

# Rehabilitation characteristics and outcomes of adults with traumatic brain injury: A retrospective study in UMMC, a tertiary centre in Klang Valley

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## ABSTRACT

**Introduction:** Traumatic brain injury (TBI) is a major cause of disabilities among young adults worldwide. Although rehabilitation interventions were shown to reduce the extent of disabilities, there is limited data on the rehabilitation details of TBI patients in Malaysia. This current research is aimed at describing the rehabilitation characteristics of adults with TBI in UMMC, which include the characteristics of patients referred, the rehabilitation setting, intensity of therapy and duration of rehabilitation interventions. Secondly, it is aimed at examining the patients' outcomes at discharge and 1 year.

**Materials and Methods:** This research is a retrospective review on 201 electronic medical records of TBI patients referred for the multidisciplinary acute rehabilitation. Data on socio-demographic, TBI-related characteristics, rehabilitation details and functional outcomes at admission, discharge and 1-year post-TBI were analysed.

**Results:** From the study population, males and Malay ethnicity were predominant and the Mean (SD) age was  $42 \pm 19$  years. About two-thirds had severe TBI (63%), with concomitant fractures (70%), and 43% were first referred for rehabilitation during post-traumatic amnesia (PTA) state. 63% of them were directly transferred to the inpatient rehabilitation ward with an average length of stay of  $18.8 \pm 18.3$  days. Only 25% of the patients received the full multidisciplinary team input and interventions during the acute inpatient rehabilitation program. The average hours of therapy received during the acute rehabilitation was 7 hours in a 5 day-week, translating to about 1.5 hours per day. In the first-year post-injury, most patients only received outpatient therapy less than once a month after the rehabilitation discharges. Significant improvements were noted in the Modified Barthel Index, Montreal Cognitive Assessment, 6-Minute Walk Test and Westmead PTA scales from rehabilitation admission to discharge and at 1-year post-TBI ( $p < 0.05$ ).

**Conclusion:** More than two-thirds of the TBI patients were transferred to the rehabilitation ward within the first three weeks of injury. Significant improvement in general function, cognition, physical mobility and endurance were reported at the rehabilitation discharge and 1 year. These improvements highlight the positive gains of acute rehabilitation interventions after TBI.

## KEYWORDS:

*brain injuries; rehabilitation; outcome assessment; Malaysia; functional status*

## INTRODUCTION

Traumatic brain injury (TBI) can be defined as an alteration in brain function or other evidence of brain pathology brought upon by an external force.<sup>1</sup> The global incidence of TBI is on the rise primarily due to an increased use of motor vehicles especially in low- and middle-income countries (LMICs). In some countries, TBI is the leading cause of death with high long-term disability rates.<sup>2,3</sup> This is also true in the Malaysian context, where trauma remains among the top five primary causes of death, especially in the younger age groups.<sup>4</sup> 80% of trauma cases occurred following road traffic accidents with 85% involving the head and neck,<sup>5</sup> leaving TBI an inevitable consequence. The burden of care after TBI in Malaysia includes the loss of productivity and financial independence from an inability to return to work.<sup>6</sup>

Rehabilitation interventions for TBI exist in a large scale which involves a comprehensive multidisciplinary team (MDT). They are typically initiated when patients are deemed medically stable and received definitive treatments. Studies have shown that multidisciplinary inpatient rehabilitation programs and early rehabilitation are beneficial to TBI patients, with improvements seen in terms of cognition, self-care and mobility, shorter duration of coma and length of stay and higher likelihood of discharge to home.<sup>7</sup> However, existing evidence remains limited in LMICs with varying availability of acute rehabilitation resources compared to developed countries.

In Malaysia, referral of patients with TBI to the multidisciplinary rehabilitation team is not part of the standard operating procedure during acute admission. Understanding the referral practice to the rehabilitation team in an acute care hospital, and the characteristics of patients being referred, is crucial to gain further insight into the patients' outcomes. University Malaya Medical Centre (UMMC) is one of the acute centres in Malaysia with a dedicated inpatient and outpatient brain injury rehabilitation program led by the rehabilitation specialists. A previous study at the centre showed that patients with moderate and severe TBI receiving early intensive inpatient rehabilitation have a significantly good outcome at 1 year.<sup>8</sup>

The TBI patients admitted in UMMC mostly reflect the population in Klang Valley.

Since the referral practices and the rehabilitation details have not been previously explored in the local context, there is a need for further investigation. This research aims to describe the rehabilitation characteristics of adults with TBI at UMMC, including patients referred, the rehabilitation setting, intensity of therapy and duration of rehabilitation interventions. Secondly, it aims to explore patients' outcomes at discharge and 1-year post-injury. This study may provide insights into the effectiveness of the rehabilitation interventions and identify areas for improvement in the management of TBI patients. The findings may also inform the development of evidence-based rehabilitation protocols for TBI patients and contribute to improving the quality of care and outcomes for TBI patients in the local context.

## MATERIALS AND METHODS

The present study was approved by the UMMC Medical Research Ethics Committee, with registration number 202162-10191. This is a retrospective study on adults with TBI who received inpatient rehabilitation interventions in UMMC from June 2013 to June 2021. The list of patients was extracted from the departmental referral book and from the electronic medical records. The inclusion criteria were Malaysian adults with TBI, aged 18 and above and referred for rehabilitation interventions to the physician-led MDT. The exclusion criteria were premorbid conditions with other acquired brain injuries, pre-existing cognitive, behavioural and physical disability and history of substance abuse.

The data collected encompasses socio-demographic factors, TBI-related factors, rehabilitation profiles, discharge destination and outcomes assessed during rehabilitation ward admission, at discharge and at 1-year post-TBI. TBI severity was assessed using the initial post-treatment Glasgow Coma Scale (GCS), with scores of 13 to 15 indicating mild TBI, scores of 9 to 12 indicating moderate TBI and scores of 3 to 8 indicating severe TBI.<sup>1</sup> The complete MDT consists of rehabilitation doctors, physiotherapists, occupational therapists, speech and language therapists and rehabilitation nurses, based on the standard practice in UMMC.

Outcome measures included were Modified Barthel Index (MBI), Mini Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), Berg Balance Scale (BBS), Westmead post-traumatic amnesia (PTA) Scale and 6-Minute Walk Test (6MWT). We selected these outcomes because they were the common outcome measures in rehabilitation practice at UMMC and other rehabilitation practices in Malaysia. We considered an MBI score of >60 to indicate good functional outcomes at discharge from rehabilitation and 1-year post-injury. We screened all records and missing data were classified as unknown.

### Statistical Analysis

Analysis of data was conducted using IBM SPSS Statistic software version 25. Socio-demographic factors, TBI-related factors, rehabilitation characteristics, outcome measures at rehabilitation admission, discharge and 1-year and discharge

destination were analysed using descriptive statistics. Continuous variables were reported as median and standard deviations, and categorical variables were reported as numbers and percentages. Non-parametric tests Kruskal–Wallis H and Mann–Whitney U were performed to determine differences in scores of the outcome measures. These tests were also used to determine the association between the demographic factors, injury-related factors and rehabilitation characteristics with good outcomes, defined as MBI >60 at rehabilitation discharge. Statistical significance was taken at  $p$  value < 0.05.

## RESULTS

A total of 428 names were listed in the referral book but only 201 records were finally obtained from the electronic records and screened because of the difficulties obtaining the full complete older records.

Table I shows the distribution of the patients' socio-demographic and TBI characteristics. Majority of the patients (84.1%) were male, with mean age of  $42 \pm 19$  years old. Half of the patients were married (52.7%). The ethnicity distribution in our patients was similar to the Malaysian ethnicity distribution with majority of them being Malays. For TBI severity, more than half of the patients (63.2%) had severe TBI. Among the severe TBI who were ventilated, the mean duration of ventilation was  $9 \pm 6.7$  days. Only 24% of them were reported to have acute post-traumatic medical complications. Almost two-thirds of the patients (69.2%) had concomitant fractures, and among them, 25.4% were having long bone fractures.

The characteristics of the patients' rehabilitation profiles are shown in Table II. Majority were referred to the MDT by neurosurgeons (88.6%). The remaining patients were referred by a variety of medical professionals including general surgeons, neurologists, orthopaedic surgeons, emergency physicians, general physicians, respiratory physicians, geriatricians, haematologists and fellow rehabilitation physicians from other hospitals. Larger numbers of patients were first referred when they were in the PTA state (43%), followed by patients in the disorder of consciousness (DOC) state (25%). Of those in PTA, 49% were in the stage of acute agitation.

Majority (92.5%) received the first rehabilitation intervention within the first 3 months of injury and at least 63% of the patients received both inpatient and outpatient interventions. 34 patients (16.9%) had multiple admissions to the rehabilitation ward for different rehabilitation interventions and goals throughout the years. Only 24.4% of patients received the complete MDT input and interventions with all team members during the acute inpatient rehabilitation program. Another 69.7% had received inpatient services but not from the complete team of members. The remaining 5.9% received inpatient care exclusively from rehabilitation doctors, due to medical complications developed during the acute rehabilitation care, which prevented them from undergoing active rehabilitation interventions.

Table I: Socio-demographic and traumatic brain injury characteristics of the study population

| Variables                            | N (%)      |
|--------------------------------------|------------|
| Age                                  |            |
| 18–40                                | 114 (56.7) |
| > 40                                 | 87 (43.3)  |
| Gender                               |            |
| Male                                 | 169 (84.1) |
| Female                               | 32 (15.9)  |
| Ethnicity                            |            |
| Chinese                              | 56 (27.9)  |
| Indian                               | 49 (24.4)  |
| Malay                                | 93 (46.3)  |
| others                               | 3 (1.5)    |
| Education level                      |            |
| Primary                              | 8 (4.0)    |
| Secondary                            | 42 (20.9)  |
| Tertiary                             | 14 (7)     |
| Unknown                              | 137 (68.2) |
| Marital status                       |            |
| Single/widowed                       | 91 (45.3)  |
| Married                              | 106 (52.7) |
| Divorced                             | 4 (2.0)    |
| Place of residence                   |            |
| Home                                 | 193 (96.0) |
| Hostels                              | 2 (1.0)    |
| Nursing home                         | 5 (2.5)    |
| Presence of medical comorbidities    |            |
| No                                   | 142 (70.6) |
| Yes                                  | 59 (29.4)  |
| Severity of TBI                      |            |
| Mild                                 | 14 (7.0)   |
| Moderate                             | 60 (29.9)  |
| Severe                               | 127 (63.2) |
| Aetiology of TBI                     |            |
| MVA                                  | 149 (74.1) |
| Falls                                | 49 (24.4)  |
| Assault                              | 3 (1.5)    |
| Ventilation                          |            |
| No                                   | 53 (26.4)  |
| Yes                                  | 141 (70.1) |
| Unknown                              | 7 (3.5)    |
| Days of ventilation (mean ± SD)      | 9 ± 6.7    |
| Post-TBI acute medical complications |            |
| Hydrocephalus                        | 8 (4.0)    |
| Seizure                              | 28 (13.9)  |
| Others                               | 13 (6.5)   |
| Nil                                  | 152 (75.6) |
| Concomitant fracture                 |            |
| No                                   | 62 (30.8)  |
| Yes                                  | 139 (69.2) |

In the first-year post-injury, most patients received outpatient therapy at a frequency of only less than once a month following discharge from inpatient rehabilitation. Some patients had therapists attended to them in their homes in between hospital therapy schedules, otherwise majority were not able to attend therapy more frequently because of transport and financial issues. Nevertheless, more than one-third of patients had an active follow-up with the rehabilitation team over than 5 years.

Table III depicts the outcome measures at admission, discharge and 1-year post-TBI. There were statistically significant differences in the scores for MBI ( $\chi^2(2)=80.617$ ,  $p<0.001$ ), MoCA ( $\chi^2(2)=6.365$ ,  $p=0.041$ ), 6-MWT ( $\chi^2(2) = 24.354$ ,  $p< 0.001$ ) and Westmead PTA scores ( $U=1426.5$ ,

$p<0.001$ ) from rehabilitation admission. These signified improvement in the overall function, cognition and physical mobility and endurance, respectively. Post-hoc test using the pairwise comparison with a Bonferroni correction for multiple comparisons were performed for groups with  $p<0.05$ .

The post-hoc test revealed that for MBI, all groups had statistically significant differences ( $p<0.001$ ). For MoCA, there was a statistically significant difference in scores between admission into inpatient rehabilitation and 1-year post-TBI ( $p=0.037$ ), but not at discharge ( $p=0.291$ ). This was also true between discharge and 1-year post-TBI ( $p=0.959$ ). For the 6MWT, all groups had statistically significant differences ( $p<0.001$ ) but not between admission into inpatient rehab and 1-year post-TBI ( $p=0.001$ ).

Table II: Rehabilitation profiles of patients referred to the multidisciplinary team

| Variables  | n (%)       |
|--|-------------|
| Referring doctor   |             |
| Neurosurgeon   | 178 (88.9)  |
| Other specialties  | 17 (8.5)    |
| Unknown  | 5 (2.5)     |
| Cognitive functioning on the first referral to rehabilitation team according to RLA classification                 |             |
| 1,2,3  | 51 (25.4)   |
| 4,5,6  | 87 (43.2)   |
| 7,8  | 10 (5.0)    |
| Unknown  | 53 (26.4)   |
| Interval between TBI onset and first rehabilitation intervention   |             |
| 24 hours to 21 days post-trauma  | 152 (76.1)  |
| 3 weeks to 3 months post-trauma  | 33 (16.4)   |
| >3months post-trauma   | 15 (7.5)    |
| Rehabilitation setting   |             |
| Both inpatient and outpatient  | 132 (65.7)  |
| Inpatient only   | 67 (33.3)   |
| Outpatient only  | 2 (1.0)     |
| Types of inpatient rehabilitation services received  |             |
| Medical rehabilitation (rehabilitation doctors only)   | 12 (5.9)    |
| The multidisciplinary team (medical rehabilitation, PT, OT, SLT, rehabilitation nurse)                             | 49 (24.4)   |
| Others   | 140 (69.7)  |
| Total duration of inpatient rehabilitation stay*<br>in days <sup>a</sup> (n=199)                                   | 18.8 ± 18.3 |
| Average hours of inpatient therapy per week excluding therapy from rehabilitation nurses (5days/week) <sup>a</sup> |             |
| PT (n=95)  | 2.8 ± 1.5   |
| OT (n=92)  | 2.1 ± 1.1   |
| SLT (n=68)   | 2.0 ± 1.0   |
| Frequency of outpatient therapy in the first year post-TBI   |             |
| PT   |             |
| Once a fortnight   | 5 (4.0)     |
| Once a month   | 28 (22.6)   |
| Less than once a month   | 91 (73.4)   |
| OT   |             |
| Once a fortnight   | 6 (4.9)     |
| Once a month   | 31 (25.4)   |
| Less than once month   | 85 (69.7)   |
| SLT  |             |
| Once a fortnight   | 1 (1.1)     |
| Once a month   | 10 (10.9)   |
| Less than once a month   | 80 (87.9)   |
| Frequency of rehabilitation medicine specialist clinic follow-up after discharge                                   |             |
| 3 monthly  | 20 (10.0)   |
| 6 monthly  | 20 (10.0)   |
| 6-12 monthly   | 161 (80.1)  |
| Duration of active follow-up with rehabilitation medicine specialist   |             |
| 1-2 years  | 4 (13.8)    |
| >2-5 years   | 14 (48.3)   |
| > 5 years  | 11 (37.9)   |
| Total duration of active rehabilitation  |             |
| <1 month   | 58 (28.9)   |
| 1-12 months  | 61 (30.3)   |
| >12 months   | 82 (40.8)   |
| Discharge destination*   |             |
| Home   | 181 (90.0)  |
| Institutions and other hospitals   | 16 (8.0)    |
| Mortality  | 4 (2.0)     |

\* During the first rehabilitation admission   <sup>a</sup> Mean ± SD

RLA = Ranchos Los Amigos, PT = physiotherapy, OT = occupational therapy, SLT = speech and language therapy

Table III: Outcome measures during rehabilitation admission, discharge and 1-year post-discharge

| Variables                       | Sample size (n) | Mean $\pm$ SD     | Mean Rank | p        |
|---------------------------------|-----------------|-------------------|-----------|----------|
| MBI score <sup>a</sup>          |                 |                   |           | < 0.001* |
| Rehab admission                 | 111             | 22.2 $\pm$ 23.9   | 91.27     |          |
| Rehab discharge                 | 142             | 52.5 $\pm$ 23.3   | 156.73    |          |
| 1-year post-TBI                 | 20              | 90.1 $\pm$ 20.7   | 240.08    |          |
| MMSE score <sup>a</sup>         |                 |                   |           | 0.129    |
| Rehab admission                 | 20              | 22.7 $\pm$ 6.1    | 39.03     |          |
| Rehab discharge                 | 50              | 24.7 $\pm$ 4.9    | 50.26     |          |
| 1-year post-TBI                 | 28              | 24.6 $\pm$ 6.7    | 55.63     |          |
| MoCA score <sup>a</sup>         |                 |                   |           | 0.041*   |
| Rehab admission                 | 5               | 18.6 $\pm$ 4.7    | 8.80      |          |
| Rehab discharge                 | 12              | 23.0 $\pm$ 5.9    | 18.58     |          |
| 1-year post-TBI                 | 22              | 25.3 $\pm$ 3.9    | 22.57     |          |
| BBS score <sup>a</sup>          |                 |                   |           | 0.071    |
| Rehab admission                 | 15              | 42.8 $\pm$ 17.4   | 23.97     |          |
| Rehab discharge                 | 39              | 42.5 $\pm$ 11.7   | 34.44     |          |
| 1-year post-TBI                 | 11              | 46.1 $\pm$ 12.7   | 40.23     |          |
| Westmead PTA score <sup>b</sup> |                 |                   |           | < 0.001* |
| Rehab admission                 | 66              | 4.4 $\pm$ 3.7     | 55.11     |          |
| Rehab discharge                 | 75              | 8.6 $\pm$ 3.0     | 84.98     |          |
| 6MWT score <sup>a</sup>         |                 |                   |           | < 0.001* |
| Rehab admission                 | 6               | 157.8 $\pm$ 85.1  | 65.19     |          |
| Rehab discharge                 | 28              | 176.3 $\pm$ 113.9 | 98.13     |          |
| 1-year post-TBI                 | 10              | 213.4 $\pm$ 104.8 | 72.18     |          |

<sup>a</sup> Kruskal–Wallis H test.

<sup>b</sup> Mann–Whitney U test.

\* Significant difference (<0.05)

MMSE = Mini mental state examination, MoCA = Montreal cognitive assessment, BBS = Berg balance scale, PTA = Post-traumatic amnesia, 6MWT = 6 minute walk test

## DISCUSSION

This is the first study describing rehabilitation characteristics of adult TBI patients receiving the multidisciplinary physician-led rehabilitation interventions in a local setting. It was found that patients with TBI were mainly referred by neurosurgeons since UMMC is a tertiary medical centre with the availability of in-house neurosurgeons. However, it is interesting to note that at least 11% of the patients were also referred by other specialties, presuming the patients were admitted in their wards due to other medical complications apart from the TBI. This reflects the awareness of rehabilitation referral for TBI patients among other medical professionals too.

The interval between TBI onset and rehabilitation admission in UMMC was also shorter, which was at three weeks, compared to other neighbouring countries. In contrast, a multicentre study performed at 14 tertiary care centres with inpatient rehabilitation services across Thailand reported that the average duration between injury onset and rehabilitation admission was 5 months.<sup>9</sup> Previous studies have shown that early inpatient rehabilitation by the MDI within 35 days, leads to greater and sustained functional improvements.<sup>9</sup> Benefits include earlier gains in independence, improved mobility, reduction in coma length and length of stay, higher cognitive levels at discharge and home discharge.<sup>7,10-12</sup> This practice also complies with the clinical practice guideline for rehabilitation of adults with TBI which recommended that timely specialised interdisciplinary rehabilitation services must be initiated soonest after achieving medical stability.<sup>13</sup>

Almost half of the patients were referred while in PTA. This is a specific stage of TBI recovery with key features of anterograde memory impairment, confusion and agitation. At this stage, rehabilitation intervention focuses on the integrated reality orientation program while managing the agitation and confusion. A more intensive rehabilitation therapy is introduced gradually.<sup>13</sup>

The availability of resources in the UMMC rehabilitation ward to handle acute agitation in TBI patients has allowed the early transfer of patients in this stage from the acute ward to initiate rehabilitation. These facilities include padded rooms, Posey bed and rooms with reduced stimulation.

Patients in DOC (coma, vegetative state/unresponsive wakefulness syndrome and minimally conscious state) were the second commonest types of patients referred for inpatient rehabilitation in UMMC. The rehabilitation interventions for these patients included comprehensive early detection of covert motor and cognitive function, promotion of recovery via neuromodulation techniques, management of generalised spasticity and supportive care. Emerging evidence suggests that covert consciousness is present in up to 15–20% of patients with DOC and that early detection can predict functional recovery at 1-year post-injury.<sup>14</sup> This knowledge can benefit the rehabilitation team to mobilise resources optimally.

The recommended hours of therapy per day in medically stable TBI patients admitted to rehabilitation centres should be at a minimum of 3 hours per day.<sup>13</sup> However, this study

showed that average hours of therapy received during the acute rehabilitation admission was about 7 hours in a 5 day-week, which translated to about 1.5 hours per day. We want to highlight that this therapy duration excluded the therapy provided by the rehabilitation nurses in the ward. There was a difficulty to differentiate between the active therapy provided by the rehabilitation nurse and the acute nursing care from the electronic medical records available. The role of rehabilitation nurses is relevant in all phases of rehabilitation care. In the post-acute stage, they play an essential role in ensuring mobility and self-care including educating the patient and caregivers. Apart from supporting specific interventions such as bladder and bowel management, they also play a part by providing the cognitive behavioural treatments during PTA and agitation.<sup>15</sup> This is considered a type of therapy session.

The other possible reasons for a lower intensity of therapy in UMMC include the fact that TBI patients in UMMC were transferred much earlier from the acute surgical wards when they were still having excess lethargy and sleep disorders such as hypersomnolence, at higher risk of developing acute medical and surgical complications which required transfer to the acute surgical ward for procedures, and the caregiver was not able to fully participate with therapists for the DOC program. All these halted the therapy sessions temporarily. Limitation of manpower was also another reason for the average lower intensity of therapy compared to other studies conducted in developed countries.

We found that there were significant improvements in all outcome measures from admission to discharge and 1-year post-TBI, except for BBS and MMSE. BBS usually detects higher balance capabilities which normally takes more than 1 year to achieve in severe TBI. As for MMSE, it is not sensitive to detect further cognitive improvement as compared to MoCA. Therefore, when we examined the cognitive function using MoCA, there was a significant improvement from admission to discharge. These improvements highlight the positive gains of acute rehabilitation interventions despite the suboptimal intensity of rehabilitation compared to other centres in developed countries.<sup>11</sup>

The finding from our study showed that the average frequency of outpatient rehabilitation therapy within the first year of TBI was less than once a month after discharged from the rehabilitation care. Rehabilitation programs are highly individualised to each patient and therefore the outpatient follow-ups among patients in UMMC were also highly variable. For example, some patients received weekly outpatient therapy for the first few months' post-injury however towards the end of the first year, therapy sessions were more spread out. The high cost of travelling and attending the therapy sessions in UMMC<sup>16</sup> may have contributed to the hesitancy of patients and family members to come more frequently.

Notwithstanding, we also found that more than 85% patients still have an active follow-up duration of more than 2 years. To date, there has been no consensus on how frequent follow-ups should be conducted. Barnes MP<sup>12</sup> has shown that routine follow-ups significantly reduce social morbidity and severity of symptoms via the offering of additional information,

advise, support and further interventions. They have recommended that long-term support is maintained for some time after discharge, for at least 2 years, which complies with the standard of practice in this study. Due to the regular follow-up of longer than 2 years in UMMC, long-term recovery patterns and complications that can impede optimal recovery were detected early. In our study, 16.9% of the patients were offered re-admission for intensive rehabilitation to address different goals and objective, based on the condition reviewed in clinic.

The heterogeneity of the rehabilitation interventions and the types of patients admitted (in DOC, in acute agitation, in amnesia state) caused difficulty to examine the association between the different rehabilitation intensity and frequency; with the overall outcome at rehabilitation discharged. The retrospective nature of this study is also another limitation with a lot of missing details of the specific interventions provided. Despite these limitations, we believe that our findings can improve the understanding of local rehabilitation characteristics of TBI patients and assist in the plan to improve the process of referral for rehabilitation. Future studies can be conducted using a prospective, multicentre cohort study and to use standard rehabilitation interventions suggested.

## CONCLUSION

The characteristics of adult TBI patients receiving acute inpatient rehabilitation interventions in UMMC were similar to that reported globally. Majority of the patients were referred during the post-traumatic amnesia state within the first 3 weeks of injury, and rehabilitation interventions were promptly initiated. Improvements in functional, physical and cognitive outcomes were significantly noticed at discharge after an average of 3 weeks duration of inpatient rehabilitation care. These improvements highlight the positive gains of acute rehabilitation interventions after TBI.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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