Original Article

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Potential Predictors of Prolonged Hospital Stay in Operated Traumatic Brain Injury at Tertiary Center in Northern India: Retrospective Analysis

Harsha A. Huliyappa*, Manish Jaiswal, Bal Krishna Ojha***, Sunil Kumar Singh****, Anil Chandra****, Chhitij Srivastava*****

Abstract

Objective: Establishing a reliable prognosis after surgery for traumatic brain injury(TBI) is difficult. Majority of the prognostic models help in morbidity and mortality assessment. In a developing country, unexpected prolonged hospital stay can have a cumulative effect on limited hospital resources and lessen the caretaker's compliance. *Patients &Methods:* Records of 256 patients who had hospital stay for more than 15 days during a period of 3 years were obtained and grouped into 15-30 days (Group 1) and > 30 days (Group 2) of hospital stay groups. Demographic data, comorbid factors, mode of injury, Glasgow coma scale (GCS), pupil status, Computed tomography (CT) features, tracheostomy, associated significant injuries, septic foci with cultures and second-surgeries were compared and analyzed. *Results:* In Group 1, age<50 years, GCS:3-5 at presentation, bilateral fixed but normal sized pupils, bilateral fixed and dilated pupils, CT features of Extradural hematoma (EDH), subdural hematoma (SAH), cerebral edema & Midline Shift (MLS) of >6mm were found to be significantly associated with prolonged stay ($p<0.001$). In Group 2, GCS 6-8, unilateral fixed and dilated pupils, CT features of SDH & ischemia and infarcts, associated orthopedic injuries, abdominal injuries and soft tissue loss, comorbidities, pneumonia, tracheostomy, wound infection, meningitis, and second surgery, were found to have significant association ($p<0.001$). No association was found with the mode of injury, GCS>9, contusions/IVH/ depressed fracture, chest injuries, chronic kidney disease, deranged coagulation, an appearance of seizures and microbial flora. *Conclusion:* Age, GCS at presentation, pupil size and reaction, CT features, second surgery, comorbid conditions and presence of tracheostomy with recurrent lower respiratory tract infection (LRTI)/ upper respiratory tract infection (URTI) were significant predictors of prolonged hospital stay. As majority of these can be assessed at the time of admission and happens in the due course, a fairly reliable prediction regarding duration of hospital stay can be can be established.

Keywords: Traumatic Brain Injury; GCS; Hospital Stay; Prognostic Factor.

Introduction

Traumatic brain injury (TBI) remains the leading cause of death and disability worldwide. Every year about 1.5 million affected people die and several million receive emergency treatment [1]. Most of the burden (~90%) is in low and middle-income countries. According to the World Health Organization (WHO), TBI will surpass many diseases as the primary cause of death and disability by the year 2020, mainly due to increasing road traffic accidents (RTA) and an ever-growing political and civil violence in certain regions [2]. Traditionally, TBI has been classified by the mechanism (closed vs. penetrating), by clinical severity (Glasgow Coma Scale [GCS]), and by assessment of structural damage (neuroimaging). Even though multiple classification schemes for TBI severity has been validated, GCS remains the most widely used clinical severity rating tool. Establishing a reliable prognosis early after injury is notoriously difficult, as is captured in the Hippocratic aphorism, "No head injury is too severe to despair of, nor too trivial to ignore". Common

Author's Affiliation: *Assistant Professor, Department of Neurosurgery, J.S.S. Medical College & University, Mysore, Karnataka, India & Ex. M.Ch Senior Resident, Department of Neurosurgery, King George's Medical University, Lucknow, U.P., India. **Assistant Professor ***Professor & Head ****Professor *****Additional Professor, Department of Neurosurgery, King George's Medical University, Lucknow, U.P., India.

Reprint Request: Manish Jaiswal, Assistant Professor, Department of Neurosurgery, King George's Medical University, Chowk, Lucknow, U.P., India-226003
E-mail: manishjaiswal@kgmcindia.edu

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predictors of outcome that have been used both individually and in combination include age, GCS, pupillary reactivity, early hypoxia and hypotension, brain stem reflexes and computed tomography (CT) head findings [3, 4]. TBI is frequently associated with extracranial injuries (limb fractures, thoracic or abdominal injuries) in about 35% of cases, which increases the risk of secondary brain damage due to hypoxia, hypotension, pyrexia, and coagulopathy [5]. So far no valid predictive model is available which will guide in the management of the patient keeping in view the morbidity and the extent of hospital stay. Such a model is required especially in developing countries where patient care is directly reflected by the resources available and by efficient channelization. Prognostic models can also be used to combine different characteristics of an individual patient to provide realistic information to relatives and can provide a reference for assessing the qualityof health care delivery. This retrospective analysis was conducted to elucidate the risk factors that can help in predicting the morbidity and hence the duration of hospitalization. It thus would assist in establishing a predictive model that can be used upon prospectively in a different set of patients.

Our study was aimed to identify the factors responsible for prolonging hospitalization(>15days) in patients operated for TBI. Inclusion criteria: All operated TBI patients with duration of hospital stay of more than 15 days during a period of four years.Exclusion criteria: Patients with incomplete records, associated spinal injuries, prolongation on patients request or other recommendations & when outcome assessment was not documented.

Patients & Method

This study is a retrospective analysis of 284 patients who were hospitalized for more than 15 days at our Trauma centre, during a period of 3 years. A total of 256 patients were included in the study and 28 excluded based on the criteria. The cases were segregated based on the duration of hospital stay into two groups for easy comparison - hospitalization of 15-30 days (Group 1), and of 30 days (Group 2). Factors considered were –Age (<20 YEARS, 21-50 YEARS, >50YEARS), Sex (Male, Female), Mode of injury(RTA, Fall from height, Fall from train, Assault, Spontaneous fall and unknown), Pupillary size and reaction, GCS score (3-5, 6-8, 9-12, 13-14, 15), CT head features(midline shift, contusion, EDH, SDH Acute/ Chronic, SAH, Cerebral edema, intraventricular hemorrhage [IVH] & depressed fractures), significant associated injuries, comorbid conditions(diabetes/ hypertension/coronary artery disease/COPD/ chronic kidney disease/deranged renal function test [RFT] (S. Creatinine 1.5 – 2.5mg/dl, >2.5mg/dl), deranged coagulation parameters (PT/INR:1.3 – 2, >2), severe Anemia (Hb<5g/dl), deep vein thrombosis [DVT] (clinical/radiological), pneumonia (ventilator associated/non-ventilator associated), presence of tracheostomy, seizures and the final outcome (alive/ dead). Details of the procedure including second surgery were analyzed. Any evidence of septic foci with organism on culture analysis was also charted.

These factors were tabulated, and analyzed using the Chi-square test and the independent - samples T-test to determine significant association with longer hospital stay in each group.

Results

59% of our patients were male with the mean age of presentation being 31±16 years with patients of <20 years having a favorable outcome and comparatively lesser duration of hospitalization. No such significance was drawn in age group >50years. Majority had RTA(54%), followed by fall from height (22%) and assault injuries (18%), all together constituting 95% of cases **(Table 1)**.

38% of cases had GCS score of 9 to 12 followed By 6 to 8(25%) and 3-5(18%). GCS score was significant predictors of duration of hospitalization and in specific GCS 6-8 had a higher predilection for stay >30days **(Table 2)**. Low GCS patients usually had higher fatality rates. 78% of the patients with absent pupillary light reflex were found to have a significant correlation. Bilaterality showed early mortality whereas unilateral involvement had better survival **(Table 2)**.

The majority had contusions constituting 159 cases with the various combination of its presence with hematoma or MLS **(Table 3)**. EDH patients had an excellent recovery with only seven patients having associated contusions demanding >30 days stay. SAH and severe cerebral oedema patients succumbed early & hence a lesser prolonged stay. 80% of MLS on CT head were minimal or absent. Cases with larger MLS had poorer outcome among which some had to undergo second surgery(mainly decompressive craniectomy (DECRA) **(Table 5)**. Soft tissue loss requiring plastic surgery care and fractures requiring orthopedic intervention constituted the majority of associated injuries with significant longer stay **(Table 3)**.

Comorbid conditions constituted chiefly Diabetes, hypertension and deranged RFT and had greater influence in delayed recoupment due to delayed healing and soft tissue damage. Deranged coagulation was usually treated preoperatively and hence had less impact on the recovery time. Severe anemia and DVT had less prognostic significance as were often treated adequately **(Table 1)**. 65% of patients had episodes of LRTI/pneumonia with significant 68% of them being ventilator associated. As LRTI occurs commonly and repeatedly, it was an important factor for prolonged hospitalization. Nearly 43% of the patients had a tracheostomy, and related chest infection with tracheostomy secretions was again an essential element for a longer stay. Meningitis with repeated culture positivity showed prolonged stay in wait for tissue clearance of the infection **(Table 4)**. The majority of the second surgeries performed were for post op oedema with significant mass effect and MLS requiring decompressive craniectomy and augmentation duroplasty.

Patient with single surgeries did much better with early recovery.Patients with gram negative infection usually showed higher mortality while methicillin resistant Staphylococcus Aureus (MRSA) and mixed floral infections had the worst outcome with prolonged time for clearance **(Table 4)**.

Table 1: Correlation of Age, Mode of injury and Comorbidities with prolonged hospital stay

Factors (No. of Cases)	Percentage	15-30 days (n=126)	>30 days (n=130)	p* value
Age				
<20 years (41)	16%	28	14	p-0.001
21-50 years (174)	68%	135	39	p-0.001
>50years (41)	16%	14	27	p-0.01
Mode of injury				
Road traffic accident (138)	54%	93	45	p-0.01
Fall from height (56)	22%	20	35	p-0.01
Assault including fire arm (46)	18%	39	6	p>0.05
Fall from train (8)	3%	5	3	p>0.05
Spontaneous fall (5)	2%	4	1	p>0.05
Unknown injury (3)	1%	3		p>0.05
Comorbidities				
Diabetes (56)	22%	14	42	p-0.01
Hypertension (177)	69%	81	97	p-0.001
IHD* (87)	34%	24	63	P-0.01
CKD* (5)	2%	1	4	p>0.05
CVA* (11)	5%	6	5	p>0.05
Deranged RFT* (108)	42%	31	77	p-0.001
Deranged coagulation studies (33)	13%	31	2	p>0.05
Severe anemia (8)	3%	4	4	p>0.05
DVT* (5)	2%	4	1	p-0.001

*p= Level of confidence, IHD= Ischemic heart disease, CKD= Chronic disease, CVA= Cerebrovascular accident, RFT= Renal function test, DVT= Deep vein thrombosis

Table 2: Correlation of GCS and Pupillary changes with prolonged hospital stay

Factors (No. of Cases)	Percentage	15-30 days(n=126)	>30 days (n=130)	p* value
GCS*				
3 to 5 (46)	18%	39	7	p-0.0001
6 to 8 (64)	25%	21	44	p-0.0001
9 to 12 (97)	38%	44	53	p-0.001
13 to 14 (35)	13%	14	17	p-0.001
>15 (16)	6%	8	8	p>0.05
Pupils				
Unilateral fixed and dilated (80)	31%	21	59	p-0.001
Bilateral fixed normal size (110)	43%	66	44	p-0.001
Reacting (56)	22%	33	23	p>0.05
Bilateral fixed and dilated (10)	4%	6	4	p-0.001

*p= level of confidence, GCS= Glasgow coma scale

Table 3: Correlation of CT head features, midline shift & associated injuries with prolonged hospital stay

Factors (No. of Cases)	Percentage	15-30 days (n=126)	>30 days (n=130)	p* value
CT* head features				
Contusion (159)	62%	73	86	p<0.1
Extradural hemorrhage (31)	12%	24	7	p-0.0001
Subdural hemorrhage (113)	44%	39	74	p-0.0001
Subarachnoid hemorrhage (74)	29%	56	18	p-0.0001
Cerebral edema with significant mass effect (133)	52%	84	49	p-0.0001
Intra-ventricular hemorrhage (54)	21%	32	22	p<0.1
Depressed fractures (10)	4%	2	8	p<0.1
Ischemia/ infarcts (88)	33%	34	54	p-0.0001
Midline shift				
No shift (44)		17	27	p<0.1
Shift present				
3-5mm (181)		96	85	p<0.1
6-10mm (23)		15	8	p-0.0001
>10mm (8)		5	3	p-0.0001
Associated injuries				
Orthopedics surgical intervention (56)	22%	14	42	p-0.0001
Bone injury – conservatively (110)	43%	50	60	p<0.1
Significant chest injury (89)	48%	45	44	p<0.1
Blunt injury abdomen (28)	11%	9	19	p-0.001
Significant facial injury (23)	9%	11	12	p<0.1
Soft tissue loss (158)	75%	39	119	p-0.0001

Table 4: Correlation of septic foci and culture characteristics with prolonged hospital stay

Factors	No. of cases	15-30 days (n=126)	>30 days (n=130)	p* value
Septic foci				
URTI*/ LRTI*	197	96	101	p-0.01
Wound infection	54	24	30	p-0.01
Meningitis	83	34	49	p-0.01
Malaria	5	5		p>0.05
Typhoid	14	13	1	p>0.05
Dengue	2	2		p>0.05
Soft tissue infection/ cellulitis	15	11	4	p>0.05
Culture				
Gram positive	321	145	177	p>0.05
Gram negative	222	184	38	p>0.05
MRSA*	98	25	73	p>0.05
Mixed flora	132	56	76	p>0.05
E.coli	154	82	72	p>0.05
Acinetobacter	122	46	76	p>0.05

*p= Level of confidence, URTI= Upper respiratory tract infection, LRTI= Lower respiratory infection, MRSA= Methicillin resistant Staphylococcus Aureus

Table 5: Correlation of various neurosurgical procedures with prolonged hospital stay

Factors	No. of cases	15-30 days (n=126)	>30 days (n=130)	p* value
Neurosurgery				
Single sitting	235	164	71	p-0.01
Second surgeries	49	16	33	p-0.01

*p= Level of confidence

Discussion

A PubMed search with the keywords as "prolonged hospitalization", "delayed discharge", "morbidity outcome" and "prolonged stay" was performed. None of the articles seemed to highlight the risk factors associated with prolonged hospitalization, but the majority concentrated on explaining the independent risk factors related to poorer outcome. There has been no study which has looked into the specific parameters governing such an event. Our observations would help in prognosticating the patient/family and render the

attendants about the possible course of recovery from TBI. It would also assist the hospital and the medical care system in better allocation of the resources.

It is an established fact that older age is associated with the worst outcome; in our study elderly population had a longer duration of stay (27/41) as compared to the younger population (14/41) (**Table 1)**. There was no statistically significant correlation with respect to the mode of injury which hence indicates that the mechanism of trauma(blunt/ penetrating) is more important for prolonged stay than just the mode of injury [6]. In particular, a GCS score of 3 at presentation has been associated with a significantly poor outcome (100% mortality) as it was in our study [7]. Very low GCS was not a predictive factor as most of them expired during the early postoperative course. GCS between 6-8 is a strong predictive factor of prolonged hospital stay (44/64). GCS > 8 again is not a major factor as in this group hospital stay is governed by other factors and not merely GCS. Reactivity of the pupil is also a good predictor of the functional outcome at 6-month follow-up [8]. In a study, a comparable good functional outcome was achieved in patients presenting with bilateral reactive pupils and with a unilateral fixed & dilated pupil than with bilateral fixed, non-dilated pupils & bilateral fixed, dilated pupil (highest mortality rate of 79.7%) [9]. In this study, there were only ten patients with bilateral dilated and fixed pupils as because of associated low condition most of them succumb to their injuries within 15 days of hospital days. In this group patients with unilateral dilated and fixed pupils suggesting uncal herniation are associated with prolonged hospital stay. Rest other papillary factors does not govern the difference in duration of hospital stay **(Table 2)**.

Significant midline shift >5mm is associated with higher mortality rates as in other studies [10, 11]. Epidural hematoma had a relatively better prognosis and hence are discharged early (24/31 in Group 1). Patients with an SDH or SAH, or midline shift, and an abnormal third ventricle had significantly lower GCS scores and had early mortality. SDH with significant MLS had a prolonged recovery period as with cerebral edema with significant MLS. These lesions were present in at least 50% of patients. Evacuable SDH underwent early surgery, and hence, the chance of survival increased with the longer stay. A Subdural hematoma usually has associated significant midline shift and uncal herniation. This group is an important predictor of prolonged hospital stay (74/113 in Group 2) Contusion constituted the most frequently seen lesion in the CT head as it takes a longer period for both its evolution and dissolution and for its appearance in different space and time. The majority of the intraventricular and cisternal hemorrhages in our study were of smaller volume with no effect on the CSF dynamic nor showing any cisternal effacement with MLS. The presence of "obliteration of third ventricle or basal cisterns" on computed tomography was associated with the worst prognosis at 14 days. This is supported by recent findings that absence of basal cisterns is the strongest predictor of six month mortality [12].

In our study presence of ischemia and infarction were usually of unilateral anterior cerebral artery (ACA)/ posterior cerebral artery (PCA) territory. These often showed a lesser degree of mass effect than middle cerebral artery (MCA) infarcts and hence its appearance in CT head of patients staying for >1 month. According to a study, the presence of serious concomitant injuries especially Lung injuries does contribute to greater morbidity including longer stays [13]. Similar results were seen in our study with 48% having various degree of significant chest injuries. Orthopedic injuries undergoing instrumentation, blunt injury abdomen and soft tissue injuries undergoing procedures also adds to the extra stay. Common comorbid conditions such as Diabetes, hypertension, and ischemic heart disease were associated with significant delay in recovery from trauma. The results of a study conducted at Taiwan on 3,312 TBI patients looking into the length of stay showed a positive correlation between the existence of diabetes mellitus (DM), hypertension, myocardial infarction (MI) and end stage renal disease (ESRD) and a longer duration of intensive care unit (ICU) stay, and a shorter duration of ward stay of 0.8 months [14]. In one study, 36% of patients had coagulopathy associated with specifically penetrating head injury [15]. We experienced comparatively lesser cases of deranged coagulopathy. Venous thromboembolism rate with TBI was not significant in our study as also some studies showed similar incidences [16].A study concluded that 653 trauma cases with an early tracheostomy are associated with shorter duration of mechanical ventilation and ICU stay without affecting the outcome in TBI patients [17]. >95% of our patients undergo early ER tracheostomy with 60% of patients continue to have tracheostomy at the end of 1 month due to repeated chest infections. Majority of the study advice prolonged tracheostomy care for three months at least before attempting decannulation while our study has a decannulation period of 1 month on an average.

In a national trauma databank analysis of 25,525 patients with TBI, 6.5% had pneumonia with each additional day on ventilator support incurring 7%

increased risk of pneumonia [18, 19]. We had 68% of pneumonia with ventilator association requiring prolonged antibiotic therapy and physiotherapy/ rehabilitation. A significantly higher rate of septic complications of URTI/LRTI, wound infection, and meningitis was detected in our study due to a frequent prevalence of resistant organism requiring fumigation and sterilization. Other infective causes like malaria, typhoid & dengue fever were of insignificance.

Conclusion

In this retrospective study, Age group of 50 years, GCS–6-8, unilateral dilated and fixed pupils, subdural hematoma on CT scans were independent significant predictors of prolonged hospital stay. Associated bony injuries, abdominal injuries and soft tissue loss, a presence of comorbid conditions like DM, HTN, IHD, deranged RFT, Pneumonia, presence of tracheostomy, URTI/LRTI with wound infection, a presence of meningitis and second surgery were significantly present in patients with a long stay of > 1 month. As majority of these can be assessed at thetime of admission or soon, an early predictive knowledge about the expected pattern of patient's recovery can be predicted. This would help in prognosticating the injury and provide the relatives a quantifiable risk which includes the prolonged stay so that they prepare themselves for this new ordeal.

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