature search, data collection and analysis, writing review, editing.

Ibrahim S. Abdullahi: Conceptualization, literature search, data collection and analysis, writing review, editing.

Abubakar M. Ballah: Conceptualization, literature search, data collection and analysis, writing review and editing.

Rabiu Mohammad: Literature search, data collection and analysis, writing review and editing.

Olayere H. Obanife: Literature search, data collection and analysis, writing review and editing.

Alhamdu Ibrahim: Literature search, data collection and analysis, writing review and editing.

Oluchukwu B. Ogunleye: Literature search, data collection and analysis, writing review and editing.

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