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Child Outcomes and Family Characteristics 1 Year After Severe Inflicted or Noninflicted Traumatic Brain Injury

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Abstract

OBJECTIVE—To assess outcomes 1 year after severe traumatic brain injury (TBI) among young children and to compare outcomes between children with inflicted versus noninflicted injuries.

STUDY DESIGN—Prospective cohort study.

METHODS—All North Carolina-resident children who were hospitalized between January 2000 and December 2001 in any of the state's 9 PICUs and who survived a severe TBI that occurred on or before their second birthday were eligible to participate. Child health status, child use of ancillary medical resources, and family characteristics were determined through maternal caregiver interviews ~1 year after injury. Comparisons were made between family characteristics and child outcomes according to injury type.

RESULTS—Seventy-two interviews of maternal caregivers were completed among 112 survivors (64.3%). Children with inflicted injuries ($n = 41$) had worse outcomes than did children with noninflicted injuries ($n = 31$), as measured with the Pediatric Outcome Performance Category and Stein-Jessup Functional Status II (Revised) tools. However, ~50% of children with inflicted injuries had only mild deficits or better. Children with inflicted injuries had a higher use of ancillary medical resources. Families caring for the children did not differ substantively, with a large proportion of single, working, minority mothers.

CONCLUSIONS—Children with inflicted TBIs had worse outcomes than did children with other TBIs 1 year after injury. However, outcomes for these children were better than those reported previously. Many families caring for children after severe TBI are socially disadvantaged. Interventions to improve child outcomes may include enhanced family support.

Keywords

traumatic brain injury; child abuse; outcomes; shaken infant syndrome

Traumatic Brain Injury (TBI) is an important cause of morbidity and death among young children.[1] Children with early TBI differ from older children in both the cause of injury and the pattern of recovery and may require special attention.[2] Among children <2 years of age,

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inflicted TBI accounts for approximately one half of children admitted to the PICU for treatment of TBI.[3] Longitudinal studies of children with TBI who were injured at a young age are few and often intentionally exclude children with abusive injuries. Although it was once thought that the plasticity of the infant brain would allow very young children to compensate for injuries, that premise has been brought into question.[4–6] Surviving children may be faced with lifelong impairments in multiple areas of functioning. In addition to their injuries, some of these children continue to face adverse social environments, which have been shown to affect the well-being of children as early as preschool ages.[7] We undertook a prospective cohort study of children who suffered TBI (inflicted or noninflicted) before their second birthday, to examine child medical outcomes and medical resource use ~1 year after their date of injury. We sought to explore whether differences existed in the outcomes of children with inflicted versus noninflicted TBI and to characterize differences in families that might affect a family's ability to access resources for their child.

METHODS

Study Population and Follow-Up Interviews

This study was reviewed and approved by the institutional review board at the University of North Carolina at Chapel Hill and by the local board of each participating hospital. All children who were North Carolina residents and were hospitalized between January 2000 and December 2001 in any of the 9 PICUs in North Carolina for treatment of a TBI that occurred on or before their second birthday were identified prospectively. Evidence of TBI had to be demonstrated either with an imaging study or during surgery. Methods of subject identification have been described previously.[3] The maternal caregiver of each surviving child was approached and asked for consent to be enrolled in the follow-up portion of the study. In cases in which the child was in the custody of the Department of Social Services (DSS), both the legal guardian and the mother were asked for consent when possible. In cases in which the child was in DSS custody and the mother could not be asked for consent during the hospitalization, consent for continued participation was obtained before change of legal custody. One year after the child's injury, each child's maternal caregiver was interviewed, by a single interviewer (M.N.), regarding the child's health status, the use of ancillary medical services, and the family composition. Up to 6 attempts to contact the maternal caregiver were made, at different times of the day and in the evening. Maternal caregivers were sent postcards quarterly, to track when families moved. In addition, all study participants were provided with a toll-free telephone number, to contact the investigators to schedule an interview.

Injury Type

TBIs were classified as intentional or unintentional by the treating physicians and/or social service investigators. We reviewed the injury histories to verify that the classification of intentionality seemed appropriate. A procedure was developed to adjudicate cases in which there seemed to be a discrepancy between the findings of the treating physicians and our findings; however, this procedure was never required for cases in which the children survived.

Injury Severity

The child's initial injury severity was judged in 2 ways. First, we used the child's initial Glasgow Coma Scale (GCS) score.[8] GCS scores were then categorized as 3 to 8, 9 to 12, or 13 to 15. The second method was adapted from the study by Michaud et al.[9] Severe injury was defined as a GCS score of ≤8 and no spontaneous movement for 72 hours. All other children were considered to have moderate injury. No children had minimal injury, because entry into the study required computed tomographic or pathologic findings of intracranial injury. Details of the children's presentations and ICU courses were described previously.[10]

Child Outcomes

Children's outcomes were assessed with 3 separate instruments. The first was the Pediatric Outcome Performance Category (POPC).[11] This scale measures functional morbidity and cognitive outcomes. It was developed as an outcome measure for children who had been hospitalized in the PICU. The POPC score has been related significantly to the Bayley Psychomotor Development Index[12] and the Vineland Adaptive Behavior Scales.[13,14] Children's outcomes are ranked from 1 to 6. A score of 1 indicates that the child is healthy, alert, and capable of age-appropriate activities. A score of 6 indicates death. Because of the difficulty in detecting mild delays among very young children, we categorized the POPC results as good versus poor outcomes. Children were considered to have good outcomes if they scored 1 or 2 on the POPC, consistent with mild disability at most. Children were considered to have poor outcomes if they scored 3 or 4 on the POPC, consistent with moderate/severe disability. There were no survivors in a vegetative state (POPC score of 5). The POPC category was determined with direct questions about the child's ability to perform age-appropriate activities, use of rehabilitative services, and physical disabilities.

The second outcome measure used was the Stein-Jessup Functional Status II (Revised) [FSII (R)] measure.[15] To keep the interview <45 minutes in length, the short form (14 items) was chosen. This scale is designed to measure the health status of children who have ongoing health conditions. It measures behavioral inventories that interfere with the child's age-appropriate activities. This scale was compared previously with population normative values. Validation was performed among children 0 to 16 years of age. The correlations between response and functional status are consistent across age ranges and for both the long and short forms.[15] This scale was chosen in part because it measures the child's functioning in a setting of a chronic disability, including whether deficits in functioning are attributable to the child's illness; also, it can be used in longitudinal studies and is available in both Spanish and English. Among well children, the mean score is 96.1 ± 8.2; among children who are ill, the mean score is 86.8 ± 15.7.

The third measure used was the Global Health Index.[16] This is a measure used to assess the respondent's perception of 5 areas, including the child's general health, physical well-being, role functioning, psychological distress, and social functioning. Each area is measured with a 4-point Likert scale, with higher numbers indicating better performance.

Family Characteristics

Family characteristics, including whether the child was in the home of origin, the age, educational status, and marital status of the maternal caregiver, the number of children in the home, and whether the maternal caregiver was employed, were assessed. The maternal caregiver's social capital was also assessed. Social capital is a measure of a person's social relationships in their community and family.[17] The social capital index used for this study was composed of questions about maternal social support, neighborhood support, and church attendance, the number of children in the home, and whether the maternal caregiver had a partner. This index has been used in a set of longitudinal studies of preschool-aged children at high risk for poor developmental outcomes because of adverse social or economic conditions.[7] The social capital index was associated strongly with the child's well-being; scores of ≥4 were associated with children faring well, and scores of <4 were associated with children faring poorly.[7]

Medical Resources

Children's use of ancillary medical resources was evaluated on the basis of maternal reports. Items included whether the child had a primary pediatrician, use of medications, use of home health services, and use of occupational, physical, and speech therapies. Children who used ≥2 therapies >1 time per week were categorized as "high users" of resources.

Statistical Analyses

Frequencies and percentages were used to describe the population. Children eligible for the study were compared with children who participated in the study and children who did not participate in the study with χ^2 analyses. We also used χ^2 analyses to compare categorical child and family characteristics. For continuous measurements, means were calculated and comparisons were made with *t* tests. Medians with interquartile range (IQRs) were calculated for continuous measurements with nonnormal distribution. Comparisons of nonnormally distributed data were made with the Mann-Whitney *U* test. Finally, a binomial regression model was constructed to assess variables found to be related to children's outcomes in the bivariate analyses. Covariates that changed the estimate by <10% were eliminated from the model. Adjusted relative risks (RRs) with 95% confidence intervals (CIs) were calculated. Sensitivity and specificity were calculated with standard formulas.[18]

RESULTS

There were 112 survivors (73.7%) of the 152 children with TBI who were identified during the study period. Of the 112 eligible patients, 86 (76.8%) consented to the follow-up study and 72 (64.3%) actually completed the interview. Reasons for not completing the evaluation included inability to contact the parents (7 children), inability to reach the parents for consent after the children were removed from DSS custody (5 children), death (1 child), and the family moved out of the country (1 child). The median age of the children at the time of the interview was 1.5 years (IQR: 1.3–2.0 years) and the median age at injury was 0.4 years (IQR: 0.2–0.8 years). Children with inflicted injuries tended to have incurred their injuries at a younger age (0.3 years; IQR: 0.2–0.5 years), compared with children with noninflicted injuries (0.7 years; IQR: 0.1–1.6 years). Of the 72 maternal caregivers who completed the interview, 41 (56.9%) were caregivers to children with inflicted TBI and 31 (43.1%) were caregivers to children with noninflicted TBI. There were no substantive differences between the children and mothers who were eligible to be interviewed, those who were interviewed, and those who were not interviewed (Table 1).

Children with inflicted TBI had worse outcomes than did children with noninflicted TBI (Table 2). Children with inflicted TBI also were more likely to have a mean score on the FSII(R) in the range of scores for children with chronic health problems than were children with noninflicted injuries. Because the FSII(R) scores were not distributed normally, medians were compared and found to differ according to whether the injury was inflicted or not ($P \leq .05$). With the Global Health Index, children with inflicted injuries were more often reported to be in fair or good health, rather than excellent health, but this did not reach statistical significance ($P = .08$). Children with inflicted injuries were more likely to have moderate/severe disability than were children with noninflicted injuries (RR: 1.9; 95% CI: 1.0–3.9) as measured by the POPC. Results of the POPC and FSII(R) were in agreement. Children with moderate/severe disability outcomes on the POPC had a mean score of 77.7 (95% CI: 70.5–85.0) on the FSII (R), whereas children categorized as having returned to baseline or having mild deficits with the POPC had a mean score of 97.1 (95% CI: 94.9–99.3) on the FSII(R). Children categorized as faring poorly with the POPC exhibited scores in the range of those for children with chronic health problems on the FSII(R).

Initial assessments of injury severity were compared with year 1 outcomes as judged with the POPC. Children with GCS scores of ≤8 had an elevated risk of a poor outcome (RR: 3.0; 95% CI: 1.4–6.3), as did children with GCS scores of 9 to 12 (RR: 2.5; 95% CI: 1.2–5.0), compared with children with GCS scores of ≥13. When the injury severity score was used, children who had more-severe injuries had an elevated risk of a poor outcome (RR: 5.3; 95% CI: 1.5–19.2).

The GCS scores and injury severity scores were assessed for their sensitivity and specificity in predicting 1-year outcomes. The sensitivity and specificity of GCS scores of ≤8 for poor outcomes were 70% and 88%, respectively, whereas the sensitivity of GCS scores of 9 to 12 for poor outcomes was somewhat higher (81%), with decreased specificity (78%). The injury severity score was the most specific indicator (96%) but was the least sensitive (46%).

Clinical data from the period of the child's hospitalization were examined to determine whether they were predictive of the child's outcome on the POPC 1 year after injury. Children with inflicted injuries versus non-inflicted injuries were more likely to have a poor outcome (RR: 1.9; 95% CI: 1.0–3.9), as were children who experienced a seizure at any time during their prehospital or hospital course (RR: 2.1; 95% CI: 1.2–3.6), received cardiopulmonary resuscitation (CPR) (RR: 1.6; 95% CI: 1.1–2.1), or experienced a loss of consciousness (RR: 1.5; 95% CI: 1.1–2.0). Age at injury (≤1 year versus >1–2 years) seemed to be a less important predictor of outcome (RR: 1.1; 95% CI: 0.9–1.5). Binomial regression modeling showed that CPR (RR: 2.2; 95% CI: 1.2–3.9) and seizures (RR: 1.8; 95% CI: 0.9–3.9) were the strongest predictors of poor outcome, after adjustment for other covariates (injury type, loss of consciousness, and age at injury).

Family characteristics at 1 year were not substantively different when compared according to injury type (Table 2). Slightly more than 50% of maternal caregivers in both groups were unmarried, minority women, and employed. Social capital index values at follow-up assessments were similar in the 2 groups. Families differed according to injury type in maternal caregiver age and whether the maternal caregiver was a foster parent, with older caregivers and more foster parents in the inflicted TBI group. Children in foster care were with related foster parents (usually a grandmother) ~50% of the time.

Almost all children in the study at 1 year after injury had a pediatrician (95.8%). The 3 children without a primary care pediatrician were all in the noninflicted TBI group. Home health resources were used by 30 children (41.7%), with 20 (27.8%) being in formal rehabilitation programs. Use of ancillary medical resources differed according to type of injury. Children with inflicted injuries demonstrated greater use of ongoing physical and occupational therapy at 1 year after injury, compared with children with noninflicted injuries, although this did not reach statistical significance (Table 3). Rates of speech therapy use were similar for the 2 groups. The need for chronic medication treatment was slightly higher in the inflicted TBI group. Ten of the 11 children in the inflicted TBI group who required medications were receiving anticonvulsants.

When children were divided into high resource users versus low resource users, children with inflicted injuries were somewhat more likely to be high users of resources (RR: 1.8; 95% CI: 0.9–3.8), compared with children with noninflicted injuries. Resource use did not differ according to race (RR: 1.0; 95% CI: 0.6–1.6). Good or poor outcomes on the POPC were highly predictive of resource use (RR: 19.8; 95% CI: 2.9–134.7), although the precision of this estimate was poor because of small numbers in some groups.

DISCUSSION

This study demonstrated that children with inflicted TBI had worse outcomes than did children with noninflicted TBI when the study population was restricted to children <2 years of age at the time of injury. As might be expected from the worse outcomes, children with inflicted TBI also exhibited greater use of ancillary medical resources, such as occupational and physical therapies. Families caring for children after TBI were remarkably similar in terms of social and financial capital.

The poorer outcomes seen in this study seemed to be related most strongly to a requirement for CPR and/or seizures, either at presentation or at some time during the child's hospitalization. Early posttraumatic seizures were associated with worse neurodevelopmental outcomes, at 3 years after injury, among children with inflicted TBI in a series reported from Scotland.[19] Other possible reasons for the worse outcomes might include the mechanism of injury, the increased frequency of repeated injuries among children with inflicted injuries versus noninflicted injuries, and the possibility that children with inflicted injuries present later after their injury event. We showed previously that children with inflicted TBI were more likely to present with seizures than were children whose TBI was not inflicted.[10] Approximately 35% of the children in the inflicted TBI group had evidence of previous neurologic injury, compared with none of the children with noninflicted injuries,[10] which is consistent with findings from other studies of children with inflicted TBI.[20,21]

Although children with inflicted injuries seemed to fare worse overall than did children with noninflicted injuries, slightly more than 50% of them were faring well, as scored on the POPC, and the upper 25th percentile had scores in the well range on the FSII(R). This differs somewhat from earlier reports that indicated that the majority of children with inflicted TBI tended to fare poorly.[22] This is also somewhat more hopeful than the results reported by Ewing-Cobbs et al.[20] They reported on the outcomes of 40 children with TBI (20 with inflicted TBI and 20 with noninflicted TBI), who ranged in age from birth to 6 years, at ~1.3 months after recovery from traumatic amnesia. In that study, only 20% of the children with inflicted TBI were faring well, as measured with the Glasgow Outcome Scale[23] adapted for children, compared with 55% of children with noninflicted TBI. The differences in outcomes between our study and the study by Ewing-Cobbs et al[20] might be related to follow-up periods, sample sizes, or ages at the time of injury or might reflect the wider variation in initial severity related to complete population-based recruitment of participants, compared with recruitment from a single specialized center. Skills that are in a rapid stage of development might be more vulnerable to disruption by trauma than skills that have already been acquired,[4] and children with inflicted TBI tend to be younger than children with noninflicted TBI. Age at injury has been shown to account for some of the variance in recovery of executive functioning among children with TBI who are <6 years of age.[2] It is not known how this group of young children will perform in acquiring new skills as cognitive tasks and behavioral skills become more demanding. It is possible that more-subtle deficits caused by the brain injury are not well recognized by caregivers or measured with psychological testing at this early age.

Neither GCS scores nor injury severity scores were sufficiently sensitive and specific for use in definitively predicting longer-term outcomes. The injury severity score, with a specificity of 96%, is the most useful of the injury severity scoring systems. Very few children with an injury severity score indicating severe injury fared well; however, the scale is not sensitive.

Surprisingly, the sensitivity and specificity of GCS scores with the traditional cutoff value of ≤8 versus a cutoff value of ≤12 were not much different in this population. This might be because lesser injuries have more profound consequences among very young children, compared with older children and adults. Previous research showed that GCS scores have limitations in predicting outcomes among children.[24]

Use of ancillary medical resources was frequent for all children, with ~40% requiring some type of therapy weekly or more frequently. Children with inflicted injuries were somewhat more likely to be high users of services, on the basis of the severity of injury. Most families of children with moderate/severe disability outcomes were able to access therapy for their children, and most had a primary care physician. These results were encouraging, because ability to access health care has been shown to differ according to race and socioeconomic status.[25] A previous qualitative study of children with TBI performed in Arkansas also found that children were able to access rehabilitative resources.[26] However, most of the children in that study were injured at an older age and accessed resources through the school system. Children in our study were not yet old enough to be in the public school system, which could have made resources less accessible for families.

The families of the children with inflicted and noninflicted TBI seemed remarkably similar. The main differences in these families were the age of the maternal caregiver and the proportion of caregivers who were foster parents. This is not surprising, because many of the foster parents were grandparents. One year after injury, almost 50% of children with inflicted TBI were still in some type of foster care (family or unrelated). For both groups of children, the majority of maternal caregivers were from a minority group, unmarried, and employed. Caregivers did not differ in measures of social capital. It is possible that some children with inflicted TBI had their social capital enhanced, because families providing foster care are more likely to be older and are screened by DSS. Social outcomes of pediatric TBI survivors have been shown to be affected by family environments, including family resources.[27] Severe TBI among older children has been shown to cause greater family stress, compared with other injury types.[28] It is possible that enhanced social capital might have a moderating effect on stress created by caring for a child with a brain injury; however, many of these families might be stressed already because of adverse social circumstances, which could affect longer-term outcomes for these children. Also, although the necessity of providing complete care for an infant is expected, it is possible that the stresses of care would increase as the children reach an age at which families expect the child to be capable of more independence. Because families caring for children with TBI seem to be similar regardless of the injury mechanism, interventions designed to improve outcomes of children with early TBI may be applicable to both groups of children.

This study has limitations. Not all families enrolled in the follow-up portion of the study. Although families that participated or did not participate seemed similar to the entire cohort, they might have been different in ways that were not measured, which would create bias. In addition, families might differ in the way they function, which was not measured in this study. The child outcome portion of this study was performed through telephone interviews and not direct measurement of the child’s abilities, which might reduce its sensitivity. However, this approach allowed us to maintain a larger cohort of children, because there were no geographic restrictions on follow-up monitoring. It is not known whether foster mothers might assess children differently, compared with biological mothers who knew the child before injury. In addition, most children were still very young at the time of this assessment; therefore, delays might be less apparent to caregivers than they would be for children at a later stage of development.

The strengths of this study include the fact that the children’s age at injury was limited to <2 years. Because recovery from injury is partly age dependent, this allows a more-equal comparison of the inflicted and noninflicted children’s outcomes. We used several measures of child outcomes, and the FSII(R) and POPC identified the same group of children with poor outcomes, which adds validity to our ability to measure child outcomes through maternal caregiver interviews. In addition, this study was able to characterize the families caring for this group of children.

CONCLUSIONS

Young children hospitalized in PICUs with inflicted TBI exhibited worse outcomes on the POPC and FSII(R) than did similar children with noninflicted injuries. However, one half of the children with inflicted injuries seemed to have only mild impairment or a good outcome 1 year after injury, a finding that is more hopeful than some previous reports. It is not known whether deficits will become more noticeable as these children age and as finer measures of cognition and behavior are used. Families of children with TBI, regardless of whether the TBI was inflicted or not, were very similar with respect to race, education, marital status, and employment. This observation suggests that medical and public health interventions to improve child outcomes should be based on injury severity instead of injury type. Because many of these families were headed by a single working mother, it might be expected that a child with significant TBI who requires multiple rehabilitative services would place enormous stress on the family. Interventions to improve child outcomes may include enhanced family support.

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Abbreviations

CI	confidence interval
CPR	cardiopulmonary resuscitation
DSS	Department of Social Services
FSII(R)	Functional Status II (Revised)
GCS	Glasgow Coma Scale
IQR	interquartile range
POPC	Pediatric Outcome Performance Category
RR	relative risk
TBI	traumatic brain injury

References

1. National Center for Injury Prevention and Control. Traumatic brain injury in the United States: assessing outcomes in children. [Accessed March 23, 2005]. Available at: www.cdc.gov/doc.do/id/0900f3ec8000f7c7
2. Ewing-Cobbs L, Prasad MR, Landry SH, Kramer L, DeLeon R. Executive functions following traumatic brain injury in young children: a preliminary analysis. Dev Neuropsychol 2004;26:487–512. [PubMed: 15276906]
3. Keenan HT, Runyan DK, Marshall SW, Nocera MA, Merten DF, Sinal SH. A population-based study of inflicted traumatic brain injury in young children. JAMA 2003;290:621–626. [PubMed: 12902365]

4. Ewing-Cobbs L, Fletcher JM. Neuropsychological assessment of head injury in children. J Learn Disabil 1987;20:526–535. [PubMed: 3320242]

5. Ewing-Cobbs L, Fletcher JM, Levin HS, Francis DJ, Davidson K, Miner ME. Longitudinal neuropsychological outcome in infants and preschoolers with traumatic brain injury. J Int Neuropsychol Soc 1997;3:581–591. [PubMed: 9448371]

6. Taylor HG, Alden J. Age-related differences in outcomes following childhood brain insults: an introduction and overview. J Int Neuropsychol Soc 1997;3:555–567. [PubMed: 9448369]

7. Runyan DK, Hunter WM, Socolar RR, et al. Children who prosper in unfavorable environments: the relationship to social capital. Pediatrics 1998;101:12–18. [PubMed: 9417144]

8. Teasdale G, Jennett B. Assessment of coma and impaired consciousness: a practical scale. Lancet 1974;2:81–84. [PubMed: 4136544]

9. Michaud LJ, Rivara FP, Grady MS, Reay DT. Predictors of survival and severity of disability after severe brain injury in children. Neurosurgery 1992;31:254–264. [PubMed: 1513431]

10. Keenan HT, Runyan DK, Marshall SW, Nocera MA, Merten DF. A population-based comparison of clinical and outcome characteristics of young children with serious inflicted and noninflicted traumatic brain injury. Pediatrics 2004;114:633–639. [PubMed: 15342832]

11. Fiser DH. Assessing the outcome of pediatric intensive care. J Pediatr 1992;121:68–74. [PubMed: 1625096]

12. Bayley, N. Bayley Scales of Infant Development: Manual. 2. San Antonio, TX: Psychological Corp; 1993.

13. Sparrow, S.; Balla, D.; Cocchetti, D. Interview. Circle Pines, MN: American Guidance Service; 1984. Vineland Adaptive Behavior Scales: Survey Form Manual.

14. Fiser DH, Long N, Roberson PK, Hefley G, Zolten K, Brodie-Fowler M. Relationship of pediatric overall performance category and pediatric cerebral performance category scores at pediatric intensive care unit discharge with outcome measures collected at hospital discharge and 1- and 6-month follow-up assessments. Crit Care Med 2000;28:2616–2620. [PubMed: 10921604]

15. Stein RE, Jessop DJ. Functional Status II(R): a measure of child health status. Med Care 1990;28:1041–1055. [PubMed: 2250491]

16. Runyan, D. Monitoring child health and well-being in large population surveys. In: Arland, T., editor. The Well-Being of Children and Families: Research and Data Needs. Ann Arbor, MI: University of Michigan Press; 2001.

17. Coleman J. Social capital in the creation of human capital. Am J Sociol 1988;94:95–120.

18. Sackett D. A primer on the precision and accuracy of the clinical examination. JAMA 1992;267:2638–2644. [PubMed: 1573753]

19. Barlow KM, Spowart JJ, Minns RA. Early posttraumatic seizures in non-accidental head injury: relation to outcome. Dev Med Child Neurol 2000;42:591–594. [PubMed: 11034451]

20. Ewing-Cobbs L, Kramer L, Prasad M, et al. Neuroimaging, physical, and developmental findings after inflicted and non-inflicted traumatic brain injury in young children. Pediatrics 1998;102:300–307. [PubMed: 9685430]

21. Jenny C, Hymel KP, Ritzen A, Reinert SE, Hay TC. Analysis of missed cases of abusive head trauma. JAMA 1999;281:621–626. [PubMed: 10029123]

22. Duhaime AC, Christian C, Moss E, Seidl T. Long-term outcome in infants with the shaking-impact syndrome. Pediatr Neurosurg 1996;24:292–298. [PubMed: 8988494]

23. Jennett B, Bond M. Assessment of outcome after severe brain damage. Lancet 1975;1:480–484. [PubMed: 46957]

24. Lieh-Lai MW, Theodorou AA, Sarnaik AP, Meert KL, Moylan PM, Canady AI. Limitations of the Glasgow Coma Scale in predicting outcome in children with traumatic brain injury. J Pediatr 1992;120:195–199. [PubMed: 1735814]

25. Simpson L, Owens PL, Zodet MW, et al. Health care for children and youth in the United States: annual report on patterns of coverage, utilization, quality, and expenditures by income. Ambul Pediatr 2005;5:6–44. [PubMed: 15656707]

26. Aitken ME, Mele N, Barrett KW. Recovery of injured children: parent perspectives on family needs. Arch Phys Med Rehabil 2004;85:567–573. [PubMed: 15083431]

27. Yeates KO, Swift E, Taylor HG, et al. Short- and long-term social outcomes following pediatric traumatic brain injury. J Int Neuropsychol Soc 2004;10:412–426. [PubMed: 15147599]

28. Wade SL, Taylor HG, Drotar D, Stancin T, Yeates KO. Family burden and adaptation during the initial year after traumatic brain injury in children. Pediatrics 1998;102:110–116. [PubMed: 9651422]

TABLE 1

Baseline Characteristics of Families and Children Eligible for Interview at 1 Year After Injury (*N* = 112), Compared With Those Who Completed the Interview (*n* = 72) and Those Who Did Not Complete the Interview (*n* = 40)

	No. (%)		
	Families Eligible for Interview (*N* = 112)	**Families Interviewed (*n* = 72)**	**Families Not Interviewed (*n* = 40)**
Children			
Inflicted TBI	62 (55.4)	41 (56.9)	21 (52.5)
Male	67 (59.8)	42 (58.3)	25 (62.5)
White	53 (47.3)	33 (45.8)	20 (50.0)
GCS score			
13–15	60 (54.6)	40 (56.3)	20 (51.3)
9–12	22 (20.0)	14 (19.7)	8 (20.5)
3–8	28 (25.4)	17 (23.9)	11 (28.2)
Good outcome	76 (67.9)	46 (63.9)	32 (80.0)
Mothers			
Married	48 (42.9)	33 (45.8)	16 (53.3)
At least high school education	70 (62.5)	54 (75.0)	19 (73.1)

No comparison achieved statistical significance, with eligible children as the reference group.

TABLE 2

Child Outcomes and Family Characteristics 1 Year After Inflicted or Noninflicted TBI

	Inflicted (*n* = 41)	**Noninflicted (*n* = 31)**	***P***
Child outcomes			
Stein-Jessup FSII(R) score			
Median (IQR)	96.4 (75–100)	100 (92.8–100)	.04
Mean ± SD	87.0 ± 17.0	94.2 ± 12.0	
Global Health Index, median(IQR)	20.0 (16.9–23.0)	21.0 (19.0–23.0)	.08
POPC			
Severe	11 (26.8)	2 (6.5)	.04[a]
Moderate	8 (19.5)	5 (16.1)	
Mild	10 (24.4)	5 (16.1)	
Good	12 (29.3)	19 (61.3)	
Family characteristics			
Maternal caregiver age, y			
Mean ± SD	34.9 ± 12.2	27.0 ± 5.7	.01
Range	18–56	19–42	
Respondent, no. (%)			
Parent	21 (51.2)	29 (93.5)	.0001
Foster parent	20 (48.8)	2 (6.5)	
Relationship of foster parent to child, no. (%)			
Grandmother	9 (22.0)	1 (3.2)	
Maternal aunt	1 (2.4)	1 (3.2)	
Not related	10 (24.4)	0	
Marital status, no. (%)			
Unmarried	22 (53.7)	17 (54.8)	NS
Married	19 (46.3)	14 (45.2)	
Maternal employment, no. (%)			
No	13 (31.7)	16 (41.9)	NS
Yes	28 (68.3)	18 (58.1)	
No. of children in household, no. (%)			
≤2	29 (70.7)	18 (58.1)	NS
>2	12 (29.3)	13 (41.9)	
Race of child, no. (%)			
Nonwhite	23 (56.1)	16 (51.6)	NS
White	18 (43.9)	15 (48.4)	
Social capital index, no. (%)			
≥4	25 (61.0)	16 (51.6)	NS
<4	16 (39.0)	15 (48.4)	

NS indicates not significant.

[a] Comparison of mild and good versus moderate and severe.

TABLE 3

Use of Medical Resources by Children With Inflicted Versus Noninflicted TBI

	Inflicted (*n* = 41)	**Noninflicted (*n* = 31)**	**RR (95% CI)**
Physical therapy			
>1 times/wk	18 (43.9)	7 (22.6)	2.0 (0.9–4.5)
<1 times/wk	23 (56.1)	24 (77.4)	
Occupational therapy			
>1 times/wk	15 (36.6)	5 (16.2)	1.8 (0.9–3.6)
<1 times/wk	26 (63.4)	26 (83.8)	
Speech therapy			
>1 times/wk	7 (17.1)	4 (13.0)	1.2 (0.5–2.8)
<1 times/wk	34 (82.9)	27 (87.0)	
Regular medication use			
Yes	11 (26.8)	5 (16.1)	1.3 (0.9–1.9)
No	30 (73.2)	26 (83.9)	
Combined therapies[a]			
High use	16 (39.0)	6 (19.4)	1.8 (0.9–3.8)
Low use	25 (61.0)	25 (80.6)	

[a] High use is defined as requiring ≥2 therapies >1 time per week.