Mild Head Injury in Children and Adolescents

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Abstract

Although mild head injury is the most prevalent type of head injury in children and adolescents, only a relatively small number of studies on this kind of head injury have been reported. This article summarizes a review of studies examining cognitive, academic, and psychosocial outcomes in children who sustained mild head injuries. Despite earlier claims of mild head injury being a "silent epidemic," the studies, which were published from 1970 to 1998, provide no compelling evidence to support this view.

Keywords

head injury; outcome; children; adolescents; cognition; achievement; behavior

Mild head injury in children and adolescents continues to be a topic that generates significant public-health concern. The initial concern was first raised in two brief reviews that appeared in the early 1980s (Boll, 1983; Boll & Barth, 1983). In these reviews, the authors suggested that mild head injury is a quiet disorder that seldom calls for medical intervention but does lead to symptoms that affect a child's cognitive, academic, and psychosocial development. This view of mild head injury as a "silent epidemic" quickly polarized the medical and scientific communities, which had traditionally viewed such injuries as trivial in terms of outcome. Although a more cautious position was advocated in another brief review of this literature (Levin et al., 1987), the pendulum again swung to the original view in a later review by Beers (1992), who concluded that "current research suggests that there are consequences of mild head injury that can be devastating, especially to children and adolescents" (pp. 314–315). It is instructive to note that these conclusions were based on only a few studies dealing specifically with children or adolescents, and an even smaller number of these studies dealt with mild injury. The majority of studies, paradoxically, focused on adults or animals with more severe injuries to the head.

THE CONCEPT AND CLASSIFICATION OF INJURY SEVERITY

Traditionally, head injuries have been classified on a continuum ranging from mild to severe. This classification is based on an assessment of the patient at the accident scene, emergency room, or hospital and includes evaluation of (a) level of consciousness (Glasgow Coma Scale; Teasdale & Jennett, 1976), (b) duration of loss of consciousness, (c) neurological status (e.g., subdural hematoma), and (d) changes in orientation and memory for recent events preceding the injury (retrograde amnesia) or following the injury (posttraumatic amnesia).

The causes of mild head injury are similar to those of more severe injury (after vehicular accidents) and are based on the concept of force. Severe head injury causes rapid acceleration-deceleration of brain substance and shearing of the long axons (which transmit information to different brain regions), leading to diffuse axonal injury, alterations in consciousness, significant cognitive and behavioral problems, or some combination of these symptoms. In mild head injury, the forces are less severe, and the effects are more variable and controversial. This variability is partly confounded by how the term "mild" is defined. Rimel, Giordani, Barth, and Jane (1982) characterized the injury as minor if the period of unconsciousness is less than 20 min in duration, the score on the Glasgow Coma Scale is between 13 and 15 (scores of 9–13 are in the moderate range, and scores less than 9 are in the severe range), and there is no evidence of hematoma and no hospitalization for more than 2 days. Other definitions vary somewhat in the criterion duration of unconsciousness and the status of length of retrograde and posttraumatic amnesia (Satz et al., 1997).

INCIDENCE OF HEAD INJURY IN CHILDREN

The incidence of head injury in children and adolescents is approximately 317 per 100,000. The vast majority (82%) of these injuries are mild, as is true for adults as well (Kraus, Fife, & Conroy, 1987). It has been suggested, however, that hospital records may markedly underestimate the incidence because some children, especially those with relatively mild injuries, may not seek medical or hospital attention.

REVIEW OF STUDIES FROM 1970 THROUGH 1995

In light of the frequency of head injury in children, as well as the earlier reviews that raised serious concerns about its consequences, my colleagues and I at the University of California, Los Angeles, conducted a comprehensive review of all known studies, published from 1970 through 1995, that addressed mild head injury in children and adolescents (Satz et al., 1997). We began by searching for the publications cited in six reviews of studies on the topic (including the reviews cited in the introduction of this article). We also searched for peer-reviewed poster sessions and papers presented at the International Neuropsychological Society conventions. Only those studies reporting data on cognitive (e.g., memory), achievement (e.g., reading, spelling), or behavioral (e.g., hyperactivity) outcomes were selected for review. We identified only 40 such studies published during this 25-year span, but these studies constitute a much larger and more representative sample of studies than included in prior reviews.

The studies varied widely in terms of methodology (e.g., sample size, control groups). Because of this variability, we first divided them, regardless of merit, according to three general outcome categories (adverse, null, indeterminate) based on the authors' conclusions. The results revealed 13 adverse, 18 null, and 9 indeterminate outcomes. Although we found more null results than either adverse or indeterminate results, such tallies do not take into account studies' methodological strengths or weaknesses and, therefore, can be misleading. For this reason, we reexamined each study to see whether it met a minimal number of key criteria that we felt were essential for research in this area: (a) inclusion of control groups (no injury or other body injury); (b) use of a longitudinal design with follow-up assessment after the injury; (c) clear definition of mild injury, with no inclusion of children with more severe injuries; (d) inclusion of at least 20 children with mild head injury; (e) use of standardized tests to measure outcomes; and (f) control for preinjury risk factors. We considered a study to have methodological merit if it met at least four of these criteria.

Only 16 studies (6 reporting adverse outcomes, 10 reporting null results) met this criterion for merit. We then looked more closely at the 40 studies to see whether the type of outcome (adverse, null) varied by test domain (academic, psychosocial, or cognitive) or by merit. We found that not one of the studies reporting adverse academic or psychosocial outcomes met the criterion for merit. In contrast, most studies reporting null results for academic and psychosocial outcomes were methodologically stronger.

The results were slightly different for cognitive outcomes. A majority of studies reporting adverse as well as null cognitive outcomes met the criterion for merit. When we examined these studies more closely, we found that a few of the stronger studies reporting adverse outcomes noted some initial alterations in cognitive function (memory, attention) that generally disappeared after 6 to 12 months. However, in none of these few studies did the mean assessment scores fall in the abnormal range, even in the period right after the injury occurred. Although one might conclude that there was an effect in those few occasions (5 of 40 studies), the effect was small and transitory.

ADDENDUM REVIEW

Since we completed our original review, we have identified 16 additional studies on the topic, 3 studies that escaped our notice in our original review and 13 that were published more recently. We therefore completed an addendum review of studies from 1995 through 1998 (Satz & Zaucha, 1998) using the same criteria to determine a study's methodological strength. Ten of the 16 studies met the criterion for merit. Eight of these studies reported no acute or long-term adverse effects of mild head injury on cognitive, academic, or psychosocial functioning. In contrast, the weaker studies reported adverse or indeterminate results. These findings strengthen our original results, which failed to show any permanent adverse effects of mild head injury in any of the outcome domains. The fact that null findings were more consistently found in the methodologically stronger studies than in the weaker studies should help to dampen some of the concerns that mild head injury is a silent epidemic.

CONCLUSIONS

There are several important unresolved issues regarding these conclusions. First, the generalizability of the results is a matter of some debate. Despite the appeal that these conclusions may have for allaying public-health concerns about mild head injury, clinicians and investigators are still polarized on this topic, especially with respect to adults, for whom persistent cognitive deficits or postconcussional symptoms continue to be reported in a minority of cases (Alexander, 1995; Satz et al., 1999). The present findings regarding children should not be generalized to adults, who differ in many ways from children, not only in terms of cognitive and psychological development but also in life experiences

and type of injury risk (e.g., vehicular accidents vs. falls).

A second issue concerns how the term mild head injury is defined and whether its effects vary depending on the severity of the injury (i.e., whether there is a spectrum of severity even within the category of mild injury). In our 1997 review, those studies that selected cases at the extreme tail of mild injury (Asarnow et al., 1995; Bijur, Haslum, & Golding, 1990) found no immediate (1 month) or long-term (12–60 months) effects on academic achievement, psychosocial functioning, or cognitive functioning. The vast majority of these children and adolescents experienced only brief symptoms of headache or dizziness with no loss of consciousness or amnesia, and only brief emergency room care. These two studies were also the strongest methodologically, having included both noninjured children and children with other kinds of bodily injury as control groups (see the next paragraph). Studies that included more severe cases of mild head injury had more variable findings, but only for certain cognitive functions (e.g., memory, attention). However, although some of these results may have been confounded by pooling mild and moderate cases, the effects were largely transitory. These results, therefore, lend some credence to the concept of a spectrum of mild head injury. However, the criteria typically used to define mild head injury are still quite arbitrary, and no definition has yet achieved widespread acceptance. As my colleagues and I noted recently (Asarnow et al., 1995),

> severity of head injury is really a dimension. Assigning labels such as "mild" and "minor" to arbitrary cut points along that dimension so as to establish categories of severity only ends up reifying the arbitrary cut points. The critical need is not to establish a consensus about the definition of the terms "mild and moderate closed head injury." What is needed is an operational definition of closed head injury severity along multiple dimensions (e.g. loss of consciousness and post traumatic amnesia). (p. 119)

An additional issue concerns the need for future studies to employ two control groups. In addition to a noninjury control group, an other-injury control group should be included, so that one can be sure that any apparent result of a head injury is specific to the head trauma. For example, in our study (Asarnow et al., 1995), the mild head injury group had more mistakes than the noninjury control group on one of the memory tests. However, further analysis revealed that this effect was observed in the other-injury group as well and therefore was not specific to mild head injury. Without this additional control group, we could have falsely attributed the memory effect to the head injury (and brain). Recent studies in behavioral medicine have shown an association between orthopedic injury (not head injury), including chronic pain, and performance on speeded tests of memory and attention as well as depression (see Satz et al., 1999, for a review). This review found only 13 studies in the past 40 years that employed an other-injury control group in the study of head injury in adults or children, and only 3 of these studies employed both a noninjury and an other-injury control. Two of the studies (Asarnow et al., 1995; Bijur et al., 1990) showed no effects specific to mild head injury. It is clear that future efforts to determine the effects of mild head injury in children or adults will require a similar use of control groups.

Three final points deserve mention. Although the effects of mild head injury do not seem to pose any permanent risk for cognitive, academic, or psychosocial functioning in children or adolescents, the outcomes might be different for children who have certain kinds of problems prior to the injury. To date, the vast majority of studies have excluded children with prior histories of learning problems, hyperactivity, or abuse. Because of this methodology, the generalizability of the findings to the general population of children is limited; many children have preexisting risk factors that may mediate or moderate outcomes after head injury (Levin et al., 1987).

Also, the age at which a child has a mild head injury could be an important factor influencing outcomes. Different cognitive skills have different developmental rates and are acquired at different ages, and it may be that those skills that are in rapid ascendancy when mild head injury occurs are particularly vulnerable to ill effects, because of a lowered threshold for impairment. This hypothesis requires investigation primarily of infants, whose cognitive and language functions are developing rapidly. Unfortunately, only a handful of such studies have been reported to date, with variable results.

Lastly, although the term traumatic brain injury (TBI) is commonly used for cases of mild head injury, it is potentially misleading in light of the findings reviewed here.

Recommended Reading

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Note

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