Traumatic Brain Injury Rehabilitation in Riyadh, Saudi Arabia: Time to Rehabilitation Admission, Length of Stay, and Functional Outcome

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Abstract

Objectives—1) To describe trends in time to rehabilitation admission and rehabilitation length of stay (LOS), and functional status, 2) To identify independent predictors of functional outcomes following rehabilitation.

Design—Retrospective cohort study.

Setting—Traumatic brain injuries rehabilitation unit of King Fahad Medical City, Riyadh, Saudi Arabia.

Participants—Adult patients with TBI discharged from inpatient rehabilitation between 2009–2014.

Methods—We collected information on time from injury to rehabilitation admission, rehabilitation LOS, Functional Independence Measure (FIM) score (admission and discharge), and demographic variables by chart review. Hierarchical regression was employed to investigate variables associated with FIM score at rehabilitation discharge.

Results—Data from 208 patients were obtained. Mean time from injury to rehabilitation admission was 263±274 days. Rehabilitation LOS was 66±43 days. FIM scores improved significantly during rehabilitation. After controlling for other variables, increasing time from

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Declaration of interest

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injury to rehabilitation admission was associated with lower FIM score at discharge from rehabilitation.

Conclusions—Time from injury to rehabilitation admission is notably longer than reported elsewhere. Decreasing this time may improve functional outcome at discharge from rehabilitation. Ensuring that information regarding TBI severity is included throughout the continuum of care would benefit patients and provide insight into TBI aetiology in Saudi Arabia.

Introduction

Traumatic brain injury (TBI) is a major cause of disability [1] that may leave individuals with long-standing cognitive, physical, and psychosocial difficulties [2] and is projected to become the third leading cause of death and disability in the world by 2020 [3]. Incidence of TBI varies substantially between countries. In the USA it is estimated at 1.5 million cases per year [4,5] or 823 per 100,000 population [6] and values range from 20 to 536 hospital admissions per 100,000 population in European nations [7]. Little information exists regarding TBI in Saudi Arabia, where incidence has been extrapolated to be 116 per 100,000 population [8].

Internationally, there is considerable variation between the time from injury to rehabilitation admission. Two US studies using data from the NIDRR TBI Model Systems National Data Base in the 1990s reported acute care length of stay, which preceded rehabilitation admission, to vary from 12±8 days for relatively mild TBI to 44±28 days for extremely severe TBI [9] and from 24±23 days to 33±36 days for younger and older individuals, respectively [10]. In a study involving children and young adults in the Netherlands, the interval between injury and admission was significantly longer for patients admitted before the introduction of an “Early Intensive Neurorehabilitation Program” (82±38 days) compared to the patients admitted after programme introduction (64±32 days) [11]. In a survey of 18 rehabilitation centres in France, time between injury and admission was 1 to 4 weeks [12]. Researchers in India reported a mean length of time to admission following severe TBI of 7.7±4.6 months [13]. In Saudi Arabia, two studies indicate a length of stay (LOS) in acute care of between 50 [14] and 94 days [8].

As with time to rehabilitation admission, LOS in rehabilitation for individuals with TBI also varies internationally. Data from the USA indicates that rehabilitation LOS ranges from 18±11 to 71±36 days with increasing injury severity [9]. In Australia, average LOS over a 5-year period in the 1990s was 62 days [15]. Italian researchers reported a mean rehabilitation LOS of 59±58 days [16] and 87±77 days [17]. In a prospective study from the Netherlands, people with moderate to severe traumatic brain injury stayed an average of 93±22 days in rehabilitation [18]. In a retrospective review at one rehabilitation hospital in Riyadh, Saudi Arabia from 2005 to 2008, Al Jadid and Robert [19] reported a mean LOS of 57±28 days for individuals with TBI.

A number of factors have been associated with Functional Independence Measure (FIM) score at discharge from TBI rehabilitation, including FIM score at admission, injury severity, age, race, time between injury to rehabilitation admission, and rehabilitation LOS. Higher discharge motor FIM scores are predicted by higher admission motor FIM scores [15] and

the relationship between admission and discharge FIM scores is usually the strongest relationship in regression models [20]. Increasing severity (as indicated by lower Glasgow Coma Scale (GCS) score) is independently associated with significantly lower FIM score at admission and discharge from rehabilitation [20] but appears to be, at best, a modest contributor to functional outcomes at discharge [21,22]. In a study comparing young versus old patients (i.e. <50 years and >55 years of age), older persons had a lower rate of change on functional measures [10]. Similarly, other research has shown younger individuals have greater gains in FIM scores during rehabilitation and higher discharge FIM scores [15]. In the USA, ethnicity has been shown to play a role in determining functional outcome following TBI with minorities reporting poorer functional outcomes post-injury relative to white persons [23,24]. Shorter time from injury to rehabilitation admission has been identified as a significant predictor of higher motor and FIM total score at discharge from inpatient rehabilitation [25,26]. Others have noted that longer acute hospitalization LOS was independently associated with significantly lower motor and cognitive FIM scores at rehabilitation admission while higher FIM score gains from admission to discharge from inpatient rehabilitation were associated with longer rehabilitation LOS [20]. In research from Australia, investigators also noted a longer rehabilitation LOS was predicted by lower admission motor FIM scores in addition to the presence of comorbidities [15]. Our review of literature revealed no information regarding predictors of FIM at discharge from rehabilitation in Saudi Arabia.

Given the limited amount of research in characterizing TBI in Saudi Arabia we conducted a study with two objectives: 1) To describe the amount of time from injury to rehabilitation admission and LOS in rehabilitation, and 2) to identify factors that have an impact on functional independence measured at discharge from rehabilitation. We hypothesized that after controlling for admission FIM score, longer time to admission and LOS in rehabilitation would be significantly negatively associated with discharge FIM score.

Methods

Rehabilitation program and participants

The inpatient TBI rehabilitation program at King Fahad Medical City, Rehabilitation Hospital located in Riyadh, Saudi Arabia, has 20 beds designated for adult individuals with TBI who can benefit from an intensive, functional and outcome-oriented program. The goal for this interdisciplinary inpatient rehabilitation unit is to maximize recovery of the individual's physical, cognitive, behavioral, and functional abilities that facilitate independence and discharge to the least restrictive environment. This is done using an approach that is individualized to each patient's strength, deficits, and activity tolerance. The treatment team consists of the patient, family, physicians, nurses, occupational and physical therapists, speech and language pathologists, psychologists, art therapists, case managers, and nutritionists.

Discharge criteria from the inpatient TBI program include: achievement of programme goals or maximum benefit; suitability for entry into outpatient rehabilitation programmes; no longer requiring skilled therapeutic intervention and family/caregivers demonstrate ability to provide adequate patient care; inability to demonstrate carryover of newly learned skills; a

plateau in functional status with no more progress expected in a reasonable amount of time; a change in medical condition that prevents continuation of rehabilitation; non-compliance with the therapy program and/or regulations; refusal of service/s that would significantly affect one's rehabilitation program.

Data were obtained from chart review of patients with TBI discharged from the inpatient rehabilitation programme between 2009 and 2014. Charts were included for review if patients were 16 years of age and were new admissions. Approval for the study protocol was obtained from the King Fahad Medical City medical ethics committee.

Data collection

Information collected from chart review included age, sex, injury type (open/closed TBI), time from injury to rehabilitation admission, LOS in rehabilitation, discharge setting (e.g. community dwelling, assisted living, chronic hospital), and the FIM which was assessed at admission and discharge from inpatient rehabilitation.

The FIM is an 18-item assessment composed of 13 motor tasks and 5 cognitive tasks that measures the level of independence in activities of daily living. These tasks are: eating, grooming, bathing, upper body dressing, lower body dressing, toileting, bladder management, bowel management, bed to chair transfer, toilet transfer, shower transfer, locomotion, stairs, cognitive comprehension, expression, social interaction, problem solving, and memory. Each item is scored on a 7-point scale with 7 indicating complete independence and 1 indicating total dependence). The reliability [27] and validity [28] of the FIM has been documented.

Indicators of severity, such as GCS score or post-traumatic amnesia were not included because this information was not available in the majority of charts, especially among those who did not enter rehabilitation directly through acute care.

Data Analyses

Descriptive statistics (means, standard deviations, range, frequencies) were performed for patient demographics, time to rehabilitation, LOS in rehabilitation and FIM scores. For the FIM total score, a 2×2 mixed model ANOVA paired-samples was used to investigate changes between individuals arriving from acute care versus those arriving from elsewhere from admission to discharge from inpatient TBI rehabilitation. Effect size (partial η^2) was calculated and is interpreted using Cohen's guidelines (0.01=small effect, 0.06=moderate effect, 0.14=large effect) [29]. Alpha was set at $p < 0.05$. Statistical software, SPSS 21 (SPSS Inc., Chicago, IL USA) was used for all analyses.

For each group (individuals arriving to inpatient rehabilitation from acute care those arriving from elsewhere), a Pearson correlation was employed to investigate if available variables (discharge FIM total score, age, gender, time from injury to rehabilitation admission, and rehabilitation LOS) were fit for entry into the regression model. Consequently, gender was omitted and a hierarchical regression was employed to identify the contribution of time from injury to rehabilitation admission and LOS in rehabilitation on discharge FIM total score while controlling for admission FIM total score. Thus, variable entered into the first block

was admission FIM total score, age was entered into the second block, and variables entered into the third and fourth block included LOS in rehabilitation and time from injury to rehabilitation admission, respectively. Assumptions for sample size, multicollinearity, outliers (2 extreme outliers were removed from the regression model for individuals arriving from elsewhere), normality and residuals were tested.

Results

Patient demographics

A total of 262 patients with TBI were discharged from rehabilitation between 2009 and December 2014. Of these, 29 were readmissions and 23 were under 16 years of age and were excluded. Of the 212 patients eligible for entry into the study, four (2%) patients were not included because FIM data were not available. Thus, 208 patients were included in analyses. Demographic information is provided in Table 1. Frequency of TBI depended on gender, with a notable increase in TBI for those males under 40 years of age (Figure 1).

Time from injury to rehabilitation admission and length of stay in rehabilitation

Time from injury to rehabilitation admission averaged 117 ± 103 days for those arriving from acute care and was almost three times longer for those arriving from elsewhere (331 ± 301 days). The average LOS in rehabilitation for both groups combined was 64 ± 43 days (Table 1).

Clinical outcomes

There was a statistically significant interaction between group and time, $F(1,206)=12.6$, $p<0.0005$, partial eta squared= 0.06. Simple main effects analysis for time, using one-way repeated measures ANOVAs with a Bonferroni correction ($p<0.025$), demonstrated that individuals arriving from acute care ($F(1,65)=131.8$, $p<0.0005$, partial eta squared= 0.67) and individuals arriving to rehabilitation from elsewhere ($F(1,141)=190.0$, $p<0.0005$, partial eta squared 0.57) experienced a statistically significant increase in FIM total score from admission to discharge. Simple main effects analysis for group, using one-way ANOVAs with a Bonferroni correction ($p<0.025$), demonstrated that there was no statistically significant difference between groups at admission ($F(1,206)=0.49$, $p=0.49$, partial eta squared= 0.002) while there was a statistically significant difference at discharge ($F(1,206)=9.7$, $p=0.002$, partial eta squared=0.04). Means and standard deviations are presented in Table 2; all FIM subcomponents increased during this time.

Predictors of clinical outcomes

For individuals arriving to inpatient TBI rehabilitation from acute care (Table 3), admission FIM total score accounted for 45% of the regression model. No other variables contributed significantly to the model.

For individuals arriving at inpatient TBI rehabilitation from elsewhere (Table 4), admission FIM total score accounted for 64% of the regression model. After accounting for admission FIM total score and age, discharge FIM total score was negatively associated with days from

injury to rehabilitation admission ($p=0.034$). Days from injury to rehabilitation admission explain an additional 1.2% of the variance of discharge FIM total score.

Discussion

This is one of the few studies to explore the timeline from injury to rehabilitation admission and discharge among people with TBI in Saudi Arabia, and the first to investigate predictors of functional outcome among persons with TBI in this country.

This study found that males were more likely to sustain a TBI with the highest frequency among those between 20–30 years of age. While this reflects a common gender difference [30,31], in our study the risk of TBI was 6.5:1 in males versus females. This far exceeds ratios of numerous countries [31] and may reflect Saudi Arabian law that prevents women from operating a motor vehicle. Compared to all other high income countries, the road traffic death rate in Saudi Arabia is highest [32] and so it is not surprising that motor vehicle accidents are the largest cause of traumatic head injury in this nation [14]. Interestingly, in the USA, about 50% of people who sustain TBI are intoxicated at the time of injury [33–35]. However, alcohol consumption is forbidden under Saudi Arabian law, which raises the prospect that either alcohol is not involved in the large number of motor vehicle accidents or that it is consumed illegally and unreported. It is also possible that the higher proportion of males entering TBI rehabilitation is not only due to a higher incidence of injury in males but may also reflect that women are less likely to access rehabilitation. However, information of TBI incidence in Saudi Arabia, which is required to gain insight into this matter, is lacking.

In recent decades, an increase in TBI in older adults has been observed in higher-income countries, resulting in part from an increased life expectancy and greater mobility of older adults [36]. We noted no increased incidence of TBI among older adults in our study. This may be a result of the notably younger population of Saudi Arabia where the median age is 27 whereas median age in the USA is 38 years and is above 40 for most European countries [37].

Time from injury to rehabilitation admission

With an average of four months and a mean of two and a half months for individuals arriving from acute care, and an average of 11 months and mean of seven months for individuals arriving from elsewhere, our findings are notably longer than that reported for the USA and European countries [9–12,38] and instead are similar to those of lower-income countries [13]. Our values also differ notably from other Saudi Arabian research which has shown mean acute care LOS to be between 50 [14] and 94 days [8]. It is possible our larger, more variable value for acute care LOS may result from differences in severity and rehabilitation centre policy.

Length of stay in rehabilitation

Unlike time from injury to rehabilitation admission, length of stay was the same between those arriving from acute care and those from elsewhere. The mean 64 days of rehabilitation LOS for all patients in this study is similar to that reported for other European countries [16–18], Australia [15], and Saudi Arabia [19]. The USA is an exception, where rehabilitation

LOS below 30 days is reported from the model systems national database [38,39]. By itself, LOS is an inadequate way to compare rehabilitation effectiveness, since a longer LOS may reflect inefficiency as much as it indicates increased therapeutic time and a shorter LOS may reflect increased efficiency/intensity or be indicative of cuts in health care provision, as seen in recent decades in the USA [40]. Accounting for the intensity of therapy, at least in terms of time [41] and ideally in terms of therapy content [42], would allow for a true comparison of rehabilitation interventions between countries.

Ultimately however, a shorter LOS may not impact functional outcome over the long term. In a study comparing individuals with short LOS to long LOS in acute care and rehabilitation, a reduced inpatient LOS did not adversely affect functional outcome at one-year post-injury as FIM scores were the same at this time. Still, the authors noted that the decreased LOS did place a greater demand on outpatient rehabilitative services as well as a greater burden on the family of the patient [43].

Change in FIM score from admission to discharge from rehabilitation

As expected, improvements in FIM motor and cognitive scores (and all subcomponents) were seen from admission to discharge from inpatient TBI rehabilitation with a FIM total score change of 35 ± 25 and 24 ± 20 for individuals arriving from acute care and individuals arriving from elsewhere, respectively. While values reported elsewhere vary for numerous reasons including study interventions and injury characteristics, our values are similar to those of others who report FIM total score change between 14 and 40 [15,39,44,45]. The greater improvement in FIM total score for individuals who arrived to rehabilitation from acute care may be a result of these individuals experiencing inpatient rehabilitation closer to the date of injury, and most recovery occurs in the weeks and months after injury and tapers off as time progresses [46]. However, both groups had the same FIM total score at admission yet those who were admitted directly from acute care had a significantly higher score at discharge from inpatient rehabilitation, indicating that delayed rehabilitation may result in a lost opportunity to maximize rehabilitation in individuals with TBI.

Predictors of functional outcome at rehabilitation discharge

In our regression models the biggest contributor to determining discharge FIM score was admission FIM score, which accounted for between 45 and 65 percent of variability in the models and is in keeping with the findings of others [15,20]. Interestingly, there was no significant impact of age on discharge FIM score, contrary to the findings of others [10,15]. This may be a result of demographic differences where a young population in Saudi Arabia results in relatively few older individuals entering rehabilitation with a TBI. As a consequence, there may not be sufficient variability for age to be a significant contributor in our regression model.

Rehabilitation LOS has been shown elsewhere to be related to FIM score [20,25,26], yet it was not a significant contributor to the model in this study. Perhaps LOS is not related to discharge FIM score because LOS is of adequate length with individuals being discharged when appropriate such that additional days in rehabilitation do not yield further improvement. Also, as mentioned earlier, LOS may be a poor metric for assessing how

rehabilitation intervention affects FIM score at discharge. Instead, the inclusion of minutes of therapy time, or more ideally, therapy intensity, would be a more appropriate factor for regression inclusion.

It is possible that TBI severity would have a notable impact on FIM score, as previous research has shown. However, it was not included because this information was not routinely collected or did not follow the patient through the continuum of care. Thus, we highlight the lack of collection of severity data as a finding of our research and recommend that steps be taken to ensure that this data is readily available for clinicians and researchers.

Time from injury to admission contributed a significant by very small amount (1.2 percent) to the model for individuals arriving from elsewhere. Others have also shown time to rehabilitation admission to be related to FIM score [20,25,26]. Our results indicate that of those individuals arriving from elsewhere there may be some benefit to reducing the time from injury to rehabilitation admission. Furthermore, when comparing those arriving to rehabilitation directly from acute care and those arriving from elsewhere we see that the groups only differ in that time from injury to rehabilitation admission is notably longer in those arriving from elsewhere and that discharge FIM total score is significantly lower in this group. Thus we suggest that efforts to reduce time to admission for those who are not admitted directly from acute care might yield better functional outcomes in individuals with TBI.

Limitations

While this study included a large sample with wide inclusion criteria, it was a retrospective cohort study design from a single rehabilitation hospital and any generalization of the results with regard to other facilities or countries should be made with caution.

While we were able to separate groups based on those admitted from acute care to those admitted from elsewhere, more specific information is not available. The latter group is potentially more heterogeneous with respect to their journey from injury to rehabilitation admission and further investigation into patient origins is warranted.

Conclusion

This retrospective study provides needed characterization of TBI rehabilitation in Saudi Arabia. Reducing the notably long time from injury to rehabilitation admission is a suggested goal for refining the continuum of patient care from injury to returning to the community as our findings suggest that this may improve functional outcome at discharge from rehabilitation. We also highlight the importance of tracking injury severity and the patient journey through the health care system since TBI is a public health concern that requires ongoing epidemiological study to benefit individual patient care, inform policy decisions, and provide insight into TBI aetiology in Saudi Arabia.

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References

1. Cassidy JD, Carroll LJ, Peloso PM, Borg J, Holst von H, Holm L, Kraus J, Coronado VG. WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. Incidence, risk factors and prevention of mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *Journal of Rehabilitation Medicine*. 2004; (43 Suppl):28–60.
2. Hart T, Whyte J, Polansky M, Millis S, Hammond FM, Sherer M, Bushnik T, Hanks R, Kreutzer J. Concordance of patient and family report of neurobehavioral symptoms at 1 year after traumatic brain injury. *YAPMR*. 2003; 84(2):204–213.
3. The Lancet Neurology. The changing landscape of traumatic brain injury research. *The Lancet Neurology*. 2012; 11(8):651. [PubMed: 22814533]
4. Roozenbeek B, Maas AIR, Menon DK. Changing patterns in the epidemiology of traumatic brain injury. *Nature Reviews Neurology*. 2013; 9(4):231–236. [PubMed: 23443846]
5. Langois, JA., Rutland-Brown, W., Thomas, KE. Traumatic brain injury in the United States: emergency department visits, hospitalizations, and deaths. Centers for Disease Control and Prevention. National Center for Injury Prevention ...; 2006.
6. Popescu C, Anghelescu A, Daia C, Onose G. Actual data on epidemiological evolution and prevention endeavours regarding traumatic brain injury. *Journal of medicine and life*. 2015; 8(3): 272–277. [PubMed: 26351526]
7. Tagliaferri F, Compagnone C, Korsic M, Servadei F, Kraus J. A systematic review of brain injury epidemiology in Europe. *Acta Neurochirurgica*. 2006; 148(3):255–268. [PubMed: 16311842]
8. Arabi YM, Haddad S, Tamim HM, Al-Dawood A, Al-Qahtani S, Ferayan A, Al-Abdulmughni I, Al-Oweis J, Rugaan A. Mortality reduction after implementing a clinical practice guidelines-based management protocol for severe traumatic brain injury. *Journal of critical care*. 2010; 25(2):190–195. [PubMed: 19592201]
9. High WMJ, Hall KM, Rosenthal M, Mann N, Zafonte R, Cifu DX, Boake C, Barth A, Ivanhoe C, Yablon S, et al. Factors Affecting Hospital Length of Stay and Charges Following Traumatic Brain Injury. *The Journal of Head Trauma Rehabilitation*. 1996; 11(5):85.
10. Cifu DX, Kreutzer JS, Marwitz JH, Rosenthal M, Englander J, High W. Functional outcomes of older adults with traumatic brain injury: a prospective, multicenter analysis. *YAPMR*. 1996; 77(9): 883–888.
11. Eilander HJ, Wijnen VJM, Scheirs JGM, de Kort PLM, Prevo AJH. Children and young adults in a prolonged unconscious state due to severe brain injury: outcome after an early intensive neurorehabilitation programme. *Brain injury*. 2005; 19(6):425–436. [PubMed: 16101265]
12. Mazaux JM, De Sèze M, Joseph PA, Barat M. Early rehabilitation after severe brain injury: a French perspective. *Journal of Rehabilitation Medicine*. 2001; 33(3):99–109. [PubMed: 11482356]
13. Gupta A, Taly AB. Functional outcome following rehabilitation in chronic severe traumatic brain injury patients: A prospective study. *Annals of Indian Academy of Neurology*. 2012; 15(2):120–124. [PubMed: 22566725]
14. Al-Habib A, A-Shail A, Alqeel A, Zamakhshary M, Al-Bedah K, Alqunai M, Al-Enazi S. Causes and patterns of adult traumatic head injuries in Saudi Arabia: implications for injury prevention. *Annals of Saudi medicine*. 2013; 33(4):351–355. [PubMed: 24060713]
15. Tooth L, McKenna K, Strong J, Ottenbacher K, Connell J, Cleary M. Rehabilitation outcomes for brain injured patients in Australia: functional status, length of stay and discharge destination. *Brain injury*. 2001; 15(7):613–631. [PubMed: 11429090]
16. Avesani R, Carraro E, Armani G, Masiero S. Exploring variables associated with rehabilitation length of stay in brain injuries patients. *European journal of physical and rehabilitation medicine*. 2012; 48(3):433–441. [PubMed: 22820827]
17. Zampolini M, Zaccaria B, Tolli V, Frustaci A, Franceschini M. GISCAR Group. Rehabilitation of traumatic brain injury in Italy: a multi-centred study. *Brain injury*. 2012; 26(1):27–35. [PubMed: 22149442]
18. Valk-Kleibeuker, L., Heijenbroek-Kal, MH., Ribbers, GM. Mood after moderate and severe traumatic brain injury: a prospective cohort study. In: Kline, AE., editor. *PLOS ONE*. Vol. 9. 2014. p. e87414

19. Al-Jadid MS, Robert AA. Length of stay of patients in different rehabilitation programs. A hospital experience in Saudi Arabia. *Saudi medical journal*. 2012; 33(3):326–327. [PubMed: 22426917]
20. Cowen TD, Meythaler JM, DeVivo MJ, Ivie CS, Lebow J, Novack TA. Influence of early variables in traumatic brain injury on functional independence measure scores and rehabilitation length of stay and charges. *YAPMR*. 1995; 76(9):797–803.
21. Zafonte RD, Hammond FM, Mann NR, Wood DL, Black KL, Millis SR. Relationship between Glasgow coma scale and functional outcome. *American Journal of Physical Medicine & Rehabilitation*. 1996; 75(5):364–369. [PubMed: 8873704]
22. Toschlog EA, MacElligot J, Sagraves SG, Schenarts PJ, Bard MR, Goettler CE, Rotondo MF, Swanson MS. The relationship of Injury Severity Score and Glasgow Coma Score to rehabilitative potential in patients suffering traumatic brain injury. *The American surgeon*. 2003; 69(6):491–7. discussion 497–8. [PubMed: 12852506]
23. Haider AH, Efron DT, Haut ER, DiRusso SM, Sullivan T, Cornwell EE. Black children experience worse clinical and functional outcomes after traumatic brain injury: an analysis of the National Pediatric Trauma Registry. *The Journal of Trauma: Injury, Infection, and Critical Care*. 2007; 62(5):1259–62. discussion 1262–3.
24. Arango-Lasprilla JC, Rosenthal M, DeLuca J, Cifu DX, Hanks R, Komaroff E. Functional Outcomes From Inpatient Rehabilitation After Traumatic Brain Injury: How Do Hispanics Fare? *Archives of Physical Medicine and Rehabilitation*. 2007; 88(1):11–18. [PubMed: 17207669]
25. Kunik CL, Flowers L, Kazanjian T. Time to rehabilitation admission and associated outcomes for patients with traumatic brain injury. *YAPMR*. 2006; 87(12):1590–1596.
26. Whitlock JA. Functional outcome of low-level traumatically brain-injured admitted to an acute rehabilitation programme. *Brain injury*. 1992; 6(5):447–459. [PubMed: 1393177]
27. Ottenbacher KJ, Hsu Y, Granger CV, Fiedler RC. The reliability of the functional independence measure: a quantitative review. *YAPMR*. 1996; 77(12):1226–1232.
28. Corrigan JD, Smith-Knapp K, Granger CV. Validity of the functional independence measure for persons with traumatic brain injury. *YAPMR*. 1997; 78(8):828–834.
29. Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*. 2. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988. p. 1
30. de Guise E, LeBlanc J, Abouassaly M. The Relationship between Acute Functional Status and Long-Term Ambulation after Severe Traumatic Brain Injury. *ISRN* 2012
31. Bruns J, Hauser WA. The epidemiology of traumatic brain injury: a review. *Epilepsia*. 2003; 44(Suppl 10):2–10.
32. World Health Organization, editor. [accessed 2016 Jun 1] Global Health Observatory data repository. 2016. <http://apps.who.int/gho/data/node.main.A997>
33. Zink BJ, Maio RF, Chen B. Alcohol, central nervous system injury, and time to death in fatal motor vehicle crashes. *Alcoholism, clinical and experimental research*. 1996; 20(9):1518–1522.
34. Gurney JG, Rivara FP, Mueller BA, Newell DW, Copass MK, Jurkovich GJ. The effects of alcohol intoxication on the initial treatment and hospital course of patients with acute brain injury. *The Journal of Trauma: Injury, Infection, and Critical Care*. 1992; 33(5):709–713.
35. Cunningham RM, Maio RF, Hill EM, Zink BJ. The effects of alcohol on head injury in the motor vehicle crash victim. *Alcohol and alcoholism (Oxford, Oxfordshire)*. 2002; 37(3):236–240.
36. Faul, M., Xu, L., Wald, MM., Coronado, VG. [accessed 2016 May 6] Traumatic brain injury in the United States: emergency department visits, hospitalizations and deaths 2002–2006. 2010 Mar. http://www.cdc.gov/traumaticbraininjury/tbi_ed.html
37. Central Intelligence Agency, editor. [accessed 2016 Jun 1] The World Factbook 2016–17. 2016. <https://www.cia.gov/library/publications/the-world-factbook/index.html>
38. Corrigan JD, Cuthbert JP, Whiteneck GG, Dijkers MP, Coronado V, Heinemann AW, Harrison-Felix C, Graham JE. Representativeness of the Traumatic Brain Injury Model Systems National Database. *The Journal of Head Trauma Rehabilitation*. 2012; 27(6):391–403. [PubMed: 21897288]
39. Frankel JE, Marwitz JH, Cifu DX, Kreutzer JS, Englander J, Rosenthal M. A follow-up study of older adults with traumatic brain injury: taking into account decreasing length of stay. *YAPMR*. 2006; 87(1):57–62.

40. Kreutzer JS, Kolakowsky-Hayner SA, Ripley D, Cifu DX, Rosenthal M, Bushnik T, Zafonte R, Englander J, High W. Charges and lengths of stay for acute and inpatient rehabilitation treatment of traumatic brain injury 1990–1996. *Brain injury*. 2001; 15(9):763–774. [PubMed: 11516345]
41. Whiteneck G, Gassaway J, Dijkers M, Backus DD, Charlifue S, Chen D, Hammond F, Hsieh C-H, Smout RJ. Inpatient treatment time across disciplines in spinal cord injury rehabilitation. *Journal of Spinal Cord Medicine*. 2011; 34(2):133–148. [PubMed: 21675353]
42. Zbogar D, Eng JJ, Miller WC, Krassioukov AV, Verrier MC. Movement repetitions in physical and occupational therapy during spinal cord injury rehabilitation. *Spinal Cord*. 2016 Oct 18.
43. Hawkins ML, Lewis FD, Medeiros RS. Impact of length of stay on functional outcomes of TBI patients. *The American surgeon*. 2005; 71(11):920–9. discussion 929–30. [PubMed: 16372610]
44. Greiss C, Yonclas PP, Jasey N, Lequerica A, Ward I, Chiaravalloti N, Felix G, Dabaghian L, Livingston DH. Presence of a dedicated trauma center physiatrist improves functional outcomes following traumatic brain injury. *The journal of trauma and acute care surgery*. 2016; 80(1):70–75. [PubMed: 26491804]
45. Steiner E, Murg-Argeny M, Steltzer H. The severe traumatic brain injury in Austria: early rehabilitative treatment and outcome. *Journal of trauma management & outcomes*. 2016; 10(1):5. [PubMed: 27006688]
46. Sandhaug M, Andelic N, Langhammer B, Mygland A. Functional level during the first 2 years after moderate and severe traumatic brain injury. *Brain injury*. 2015; 29(12):1431–1438. [PubMed: 26361939]

Figure 1.
Age at Discharge from Traumatic Brain Injury Rehabilitation- Riyadh, Saudi Arabia

Table 1

Demographic information for patients discharged from inpatient TBI

Variable	Arrived from acute care	Arrived from elsewhere
n	66	142
Gender	n (%): male=54 (82); female=12 (18)	n (%): male=118 (83); female=24 (17)
Type of TBI	n (%): closed=53 (80); open=13 (20)	n (%): closed=112 (79); open=29 (20); unknown=1 (1)
Discharge destination	n (%): home= 65 (99); other= 1 (1)	n (%): home= 135 (95); other= 7(5)
Age, years	mean=30.6, s.d.=14.1, median=25.0, range=17–77	mean=28.3, s.d.=14.3, median=23.0, range=16–98
DOI to Admission, days	mean=117.2, s.d.= 103.1, median=72.5, range=20–362	mean=331.2, s.d.= 301.0 median=215.5, range=57–1574
LOS in rehabilitation, days	mean=61.2, s.d.=42.3, median=53.0, range=8–215	mean=64.6, s.d.=43.4, median=56.0, range=10–318

n= number; s.d.= standard deviation; TBI= traumatic brain injury; Discharge destination: other= transitional living/acute unit of other facility/ chronic hospital/unknown; DOI= date of injury; LOS= length of stay.

Table 2

FIM scores at admission and discharge from inpatient TBI rehabilitation

	<u>Admission</u>	<u>Discharge</u>
Individuals arriving from acute care		
FIM total score	58.3±27.5	93.4±32.7
FIM motor score	36.6±23.2	65.4±24.8
FIM cognitive score	21.7±6.8	27.9±10.4
Individuals arriving from elsewhere		
FIM total score	55.2±29	78.7±33.4
FIM motor score	34.3±22	53.9±26.1
FIM cognitive score	20.8±9.9	24.8±9.8

All values are means±SD; FIM= Functional Independence Measure (motor score= 13–91, cognitive score= 5–35).

Table 3

Hierarchical regression for FIM total score at discharge from rehabilitation in individuals with TBI admitted to inpatient rehabilitation from acute care

	R^2	b	SE	β	95% CI
Model 1	0.45				
(Constant)		60.32	5.20		49.93 – 70.72
FIM Score at Admission		0.57	0.078	0.67	0.41 – 0.72
Model 2	0.46				
(Constant)		64.02	8.04		47.97 – 80.08
FIM Score at Admission		0.56	0.079	0.67	0.40 – 0.72
age (years)		–0.11	0.18	–0.057	–0.48 – 0.26
Model 3	0.48				
(Constant)		68.91	8.55		51.82 – 86.01
FIM Score at Admission		0.56	0.078	0.67	0.41 – 0.72
age (years)		–0.12	0.18	–0.063	–0.49 – 0.24
DOI to Admission (days)		–0.038	0.025	–0.14	–0.09 – 0.01
Model 4	0.48				
(Constant)		64.35	11.86		40.64 – 88.06
FIM Score at Admission		0.59	0.095	0.70	0.40 – 0.78
age (years)		–0.10	0.19	–0.052	–0.48 – 0.27
DOI to Admission (days)		–0.041	0.025	–0.15	–0.09 – 0.01
LOS (days)		0.042	0.075	0.064	–0.11 – 0.19

Bold= $p < 0.05$; R^2 = coefficient of determination; b=unstandardized coefficients; SE=standard error; β =standardized coefficients; CI=confidence interval; FIM= Functional Independence Measure; DOI= date of injury; LOS= length of stay.

Table 4

Hierarchical regression for FIM total score at discharge from rehabilitation in individuals with TBI admitted to inpatient rehabilitation from elsewhere.

	R^2	b	SE	β	95% CI
Model 1	0.64				
(Constant)		27.78	3.72		20.43 – 35.12
FIM Score at Admission		0.92	0.06	0.80	0.81 – 1.04
Model 2	0.64				
(Constant)		35.33	6.16		23.15 – 47.50
FIM Score at Admission		0.89	0.062	0.77	0.77 – 1.02
age (years)		-0.21	0.14	-0.083	-0.49 – 0.06
Model 3	0.65				
(Constant)		38.18	6.22		25.87 – 50.48
FIM Score at Admission		0.92	0.063	0.79	0.80 – 1.04
age (years)		-0.22	0.14	-0.085	-0.49 – 0.05
DOI to Admission (days)		-0.013	0.006	-0.11	-0.02 – 0
Model 4	0.65				
(Constant)		34.68	9.00		16.88 – 52.47
FIM Score at Admission		0.94	0.074	0.81	0.79 – 1.09
age (years)		-0.20	0.14	-0.076	-0.48 – 0.09
DOI to Admission (days)		-0.013	0.006	-0.11	-0.02 – 0
LOS (days)		0.029	0.053	0.032	-0.08 – 0.13

Bold= $p < 0.05$; R^2 = coefficient of determination; b=unstandardized coefficients; SE=standard error; β =standardized coefficients; CI=confidence interval; FIM= Functional Independence Measure; DOI= date of injury; LOS= length of stay.