Published in final edited form as:

J Head Trauma Rehabil. 2018 ; 33(3): 177–184. doi:10.1097/HTR.0000000000000348.

Racial Disparities in Outpatient Mental Health Service Use among Children Hospitalized for Traumatic Brain Injury

Megan Moore, PhD^{a,b}, Nathalia Jimenez, MD^{b,c,d}, Janessa M. Graves, PhD^e, Tessa Rue, PhD^f, Jesse R. Fann, MD^g, Frederick P. Rivara, MD^{b,d,h}, and Monica S. Vavilala, MD^{b,c}

^aSchool of Social Work, University of Washington: 4101 15th Ave NE, Box 354900, Seattle, WA 98195-4900

^bHarborview Injury Prevention and Research Center, University of Washington

^cDepartment of Anesthesiology and Pain Medicine, University of Washington

^dSeattle Children's Hospital

^eWashington State University College of Nursing Spokane

^fInstitute of Translational Health Sciences, University of Washington

^gDepartment of Psychiatry and Behavioral Health, University of Washington

^hDepartment of Pediatrics, University of Washington

Abstract

Objective—To examine racial differences in mental health service utilization after hospitalization for traumatic brain injury (TBI) among children with Medicaid insurance.

Design and Main Measures—Retrospective analysis of the MarketScan® Multi-State Medicaid database from 2007-2012 was performed. Outpatient mental health service utilization (psychiatric and psychological individual and group services) was compared at TBI hospitalization, from discharge to 3 months and from 4 to 12 months after discharge between children of non-Hispanic White (NHW), non-Hispanic Black (NHB), Hispanic and “Other” racial groups. Multivariable mixed effects Poisson regression models with robust standard errors were utilized.

Results—5,674 children (<21 years) were included in the study. There were no differences by race/ethnicity in mental health service utilization during hospitalization. At 3 months post discharge, NHB children and children in the “Other” racial category were significantly less likely to receive outpatient mental health services compared to NHW children (NHB RR=0.84; 95%CI: 0.72-0.98; Other RR=0.72; 95%CI:0.57-0.90). At 12 months, all racial minority children were significantly less likely to receive outpatient mental health services compared to NHW children (NHB RR=0.84, 95%CI:0.75-0.94; Hispanic RR=0.72, 95%CI:0.55-0.94; Other RR=0.71, 95%CI: 0.60-0.84).

Correspondance: Megan Moore, PhD, Tel.: +1 206 616 2862; fax: +1 206 543 1228. mm99@uw.edu.

The authors declare no conflicts of interest.

Conclusion—Racial disparities in utilization of outpatient mental health services exist for minority children hospitalized for TBI and insured by Medicaid. Future research should focus on improving transitions of care from inpatient to outpatient services for these children.

Keywords

racial disparities; traumatic brain injury; mental health; Medicaid; service utilization; service access; capitated payer model; transitions of care

Approximately 1.7 million individuals, including more than 500,000 children, suffer a traumatic brain injury (TBI) each year in the US.¹ Outcomes for children with TBI include long-term functional disability, poor developmental outcomes² and impaired physical, emotional, social and cognitive functioning.^{3–6} Behavioral and psychiatric problems are prevalent after TBI (affecting up to 50% of children) and have been shown in several studies to persist and worsen over time.^{7–11} Psychological distress after TBI is also associated with increased health care costs.¹² Following TBI children have been found to have higher rates of Attention Deficit Hyperactivity Disorder (ADHD), Oppositional Defiant Disorder/Conduct Disorder, substance abuse, mood disorders and anxiety when compared to control groups.¹³ Low socioeconomic status is significantly associated with challenging behavioral outcomes after TBI.⁷ Specifically, it is a predictor of clinically significant and long-term behavior problems^{14,15} and secondary ADHD¹⁶ in children with TBI, and depressive symptoms are exacerbated in children with TBI from socioeconomically disadvantaged homes.¹⁷ Racial minority children are overrepresented among children with low socioeconomic status, yet little is known about their mental health service utilization after TBI, particularly for children hospitalized for moderate to severe TBI. An estimated 1 in 6 children develop persistent posttraumatic stress symptoms after any injury, which often lead to poor physical and functional recovery.¹⁸ Disparities in a range of outcomes occur for children in low-income families, ethnic minority families, and those living in families with low education.^{19–22}

Utilization of rehabilitation services after TBI can significantly improve functional outcomes.²³ Yet, availability of rehabilitation services, particularly mental health services, is limited for children with Medicaid insurance and those in need of language interpretation, despite the fact that there is no evidence these children have lower rates of rehabilitation service needs.²⁴ However, to date, racial variation in mental health service utilization of hospitalized children after TBI has not been documented. In this study, among children insured by Medicaid, we compared mental health service utilization between children of different racial/ethnic backgrounds. We hypothesized that children from racial minority groups would have lower rates of outpatient mental health service utilization compared to their non-Hispanic White (NHW) peers.

METHODS

Design and data source

This was a retrospective analysis of the Truven Health Analytics MarketScan® Multi-State Medicaid database, a national dataset that contains patient-level inpatient and outpatient

medical claims and allows for longitudinal tracking of claims over time.²⁵ The MarketScan database contains patient demographic information and Medicaid enrollment data. Each insurance claim record provides information on the date, place, and type of service. Patients are covered under fee-for-service and capitated plans. MarketScan has strong longitudinal integrity and utilizes rigorous validation methods to ensure data are complete and accurate.²⁵ Many large-scale studies utilize MarketScan because it contains data on real-world healthcare utilization for a diverse population of insured individuals.²⁶ This study examined claims data from 14 states providing data to MarketScan from 2007 to 2012. The study was considered exempt from University of Washington Institutional Review Board.

Participants

Eligible participants were patients 0-20 years old who were hospitalized for a TBI during the study period. TBI was defined by using inpatient International Classification of Diseases, Ninth Revision (ICD-9) codes 800.0–801.99, 803.0–804.99, and 850.0–854.19. We excluded patients who died during hospitalization, those not enrolled in Medicaid the month prior to the TBI, or not continuously enrolled for 12 months following the TBI. Among the eligible group of patients, we also identified patients who were continuously enrolled in Medicaid for the 6 and 12 months prior to the TBI hospitalization in order to conduct sensitivity analyses in this subgroup of patients to better ascertain the impact of prior mental health utilization. All hospital claims with a TBI diagnosis between 2007-2012 were identified. If a patient had more than one hospitalization with a TBI diagnosis only the first hospitalization was considered in the analysis.

Covariates

The following racial groups were categorized as reported in the MarketScan database: NHW, NHB, Hispanic and Other. The “Other” racial category, includes all children who are not identified in the three categories described above. Medicaid payment models were dichotomized into fee-for-service or capitated models. Capitated payment models included fully capitated health maintenance organizations and partially capitated preferred provider organizations. Age was categorized as 0-4, 5-9, 10-14, and 15-20 years. Severity of TBI was ascertained by the Abbreviated Injury Scale scores (AIS), calculated with the STATA-ICD9 Program for Injury Categorization.²⁷ AIS scores delineate six levels of injury severity: minor, moderate, serious, critical, severe and unsurvivable. Participants with an AIS score classified as “unsurvivable” but who survived were included in analyses and labeled as “unknown” since these were clearly miscoded. Length of hospital stay was included and dichotomized as 4 or more hospital days and fewer than 4 days because a previous study indicated therapeutic rehabilitation services were often not initiated until more than 4 days post admission.²⁸ Discharge status was categorized as home, non-psychiatric facility, psychiatric facility and other. Mental health service utilization in the 30 days prior to TBI was included to account for pre-injury mental health treatment.

Outcome

The primary outcome was outpatient mental health service utilization during these time periods: acute hospitalization, from discharge to 3 months, and 4 to 12 months post TBI hospitalization. Mental health services were identified by provider and services claims for

psychiatric and psychological individual, family and group therapies. Psychiatric and psychological evaluations were also included. Due to the characteristics of the database, a single clinical encounter can generate more than one claim (a service claim and a provider claim). Therefore, in order to avoid counting a single service or procedure more than once, we identified all claims (services and provider) and then used only one claim per day.

Data analysis

We compared demographic and clinical characteristics by race/ethnicity. We conducted multivariable mixed effects Poisson regression with robust standard errors, with random effects for hospital facility and fixed effects for race and the aforementioned covariates to assess associations between race and mental health service utilization at TBI hospitalization, from discharge to 3 months and 4 to 12 months following discharge. Sensitivity analyses were conducted restricting analyses to only those with continuous Medicaid enrollment for 6 or 12 months before injury, adjusting for any mental health services received in the past 6 or 12 months respectively. The decision to conduct sensitivity analyses rather than restricting the dataset to only patients continuously enrolled 1 year prior to injury was based on the unique enrollment patterns of patients enrolled in Medicaid. Medicaid enrolled children frequently have intermittent coverage because enrollment is based on eligibility which varies largely across time for the same individual and by region. Sample size and power are important analytic considerations in this context because requirements for increasing periods of continuous enrollment significantly decreases sample size. We present analyses for the entire sample and sensitivity analyses in the subgroup of continuously enrolled patients 12 and 6 months prior to TBI hospitalization. All analyses were done using Stata/IC 13.1 (StataCorp, College Station, Texas).

Results

During the study period from 2007 to 2012, we identified 5,674 children aged 0-20 years with TBI hospitalization. Among these, the majority were NHW (N=2,827) and NHB (N=1,673), and the remainder were Hispanic (N=376) and Other race/ethnicity (N=789). There were no differences in sex or hospital length of stay, however, bivariate analyses showed significant differences in age, severity of injury, type of insurance, discharge status, and use of mental health services prior to the TBI. Compared to NHW children, racial minority children were younger at time of injury and had more severe injuries. Additionally, proportionally more minority children were covered by capitated Medicaid insurance plans and proportionally fewer received mental health services prior to the TBI (See Table 1).

In the regression analyses, there were no differences in mental health service utilization across racial/ethnic categories during TBI hospitalization. In the first 3-months post hospitalization, children in the NHB racial group and those in the "Other" racial/ethnic group were significantly less likely to receive mental health services (NHB RR=0.84; 95% CI:0.72-0.98; Other RR=0.72; 95% CI:0.57-0.90), after adjusting for covariates. Between 4 and 12 months post hospitalization, racial minority children were significantly less likely to receive mental health services compared to NHW (NHB RR=0.84, 95% CI: 0.75-0.94; Hispanic RR=0.72, 95% CI:0.55-0.94; Other RR=0.71, 95% CI:0.60-0.84),

holding all other factors constant (Table 2). Sensitivity analyses adjusting for mental health services received among children continuously enrolled 6 or 12 months prior to the TBI yielded very similar relative risk estimates although the confidence intervals were wider due to the reduction in sample size (N=4,330 for 6 months and N=3,328 for 12 months). The significant reduction in the sample size is explained by exclusion of all patients who had injuries in 2007 and who did not have continuous enrollment in the 6 or 12 months prior to injury (see supplemental Table 2a- children with continuous Medicaid enrollment 6 months prior to TBI hospitalization and supplemental Table 2b-children with continuous enrollment 12 months prior to TBI hospitalization).

Other factors associated with increased likelihood of receiving mental health services included older age (all models), hospital length of stay 4+ days (significant during hospitalization and 12 months post hospitalization), greater severity of injury (significant during hospitalization), discharge to a psychiatric facility (significant at 3 and 12 months post hospitalization), and receipt of mental services prior to the TBI hospitalization. Children with capitated Medicaid insurance coverage were significantly less likely to receive mental health services at all time points, including during the index TBI hospitalization (Table 2). For children with mental health service utilization in the month prior to TBI hospitalization (N=402), a significant disparity in service utilization is observed for NHB, Hispanic and children in the Other racial group in the first 3-months post hospitalization (Table 3).

The proportion of children receiving mental health services exhibited an upward trend in service utilization over time across all racial groups, however, utilization was persistently lower for NHB, Hispanic and children in “Other” racial group compared to NHW children (Figure 1). Among children who received mental health services, the average number of visits increased over time post discharge (Figure 2). The disparity across race/ethnic groups persisted, however, with NHW children receiving 1-2 and 2-4 more visits in the time periods 0 to 3 months and 4 to 12 months post discharge, respectively, compared to children from other racial groups (Figure 2).

Discussion

In the present study, racial/ethnic disparities in receipt of outpatient mental health services were identified following hospital discharge for children with TBI, with racial/ethnic minority children being significantly less likely to receive outpatient mental health services compared to NHW children after controlling for potential confounders. Importantly, no disparities in mental health service utilization during TBI hospitalization were observed across race/ethnic group in this study, indicating that disparities arise after discharge from the hospital and highlighting the need for improving transitions of care and to improve outpatient service access for minority children.

While it is known that many children with TBI have increased need for mental health services,⁷ there is a paucity of research on racial differences in mental health outcomes after pediatric TBI.^{29,30} Two separate comprehensive reviews of the literature on racial/ethnic differences in outcomes after TBI identified only four studies that reported on racial/ethnic

Author Manuscript

differences in outcome for emotional and neurobehavioral outcomes.^{29,30} Overall, these studies, using systematic assessment and self-report, revealed increased psychosocial comorbidities (depression, social functioning and post-traumatic stress) after TBI for African American children and one study found a protective effect for Hispanic children in development of post-concussive syndrome. One recent study in older adolescents and adults (aged 16 years and older) found that compared to White patients, African American patients had elevated rates of depression and lower life satisfaction after TBI. In the same study, depression rates increased over time for Asian and Pacific Islander adults, and anxiety was higher among African American, Hispanic and Asian/Pacific Islander patients compared to White patients.³¹

Author Manuscript

Mental health treatment after injury is important, not only for addressing mental illness, but also to assure adequate recovery after a TBI, particularly because mental health problems have an important association with functional outcomes and quality of life.^{18,32–34} Because new psychiatric disorders typically emerge in the first year after injury, it is important for children to receive early intervention and treatment following TBI.³⁵ For children with preexisting mental health service needs, our study finds that racial disparities in service utilization are present in the first 3-months post TBI hospitalization. This group of children requires particular attention from practitioners as their need for mental health services after may increase. Indeed, previous mental health disorder has been associated with post-TBI mental health service utilization for children with mild traumatic brain injury.³⁶ The differential mental health service utilization by race/ethnicity noted in the present study may in part explain previously noted racial disparities in outcomes for children after TBI.
22, 23,29,30

Author Manuscript

Research to identify strategies for addressing racial disparities in mental health service access is warranted. Of note in our study is the finding that children hospitalized for 4 or more days were more likely to utilize mental health services at time of hospitalization than those hospitalized for fewer days. Since service utilization at time of hospitalization is a predictor of outpatient service use, hastening the referral process during hospitalization may be an important first step towards linkage to mental health services after discharge. Changes in clinical practice might prioritize identifying service needs and addressing barriers to care access, such as transportation and coordination of care to facilitate access to care for minority patients. Innovations in existing care coordination models and a focus on families most at risk for facing barriers to outpatient care are needed. In addition, successful recovery requires that families understand and can act on recommended care plans. Assessing the impact of promising adult treatment models, such as telephone delivered therapy³⁷ or web based treatment,³⁸ on mental health symptoms in children may prove beneficial, particularly for those with transportation or other barriers to clinic-based services.

Author Manuscript

Policy reforms might focus on incentivizing assessment, not only of mental health disorder in the hospital and in the year following injury, but also assessment of outpatient care barriers. Screening and identification models for PTSD exist for trauma patients³⁹ and stepped care models to address PTSD⁴⁰ might serve as a model for meeting the care coordination and mental health needs of vulnerable children hospitalized after TBI. Policy reforms might also consider the particular disadvantage of children with capitated insurance

plans noted in this study. Majority of racial minority children in this sample had capitated plans and those plans, or some new iteration or combination of fee-for-service and capitated payment models, are a focus of the Affordable Care Act.^{41,42} Indeed, 70% of current Medicaid enrollees nationally are served through managed care or capitated plans, and there is variability in Medicaid eligibility requirements by state that impact the demographics of Medicaid enrollees.^{43,44} Policy makers should consider the role of race and disparities in service access when monitoring these models.

Limitations

This study has several limitations related to the use of large administrative claims data. The analysis was limited to the variables available in the dataset, and therefore we were not able to determine racial composition of children classified in the “Other” racial group, or geographic location of children or other familial and socioeconomic characteristics that might contribute to the associations of interest. As is the case in retrospective observational data, residual confounding may be present, despite controlling for confounders available in the data. However, we utilized all known variables associated with mental health utilization and available in the dataset, including severity of injury which was determined by a proxy measure (AIS score). In addition, the analyses presented here were restricted to services that were billed to Medicaid. Services provided elsewhere, either in the community or billed to another payer, were not included in analyses. We included a maximum of one service per day to avoid overcounting duplicatively billed services. While it is unlikely that a child received more than one distinct outpatient mental health services in a day, our analyses do not account for that unique situation. We cannot ascertain if mental health needs after the TBI were due to prior mental health disorders or new ones. However, we adjusted for use of mental health utilization prior to the TBI as a proxy for prior mental health needs. It is possible the disparity between Hispanic and non-Hispanic White children post-TBI can be explained by need and/or pre-existing disparity as the models adjusting for mental health services in the 6 or 12 months prior to injury did not show a significant reduction in follow up services for this group. It is also possible there is a disparity above and beyond pre-injury disparity and/or need that the sensitivity analysis did not have the power to detect.

Conclusions

There are racial disparities in mental health service utilization after hospitalization for TBI among pediatric patients. Achieving health equity after injury requires a three-pronged focus on research, practice and policy. In particular, this study calls for an emphasis on identification of strategies to address disparities including more comprehensive and earlier inpatient identification of mental health service needs and case management to address barriers to outpatient care access, innovations in care coordination models to ensure families can overcome barriers to accessing services as outpatients, and policy reforms to support these initiatives.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This work was supported by the National Center for Advancing Translational Sciences of the National Institutes of Health (KL2TR000421 to Dr. Moore) and the National Institute of Child Health and Human Development (1K23HD078453 – 01 to Dr. Jimenez). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

References

1. Faul M, Xu L, Wald MM, Coronado VG. Traumatic Brain Injury in the United States: Emergency Department Visits, Hospitalizations and Deaths 2002–2006. Atlanta (GA): Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2010.
2. Keenan H. Longitudinal Follow-up of Families and Young Children With Traumatic Brain Injury. *Pediatrics*. 2006; 117(4):1291–1297. [PubMed: 16585326]
3. McCarthy M. Health-Related Quality of Life During the First Year After Traumatic Brain Injury. *Arch Pediatr Adolesc Med*. 2006; 160(3):252. [PubMed: 16520444]
4. Robertson C, Watt J, Joffe A, et al. Childhood morbidity after severe traumatic brain injury: Increased detection with the Multiattribute Health Status Classification. *Pediatr Crit Care Med*. 2001; 2(2):145–150. [PubMed: 12797874]
5. Rivara F, Koepsell T, Wang J, et al. Disability 3, 12, and 24 Months After Traumatic Brain Injury Among Children and Adolescents. *Pediatrics*. 2011; 128(5):e1129–e1138. [PubMed: 22025592]
6. Rivara F, Vavilala M, Durbin D, et al. Persistence of Disability 24 to 36 Months after Pediatric Traumatic Brain Injury: A Cohort Study. *J Neurotrauma*. 2012; 29(15):2499–2504. [PubMed: 22757748]
7. Li L, Liu J. The effect of pediatric traumatic brain injury on behavioral outcomes: a systematic review. *Dev Med Child Neurol*. 2013; 55:37–45. [PubMed: 22998525]
8. Schwartz L, et al. Long-term behavior problems following pediatric traumatic brain injury: prevalence, predictors, and correlates. *J Pediatr Psychol*. 2003; 28(4):251–63. [PubMed: 12730282]
9. Zatzick DF, et al. Multisite investigation of traumatic brain injuries, posttraumatic stress disorder, and self-reported health and cognitive impairments. *Arch Gen Psychiatry*. 2010; 67(12):1291–300. [PubMed: 21135329]
10. O'Connor SS, et al. Association between posttraumatic stress, depression, and functional impairments in adolescents 24 months after traumatic brain injury. *J Trauma Stress*. 2012; 25(3):264–71. [PubMed: 22729979]
11. Massagli TL, Fann JR, Burington BE, Jaffe KM, Katon WJ, Thompson RS. Psychiatric illness after mild traumatic brain injury in children. *Arch Phys Med Rehabil*. 2004 Sep; 85(9):1428–34. [PubMed: 15375812]
12. Rockhill CM, Fann JR, Fan MY, Hollingsworth W, Katon WJ. Health care costs associated with mild traumatic brain injury and psychological distress in children. *Brain Injury*. 2010; 24:1051–1060. [PubMed: 20597633]
13. Lloyd J, Wilson ML, Tenovuo O, Saarijärvi S. Outcomes from mild and moderate traumatic brain injuries among children and adolescents: A systematic review of studies from 2008–2013. *Brain Inj*. 2015; 29(5):539–49. [PubMed: 25790086]
14. Chapman LA, Wade SL, Walz NC, Taylor HG, Stancin T, Yeates KO. Clinically significant behavior problems during the initial 18 months following early childhood traumatic brain injury. *Rehabil Psychol*. 2010; 55:48–57. [PubMed: 20175634]
15. Schwartz L, Taylor HG, Drotar D, Yeates KO, Wade SL, Stancin T. Long-term behavior problems following pediatric traumatic brain injury: prevalence, predictors, and correlates. *J Pediatr Psychol*. 2003; 28:251–63. [PubMed: 12730282]
16. Max JE, Schachar RJ, Levin HS, et al. Predictors of attention-deficit/hyperactivity disorder within 6 months after pediatric traumatic brain injury. *J Am Acad Child Adolesc Psychiatry*. 2005; 44:1032–40. [PubMed: 16175108]

17. Kirkwood M, Janusz J, Yeates KO, et al. Prevalence and correlates of depressive symptoms following traumatic brain injuries in children. *Child Neuropsychol.* 2000; 6:195–208. [PubMed: 11402397]
18. Kassam-Adams N, et al. Posttraumatic stress following pediatric injury: update on diagnosis, risk factors, and intervention. *JAMA Pediatr.* 2013; 167(12):1158–65. [PubMed: 24100470]
19. Zonfrillo M, Durbin D, Koepsell T, et al. Prevalence of and Risk Factors for Poor Functioning after Isolated Mild Traumatic Brain Injury in Children. *Journal of Neurotrauma.* 2014; 31(8):722–727. [PubMed: 24294826]
20. Schiraldi M, Patil CG, Mukherjee D, et al. Effect of Insurance and Racial Disparities on Outcomes in Traumatic Brain Injury. *Journal of Neurological Surgery Part A: Central European Neurosurgery.* 2015; 76(03):224–232.
21. Jimenez N, Osorio M, Ramos J, Apkon S, Ebel B, Rivara F. Functional Independence After Inpatient Rehabilitation for Traumatic Brain Injury Among Minority Children and Adolescents. *Archives of Physical Medicine and Rehabilitation.* 2015; 96(7):1255–1261. [PubMed: 25747552]
22. Jimenez N, Ebel B, Wang J, et al. Disparities in disability after traumatic brain injury among Hispanic children and adolescents. *Pediatrics.* 2013; 131:1850–1856.
23. Consensus conference. Rehabilitation of persons with traumatic brain injury: NIH Consensus Development Panel on Rehabilitation of Persons with Traumatic Brain Injury. *JAMA.* 1999; 282:974–983. [PubMed: 10485684]
24. Moore M, Jimenez N, Rowhani-Rahbar A, Willis M, Baron K, Giordano J, Ebel BE. Availability of Outpatient Rehabilitation Services for Children after Traumatic Brain Injury: Differences by Language and Insurance Status. *American Journal of Physical Medicine and Rehabilitation.* 2016; 95:204–213. [PubMed: 26259055]
25. MarketScan® Database. Truven Analytics Inc; New York, NY: 2012.
26. Hansen L, Chang S. Health research data for the real world: the MarketScan databases. Available at: http://truvenhealth.com/portals/0/assets/PH_11238_0612_TEMP_MarketScan_WP_FINAL.pdf. Accessed April 21, 2017
27. Clark DE, Turner M. ICDPIC: Stata module to provide methods for translating International Classification of Diseases (Ninth Revision) diagnosis codes into standard injury categories and/or scores. Statistical Software Components. 2009
28. Bennett TD, Niedzwecki CM, Korgenski EK, Bratton SL. Initiation of physical, occupational, and speech therapy in children with traumatic brain injury. *Arch Phys Med Rehabil.* 2013; 94(7):1268–1276. [PubMed: 23473704]
29. Gary KW, Arango-Lasprilla JC, Stevens LF. Do racial/ethnic differences exist in post-injury outcomes after TBI? A comprehensive review of the literature. *Brain Injury.* 2009; 23(10):775–789. [PubMed: 19697166]
30. Arango-Lasprilla JC, Kreutzer JS. Racial and ethnic disparities in functional, psychosocial, and neurobehavioral outcomes after brain injury. *J Head Trauma Rehabil.* 2010 Mar-Apr;25(2):128–36. [PubMed: 20234227]
31. Perrin PB, Krch D, Sutter M, Snipes DJ, Arango-Lasprilla JC, Kolakowsky-Hayner SA, Wright J, Lequerica A. Racial/ethnic disparities in mental health over the first 2 years after traumatic brain injury: a model systems study. *Arch Phys Med Rehabil.* 2014 Dec; 95(12):2288–95. [PubMed: 25128715]
32. Landolt MA, Vollrath ME, Gnehm HE, Sennhauser FH. Post-traumatic stress impacts on quality of life in children after road traffic accidents: prospective study. *Aust N Z J Psychiatry.* 2009; 43(8):746–753. [PubMed: 19629796]
33. Holbrook TL, et al. High rates of acute stress disorder impact quality-of-life outcomes in injured adolescents: mechanism and gender predict acute stress disorder risk. *J Trauma.* 2005; 59(5):1126–30. [PubMed: 16385290]
34. Zatzick DF, et al. Association between posttraumatic stress and depressive symptoms and functional outcomes in adolescents followed up longitudinally after injury hospitalization. *Arch Pediatr Adolesc Med.* 2008; 162(7):642–8. [PubMed: 18606935]
35. Wade SL, Taylor HG, Cassidy A, Zhang N, Kirkwood MW, Brown TM, Stancin T. Long-Term Behavioral Outcomes after a Randomized, Clinical Trial of Counselor-Assisted Problem Solving

- for Adolescents with Complicated Mild-to-Severe Traumatic Brain Injury. *J Neurotrauma*. 2015 Jul 1; 32(13):967–75. Epub 2015 May 7. DOI: 10.1089/neu.2014.3684 [PubMed: 25738891]
36. Jimenez N, Quistberg A, Vavilala MS, Jaffee KM, Rivara FP. Utilization of Mental Health Services after Mild Pediatric Brain Injury. *Pediatrics*. 2017; 139(3):e20162462. [PubMed: 28159872]
 37. Fann JR, Bombardier CH, Vannoy S, Dyer J, Ludman E, Dikmen S, Marshall K, Barber J, Temkin N. Telephone and in-person cognitive behavioral therapy for major depression after traumatic brain injury: a randomized controlled trial. *J Neurotrauma*. 2015 Jan 1; 32(1):45–57. [PubMed: 25072405]
 38. Belsher BE, Kuhn E, Maron D, Prins A, Cueva D, Fast E, France D. A preliminary study of an internet-based intervention for OEF/OIF veterans presenting for VA specialty PTSD care. *J Trauma Stress*. 2015 Apr; 28(2):153–6. [PubMed: 25864506]
 39. Russo J, Katon W, Zatzick D. The development of a population-based automated screening procedure for PTSD in acutely injured hospitalized trauma survivors. *Gen Hosp Psych*. 2013; 35:485–491.
 40. Zatzick D, O'Connor SS, Russo J, Wang J, Bush N, Love J, Peterson R, Ingraham L, Darnell D, Whiteside L, Van Eaton E. Technology-Enhanced Stepped Collaborative Care Targeting Posttraumatic Stress Disorder and Comorbidity After Injury: A Randomized Controlled Trial. *J Trauma Stress*. 2015 Oct; 28(5):391–400. [PubMed: 26467327]
 41. American Public Health Association. Major Affordable Care Act Delivery and Payment Reforms Summary Table. 2013. Retrieved from https://www.apha.org/~media/files/pdf/topics/aca/delivery_reforms_table_apha_oct2013.ashx
 42. Ginsburg PB. Fee-for-service will remain a feature of major payment reforms, requiring more changes in Medicare physician payment. *Health Aff (Millwood)*. 2012 Sep; 31(9):1977–83. [PubMed: 22949446]
 43. Centers for Medicare and Medicaid Services. Available at: <https://www.medicaid.gov/medicaid/financing-and-reimbursement/index.html>. Accessed April 26, 2017
 44. Kaiser Family Foundation. Available at: <http://kff.org/state-category/medicaid-chip/medicaid-beneficiaries/>. Accessed April 26, 2017

Figure 1.
Proportion of children who received mental health services

Figure 2.
Average visits among those who received mental health services

Table. 1

Characteristics of Medicaid-insured children hospitalized for TBI

	Race				P-value
	All	Non-Hispanic White	Non-Hispanic Black	Hispanic	Other
N (%)	5674	2827 (50)	1673 (29)	376 (7)	789 (14)
Sex					0.151
Male	3736 (66)	1826 (65)	1134 (68)	244 (65)	532 (67)
Female	1938 (34)	1001 (35)	539 (32)	132 (35)	266 (33)
Age					<0.001
0-4	1811 (32)	860 (30)	557 (33)	145 (39)	249 (31)
5-9	983 (17)	448 (16)	275 (16)	94 (25)	166 (21)
10-14	986 (17)	509 (18)	274 (16)	60 (16)	143 (18)
15-20	1894 (33)	1010 (36)	567 (34)	77 (20)	240 (30)
Max AIS – Head					0.001
Minor	120 (2)	62 (2)	35 (2)	3 (1)	20 (3)
Moderate	2086 (37)	1013 (36)	629 (38)	116 (31)	328 (41)
Serious	1409 (25)	689 (24)	449 (27)	95 (25)	176 (22)
Severe	1955 (34)	1013 (36)	523 (31)	159 (42)	260 (33)
Critical	97 (2)	46 (2)	34 (2)	3 (1)	14 (2)
Unknown	7 (0)	4 (0)	3 (0)	0 (0)	0 (0)
Payment Mode					<0.001
Fee-for-service	2522 (44)	1478 (52)	644 (38)	187 (50)	213 (27)
Capitated	3152 (56)	1349 (48)	1029 (62)	189 (50)	585 (73)
Hospital Length of Stay (4+ days)					0.24
Discharge Status	2291 (40)	1150 (41)	682 (41)	161 (43)	298 (37)
Home/home under care	5070 (89)	2512 (89)	1496 (89)	345 (92)	717 (90)
Non-psychiatric facility	512 (9)	260 (9)	164 (10)	26 (7)	62 (8)
Psychiatric facility	6 (0)	3 (0)	0 (0)	0 (0)	3 (0)
Other	86 (2)	52 (2)	13 (1)	5 (1)	16 (2)
Mental in month prior to TBI health service					<0.001
	402 (7)	251 (9)	97 (6)	14 (4)	40 (5)

Table 2

Adjusted multivariable regression models of predictors of mental health service utilization (n=5,674)

	TBI Hospitalization RR (95% CI)	0-3 months post hospitalization RR (95% CI)	4-12 months post hospitalization RR (95% CI)
Race			
NHW	1.00 (ref) –	1.00 (ref) –	1.00 (ref) –
NHB	1.13 (0.89 – 1.42)	0.84 (0.72 – 0.98)	0.84 (0.75 – 0.94)
Hispanic	0.99 (0.69 – 1.42)	0.79 (0.57 – 1.10)	0.72 (0.55 – 0.94)
Other	0.89 (0.69 – 1.15)	0.72 (0.57 – 0.90)	0.71 (0.60 – 0.84)
Capitated	0.47 (0.32 – 0.69)	0.70 (0.61 – 0.81)	0.66 (0.57 – 0.75)
Age			
0-4	1.00 (ref) –	1.00 (ref) –	1.00 (ref) –
5-9	1.14 (0.86 – 1.51)	1.88 (1.39 – 2.53)	2.00 (1.51 – 2.63)
10-14	1.41 (1.03 – 1.92)	1.89 (1.38 – 2.58)	2.18 (1.61 – 2.96)
15-20	1.78 (1.31 – 2.42)	2.12 (1.58 – 2.85)	2.33 (1.79 – 3.04)
Female	1.02 (0.88 – 1.18)	0.92 (0.81 – 1.05)	0.91 (0.82 – 1.01)
Max AIS – Head			
Minor	0.86 (0.49 – 1.51)	1.28 (0.94 – 1.75)	1.21 (0.93 – 1.58)
Moderate	1.00 (ref) –	1.00 (ref) –	1.00 (ref) –
Serious	0.67 (0.54 – 0.81)	0.99 (0.87 – 1.12)	0.92 (0.80 – 1.05)
Severe	0.81 (0.70 – 0.93)	1.02 (0.91 – 1.15)	0.96 (0.84 – 1.08)
Critical	1.0 (0.57 – 1.76)	1.08 (0.65 – 1.81)	1.07 (0.75 – 1.52)
Unknown	1.19 (0.40 – 3.54)	0.47 (0.24 – 0.90)	1.03 (0.40 – 2.69)
Hospital Length of Stay (4+ days)	4.50 (3.74 – 5.40)	1.03 (0.92 – 1.17)	1.20 (1.07 – 1.33)
Discharge Status			
Home/home under care	–	1.00 (ref) –	1.00 (ref) –
Non-psychiatric facility	–	1.09 (0.85 – 1.40)	1.17 (0.99 – 1.38)
Psychiatric facility	–	5.18 (2.55 – 10.50)	4.15 (2.64 – 6.52)
Other	–	0.77 (0.50 – 1.20)	0.81 (0.56 – 1.16)
Mental health service in month prior to TBI	3.11 (2.47 – 3.91)	5.86 (4.95 – 6.94)	3.72 (3.33 – 4.15)
Mental health service during TBI hospital admission	–	1.89 (1.63 – 2.20)	1.44 (1.23 – 1.69)

Table 3

Adjusted multivariable regression models of predictors of mental health service utilization for children with mental health service utilization in month prior TBI hospitalization (n=402)

	TBI Hospitalization RR (95% CI)	0-3 months post hospitalization RR (95% CI)	4-12 months post hospitalization RR (95% CI)
Race			
NHW	1.00 (ref) –	1.00 (ref) –	1.00 (ref) –
NHB/Hispanic/Other	0.95 (0.73 – 1.23)	0.85 (0.76 – 0.96)	0.91 (0.82 – 1.00)
Capitated	0.46 (0.32 – 0.66)	0.98 (0.88 – 1.08)	
Age			
0-4	1.00 (ref) –	1.00 (ref) –	1.00 (ref) –
5-9	0.72 (0.37 – 1.39)	0.98 (0.77 – 1.24)	1.07 (0.90 – 1.27)
10-14	0.92 (0.59 – 1.44)	1.05 (0.82 – 1.34)	1.08 (0.90 – 1.30)
15-20	1.12 (0.73 – 1.72)	1.04 (0.85 – 1.27)	1 (0.84 – 1.19)
Female	1.23 (0.93 – 1.62)	0.93 (0.82 – 1.06)	1.01 (0.91 – 1.12)
Max AIS – Head			
Minor	1.14 (0.64 – 2.04)	1.05 (0.81 – 1.36)	0.85 (0.62 – 1.17)
Moderate	1.00 (ref) –	1.00 (ref) –	1.00 (ref) –
Serious	0.97 (0.72 – 1.31)	1.04 (0.92 – 1.19)	0.97 (0.86 – 1.10)
Severe	0.90 (0.67 – 1.20)	1.01 (0.90 – 1.15)	1.04 (0.94 – 1.15)
Critical	1.03 (0.43 – 2.49)	1.06 (0.64 – 1.74)	0.92 (0.57 – 1.48)
Unknown	2.38 (1.38 – 4.09)	1.77 (1.18 – 2.66)	1.27 (1.01 – 1.60)
Hospital Length of Stay (4+ days)	2.90 (2.16 – 3.89)	0.82 (0.72 – 0.95)	1.03 (0.92 – 1.14)
Discharge Status			
Home/home under care	–	1.00 (ref) –	1.00 (ref) –
Non-psychiatric facility	–	0.66 (0.46 – 0.96)	0.82 (0.66 – 1.02)
Psychiatric facility	–	–	–
Other	–	0.56 (0.32 – 0.98)	0.6 (0.37 – 0.99)
Mental health service during TBI hospital admission	–	1.23 (1.07 – 1.41)	1.05 (0.95 – 1.16)