Abusive Head Trauma

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KEYWORDS

- Child abuse • Abusive head trauma
- Pediatric traumatic brain injury • Shaken baby syndrome
- Nonaccidental trauma

Child physical abuse that results in injury to the head or brain has been described using many terms, which have evolved over the past half-century or more. These items have included the battered child syndrome, whiplash injuries, shaken infant or shaking impact syndrome, and nonmechanistic terms such as abusive head trauma or nonaccidental trauma.[1–7] This evolution has occurred as the spectrum of injuries—and the mechanisms that are potentially responsible for them—have been studied in increasing detail in multiple clinical series from around the world, as well as with pathophysiologic and biomechanical modeling. Because children may present with varying histories, physical findings, and radiologic findings, the terms ''inflicted head injury,'' ''nonaccidental trauma,'' and ''abusive head trauma'' are used in this article to reflect those constellations of injuries that are caused by the directed application of force to an infant or young child resulting in physical injury to the head and/or its contents. These injuries most often include subdural and/or subarachnoid hemorrhage, with varying degrees of neurologic signs and symptoms. A high proportion of children also present with retinal hemorrhages, physical or radiologic evidence of contact to the head, upper cervical spine injuries, and skeletal injuries. These features are described in more detail in the following section.

Use of the more general terms reflects an attempt to avoid the pitfalls of assuming the exact mechanism of injury; the general terms also encompass a wide range of traumatic forces, which are potentially harmful and can result in different patterns of neurotrauma. These forces include: blunt force trauma, acceleration/deceleration (inertial) forces, penetrating trauma, and asphyxiation.

EPIDEMIOLOGY

Establishing incidence data for abusive head trauma has been challenging, in part because of the definitional issues noted; however, several studies have attempted to examine issues of epidemiology. Early studies revealed that inflicted injuries

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make up a significant portion of traumatic brain injury in children younger than 2 years of age, and such injuries account for serious morbidity and mortality in that group.[8,9] When compared with accidental head injury, the hospital length-of-stay and medical costs incurred from abusive head trauma are higher.[10]

A recent study out of North Carolina found an incidence of inflicted brain injury in the first two years of life of 17.0 per 100,000 person-years.[11] Another prospective study from Scotland during 1998–1999 found an annual incidence of 24.6 per 100,000 children younger than 1 year (a higher rate than a previous 15-year retrospective study done in the same county).[12] The authors of that study suggested that the discrepancies between the prospective and retrospective study outcomes reflect the challenge of tracking the problem caused by lack of a single international classification of diseases (ICD) code to describe the medical findings.

This challenge and others were addressed at a 2008 symposium and later summarized in articles to a supplement to the *Journal of Preventative Medicine.* The symposium was convened, in part, to discuss definitional issues regarding inflicted brain injury, as well as methods for measuring its incidence. In his commentary, Alexander Butchart, PhD, argues that determining the epidemiology of child maltreatment will help elucidate the issue as a public health concern and lead to the formation of larger scale prevention efforts.[13]

MECHANISMS

In 1946, Dr. John Caffey first recognized a possible traumatic association between head injuries and fractures in infants.[14] In the following three decades, important work by Silverman,[15] Ommaya,[16] and Guthkelch,[3] contributed to the acknowledgment of child abuse as a medical condition. Noting that many of his patients presented without a clear mechanism of trauma to explain their injuries, in 1974, Caffey coined the term "the whiplash shaken infant syndrome."[4] He used the term to describe the constellation of injuries that includes subdural hematoma, long bone fractures, and retinal hemorrhages; these are symptoms that, in the absence of a reasonable history of trauma or other medical condition, are still considered hallmarks for abusive head injury. The idea that shaking might be causative was first proposed by Norman Guthkelch, a neurosurgeon who, working with pediatricians and social workers, obtained some histories of violent shaking as a part of the injury scenario.[3] In contrast, Caffey's initial concept was that shaking might be injurious even when performed by well-meaning caretakers as a generally accepted form of discipline, because of the presumed inherent fragility of young infants.[17] These authors were aware of experiments in primates, whose heads were subjected to large magnitude angular decelerations involving crashes in high-velocity sleds, leading to unconsciousness and subdural hemorrhage.[18] Thus, the idea of angular deceleration as the causative mechanism for subdural hematoma was hypothesized as the necessary mechanism in infant shaking injuries.

Over the ensuing decades, other authors noted a high incidence of contact injuries, including scalp hematomas, skull fractures, and brain contusions, in abused infants; the injuries were visible either clinically, radiologically, or at autopsy.[19–21] Biomechanical models of young infants were developed that suggested that even violent manual shaking caused angular decelerations that were very low compared with those required to cause concussive or hemorrhagic injury in primates, but that inflicted impacts were associated with angular decelerations that were approximately 50 times greater and within the range thought more likely to be associated with brain injury.[19,22] It was suggested that physical evidence of impact might not be seen if the deformable

infant head stopped suddenly against a relatively soft surface, but large magnitude angular deceleration would still occur from this type of impact. Other authors created alternative physical models that suggested that shaking alone might generate sufficient force to be injurious.[23] Additionally, the frequent finding of upper cervical or cervicomedullary injury became increasingly recognized, although the mechanisms required to cause this type of injury and the exact contribution to the clinical constellation remains incompletely understood. Almost all infants with inflicted injuries who are found at autopsy to have cervical spine injuries also have subdural hemorrhage and other typical findings, which seem unlikely to be related only to spinal injury.[24–26]

Finally, the contributions of the initial history to the understanding of mechanism, as well as confessions by admitted perpetrators, have suggested that various scenarios may occur in the setting of violent inflicted injury in infants and young children. Although some caretakers mention shaking, this history is given spontaneously in the minority of cases in most series.[14,21,27] A history of a short-height fall or no history of trauma (that is, the child presents because of symptoms) are the most common initial histories given.[28] Although some confessions mention shaking, others involve throwing, striking, or other violent mechanisms. For all these reasons, terminology that does not suggest a specific mechanism of injury has become preferred by most professional organizations. Position papers published by such entities as the American Academy of Pediatrics[29] and the National Association of Medical Examiners[30] reflect the evolution of the medical literature over a relatively short period of time.

DIAGNOSIS

Determining whether a child's injuries are the result of child physical abuse can be a difficult process. If a traumatic cause is not readily apparent, careful assessment is warranted. Glick and Staley propose that a detailed evaluation by a multidisciplinary child protection team has become standard of care in many facilities.[31] Teams are typically directed by a child abuse trained pediatrician (subspecialty board certification available in 2009) and may include members from other medical and surgical disciplines, as well as medical social work. This approach ensures a thorough consideration of all the factors involved, including the medical and social issues, so that a final diagnosis is reached objectively.

A core component of the diagnostic process is a comprehensive history of presenting illness. The initial history should include details about timeline of symptoms and the exact events leading up to the present, including a detailed description of the events before and after the child became symptomatic. When there is a history of trauma, a detailed description of exactly what happened, what position the child was in, how the child landed, what the fall height was, how the child acted immediately afterwards and thereafter, and what the caretakers did is invaluable in reconstructing the injury events.[8] Included in this history should be: who has cared for the child; the relationship between caretakers and the child; birth/past medical history; prior trauma; and family history, particularly any history of bleeding disorders. Care should be taken not to lead the history by suggesting whether specific mechanisms or actions might have occurred; it is preferable to simply ask open-ended questions and to seek specific answers, such as: "What happened next?" or "What did you do then?" or "What did he/she look like/do?"

Focusing the history on the identification of a trigger for abuse by the caretaker may also be helpful. A commonly described trigger is crying. Abusive head trauma incidence curves correlate with periods of normal crying,[32] colic, and immunizations. Other triggers in older children include temperament, behavior, and toileting.

Obviously, the psychosocial stressors may affect a caregiver's coping skills and contribute to poor parenting or the potential for impulse control issues. After stabilization of the child, additional details can be ascertained by a multidisciplinary assessment by the medical providers, child protection personnel, and a social work team. A full psychosocial history will screen for preexisting mental health diagnoses, prior concerns of child maltreatment, and other risk factors, such as substance abuse or domestic violence.

As previously stated, abusive head injury is well recognized as a common cause of brain injury in children younger than 2 years of age, with the majority of such injuries being in the first year of life.[8,9] It also should be noted that case reports have documented its occurrence in older children.[33] In a prospective study of 66 children 36-months-old or younger with subdural hematoma, Feldman and colleagues found that 59% of the patients sustained their injury from abuse. Those patients were more likely than the accidentally injured children to have retinal hemorrhage and fractures. An important distinguishing feature was that the abused patients presented with no history of trauma or a history of a minor fall. All the accidental injuries occurred from a motor vehicle accident or a clearly documented major trauma.[34] Absent, inconsistent (eg, developmentally or mechanistically implausible) or evolving histories to explain a traumatic injury in a child can be a red flag for child physical abuse.

Although it is commonly accepted that abuse occurs across all socioeconomic demographics, there may be demographic differences in families of patients with abusive head injury as compared with the general population. Specifically victims and perpetrators are more commonly male. Parents of the patients are more likely to be young, unmarried, less educated, or from a minority group; mothers are more likely to smoke during the pregnancy, have late prenatal care, and to have delivered a low birth weight child.[35] Some point out that the outcomes may correlate with poverty status or reflect a bias in reporting for concerns of abusive head trauma.[35] More research will help clarify the issue; however, studies such as this illustrate the importance of including a social history with the medical evaluation.

Analysis of perpetrators' confession data also reflects a predominance of male perpetrators; Starling and colleagues[36] found that perpetrators are most likely to be fathers, followed by boyfriends, female babysitters, and mothers, in descending order. Some confessions have supported the notion that children are immediately symptomatic after serious trauma is inflicted. Perpetrators are more likely to confess if the victim is younger or impaired at hospital discharge.[37]

The spectrum of brain pathology observed from abusive head injury varies. Abnormalities typically include subdural hematoma, although there have been reports of subdural hematoma that is not appreciated until autopsy.[38] This phenomenon has been described in the setting of severe cerebral swelling that affects the radiographic appearance of the subdural hemorrhage because of compression of the blood by the brain. In some cases, parenchymal contusion or brain lacerations may be found, but diffuse axonal injury is uncommon. Ischemic pathology found by immunohistochemistry is a prominent finding[6,25,39] External findings may be absent, but soft-tissue swelling, bruising, or a bulging fontanelle may be seen. New studies on cerebrospinal biomarkers indicate that chemicals released by the brain after injury may have future diagnostic or prognostic uses for this patient population, but their exact role remains incompletely understood at present.[40]

The physical examination should include the entire body, paying particular attention to the skin, abdominal, and skeletal systems to assess for additional signs of trauma. Consultation by a pediatric trauma surgeon is recommended to help with diagnosis and management of extracranial injuries.

Because of the variability in injury types and injury severity among patients, the spectrum of symptoms exhibited by the child can range from very subtle to severe alterations in consciousness or coma. The most commonly described symptoms are: vomiting, seizure, apnea, lethargy, and poor feeding. When symptoms are less specific, practitioners can miss the diagnosis, attributing the presentation to conditions, such as gastroenteritis, febrile seizures or flu-like illnesses.[41]

In addition to children who present with acute injuries, a particular challenge, diagnostically, is the child who presents with chronic subdural hematomas. These patients most often present with increasing head circumference. Some authors have pointed out that the most common cause of chronic subdural hematoma is trauma; however, chronic subdural hematoma has been associated with coagulopathies, structural abnormalities, and some rare genetic diseases.[42] For many children, no specific diagnosis is ever apparent. Work up for the etiology of a chronic subdural hematoma should include screening for appropriate medical conditions, as well as screening for child physical abuse, particularly as indicated by unrecognized skeletal injuries, the evaluation of which is detailed below. Referral to neurosurgery is standard, as surgical drainage or shunting is sometimes required.

Any finding suggestive of child physical abuse requires reporting to the appropriate social service or law enforcement agency. Most practitioners are aware of this and mandated reporting laws exist in all 50 states. The issue is worth readdressing; however, as research shows that some providers may not report physical abuse when suspected.[43]

DIFFERENTIAL DIAGNOSIS

There is a long list of medical conditions that have been cited in the literature as ''mimics'' of abusive head injury. The list of conditions associated with subdural/subarachnoid bleeding is extensive and includes the following: birth and other accidental trauma, congenital malformations, genetic and metabolic conditions, hematologic disorders, infectious diseases, toxins, complications of surgical intervention, vasculitides, oncologic processes, and nutritional deficiencies.[44]

A detailed discussion of all of these entities is beyond the scope of this text; however, some of the more commonly considered diagnoses will be reviewed. It should be noted, that most of those conditions can be differentiated from child abuse by careful consideration of the history, physical examination, and radiological or laboratory studies. Despite the existence of other conditions that can mimic child abuse, there should be strong consideration of a diagnosis of abuse in any case of a young child with a serious head injury who has no history of significant trauma.[28]

Asymptomatic intracranial hemorrhage after birth in normal, healthy newborns has been described. One study showed a prevalence of 26%.[45] Assisted deliveries may increase risk of injury, but intracranial hemorrhage has been documented with normal vaginal delivery. Birth-related subdural hematomas tend to present in an infratentorial location and typically disappear by 4 weeks of age.[46]

Congenital malformations, such as cerebral aneurysms and arteriovenous malformations, are relatively rare in young infants. Sagittal sinus thrombosis may occur in infants and lead to brain swelling, but this condition usually can be diagnosed by magnetic resonance (MR) imaging and MR venogram. Laboratory tests, radiographic findings, and patterns of nontraumatic causes of intracranial bleeding are usually distinguishable from that seen with abusive head trauma.

Some genetic and metabolic disorders can present with extra-axial hemorrhage, as well as with retinal hemorrhages or skeletal abnormalities. Practitioners should be

aware of these conditions. Osteogenesis imperfecta and Menkes kinky hair disease can have skeletal abnormalities. Glutaric aciduria type I has some specific MR imaging but no associated skeletal findings. Universal screening for these and other diseases is not warranted and should be guided by the clinical presentation with input from the appropriate subspecialist. The incidence of most genetic diseases is lower than for child abuse and the possibility of comorbidity should be considered.[45]

Bleeding diatheses are a well-described group of inherited and acquired disorders that can cause intracranial hemorrhage. Coagulation studies should be done on all children with suspected abusive head injury. Screening labs should include prothrombin time, partial thromboplastin time, thrombin time, complete blood count with platelet count, fibrinogen and fibrin degradation products. Abnormal tests should prompt a hematology consult to guide further testing of platelet function or factor abnormalities. A history of prior episodes of bleeding, a positive family history, or a past history suggestive of vitamin K deficiency should direct more rapid communication with hematology specialists for specific treatment recommendations.

FORENSIC CONSIDERATIONS

After the diagnosis of abusive head trauma is confirmed, practitioners often face forensic questions from investigators with regard to identifying the mostly likely perpetrator, timing of injury, or alternative theories of injury. Generally, these types of questions are best left to the child abuse specialist if one is available. Radiology, pathology, and laboratory information, as well as determining the onset of symptoms, can help with questions of timing when a child was hurt.[47] However, it should be kept in mind that there are limits to the degree to which injuries can be timed or dated.

A number of studies support the generalization that children with abusive head injury are likely to be immediately symptomatic.[48] Most patients with acute subdural hematoma from large-force angular deceleration are immediately symptomatic, because the forces necessary to cause the rupture of parasagittal bridging veins also cause diffuse injury of the underlying brain.[49] The clinical scenario of an impact event followed by a ''lucid interval'' with later deterioration typically occurs in the setting of a clearly apparent contact event causing an expanding mass lesion, such as an epidural hematoma or subdural hemorrhage, with an associated contusion.[50,51] Second impact syndrome, a rare phenomenon usually occurring in athletes who sustain two concussive head injuries in series with potentially catastrophic brain swelling, has not been reported in young children.[52,53] In the setting of chronic subdural collections, it is well accepted that minor trauma can cause small volumes of acute rehemorrhaging into the subdural space; however, there is no evidence that significant rebleeding causing acute neurologic decline occurs spontaneously or with minor head injury.[54]

A history of a fall to account for brain injury to a child can also pose a diagnostic dilemma for practitioners attempting to differentiate between accidental and abusive head trauma. Chadwick, and colleagues[55] attempted to estimate the risk of death resulting from short falls of <1.5 m. Their review is the most comprehensive to date and reports a mortality rate of <0.48 deaths per 1 million young children per year. Other authors have cautioned that when severe injuries are seen with no history or with a history of a short fall, abuse should be seriously considered.[28] Arterial epidural hematomas can occur from low-height falls in infants and young children and can be life-threatening, but this type of injury is distinctly uncommon among abused children.[56]

In the case of fatal abusive head injury, the postmortem examination should be performed by a forensic pathologist who has experience in the standard procedures of dissection recommended in suspected child abuse cases.[57] Autopsy findings may reveal: contact injuries (skull fractures, soft tissue damage, or brain tissue contusions); inertial injuries (subdural hematomas, axonal injury, and tissue tears); injury at the craniocervical junction; secondary brain damage (hypoxic changes, cerebral edema); and associated injuries (bruises, skeletal injury, thoracoabdominal injury).[58] Axonal injury of the cervical spinal cord may be seen in children with abusive head trauma, suggesting a link to the pathophysiology of the condition. Some authors theorize that dysfunction of axons at the cervicomedullary junction causes apnea and hypoxia, which may contribute to global brain damage.[25,26,39]

ASSOCIATED INJURIES

In his 1974 paper, Caffey documented the association between head injury and long bone fractures.[14] It is worth emphasizing that child physical abuse is trauma. The possibility of multiple or occult injuries underscores the importance of a complete trauma assessment, including primary, secondary, and tertiary survey, by a well-coordinated, experienced trauma team.

As previously mentioned, the most common injuries seen in conjunction with abusive head trauma include soft tissue injury, skeletal injury, retinal hemorrhages and throcoabdominal injury, but genital injuries associated with sexual abuse, burns, and neglect may also be seen.[11,28,39] Rib fractures from squeezing of the chest and metaphyseal fractures from shearing type stresses on the end of the long bones may occur. There is generally no bruising over the fracture sites. More details regarding the radiologic evaluation of these injuries will be outlined in the following sections.

Retinal hemorrhages represent bleeding that occurs in or about the microscopic layers of the retina. The mechanism for retinal bleeding in the context of abusive head trauma has yet to be elucidated. Hemorrhaging may be preretinal, intraretinal and subretinal. Size and shape of the hemorrhagic lesions can also vary.[59,60] A detailed description or photograph of the findings during a dilated retinal examination by indirect ophthalmoscopy, preferably by an ophthalmologist, is essential in cases of suspected abusive head trauma. It is best if the eye exam is done early in the clinical course, before brain swelling or other factors might interfere with interpretation of the findings.[60,61]

The finding of retinal hemorrhages is not necessarily specific. They are observed in a variety of different medical conditions. Examples include vaginal birth (hemorrhages tend to be asymptomatic and disappear after about one month[62,63]), coagulopathy, accidental trauma, hypertension, increased intracranial pressure, papilledema, some metabolic diseases, toxins, infections, collagen disorders, and vasculitis.[61] It should be emphasized that the majority of the conditions in question can be ruled out based on history, physical examination, and lab testing.

The documented incidence of retinal hemorrhages in abusive head injury cases has ranged from 35%–100%, with most recent studies typically showing a rate of about 80%; a wide range of retinal hemorrhage characteristics, in terms of location and severity, have been described.[64–66] Severe, multilayered retinal hemorrhages in an otherwise healthy infant with a history of a low-height fall is considered by many in the field to be indicative of inflicted injury, and traumatic retinoschisis (where layers of the retina are cleaved forming a cystic cavity), optic nerve sheath hemorrhage, and vitreous or choroidal hemorrhage are ocular findings that should raise suspicion

of significant trauma.[60,61,67,68] Several studies have demonstrated that retinal hemorrhages are a very rare occurrence after cardiopulmonary resuscitation and when seen, are typically minor when compared with child abuse cases.[69,70]

IMAGING

The appropriate use of radiography in the diagnosis of child abuse is well established. Because many injuries, including intracranial injuries, are unrecognized or present with subtle symptoms, imaging studies provide crucial information for diagnosis, treatment, and prognosis. Advancement in central nervous system radiographic techniques has improved our understanding of abusive head trauma. All infants and children with suspected inflicted head injury require brain imaging. Screening brain imaging of asymptomatic infants with a suspicion of maltreatment is recommended in children under the age of one year with facial injury, rib fractures, or multiple fractures and in any infant less than six months of age with any evidence of child physical abuse.[71]

Computed tomography (CT) is the mainstay for the diagnosis for intracranial injury in abusive head trauma, especially if a patient requires urgent evaluation. It is widely available in most facilities and it can be completed rapidly. CT is relatively sensitive for diagnosing intracranial hemorrhages and severe cerebral swelling or edema. Cerebral swelling on CT may manifest as loss of the gray–white matter differentiation, with relative sparing of the basal ganglia, cerebellum, thalami and brain stem. In this phenomenon, known as the ''reversal sign,'' the above-mentioned structures appear brighter than the cortex.[72] The most common location for subdural hematoma in abusive head injury is in the parifalcine and tentorial regions or small collections over the cerebral convexities.[73,74] Despite its usefulness, CT may not detect shear injury, early cerebral edema, and skull fractures.[75] Cerebral edema may be patchy or involve one or both hemispheres, and may be seen as early as one hour post injury or may appear in a more delayed fashion over several days.[73,76–78]

Skeletal surveys are also important screening tools in any child under the age of 24 months with a suspicion of child physical abuse. In children age 2 to 5 years, skeletal survey should be reserved for cases where physical abuse is strongly suspected.[79] Any child with a confirmed abusive head injury should also have a skeletal survey. The skeletal survey consists of films of the extremities, skull and axial skeleton images, often times with multiple views. High-resolution techniques are recommended, either using special film or low-noise digital techniques. Inclusion of oblique views of the ribs may add to the detection of rib fractures. A ''babygram,'' whereby the entirety of the infant's body is filmed in a single image, should be avoided, as it provides insufficient detail. Follow-up radiographs of the ribs to assess for healing fractures not seen in the acute phase or other areas suspicious for fracture may be helpful 2 to 3 weeks after the skeletal survey. Skeletal scintigraphy (bone scan) may used in place of radiographic skeletal survey. Scintigraphy can be more sensitive, but it is less specific and requires more radiation. It is more difficult and more expensive to perform. Follow-up radiography of any suspicious lesion is also required.[80]

Skull radiography is the modality of choice for the detection of skull fractures, although in some cases these may be better seen on CT scan, depending on the location of the fracture. Routine digital imaging may lower the rate of detection of bony injuries, and high resolution techniques may be needed.[81] All types of skull fracture can be seen with abusive injuries. Midline fractures, occipital fractures, multiple, complex, diastatic and depressed fractures are more suggestive of abuse if there is

not a correlating history of an accident. Dating skull fractures can be difficult as compared with other bones, as the skull does not heal with typical callus formation.[82]

Magnetic resonance (MR) imaging is most frequently used to further delineate CT findings; however, some suggest that it may be an option for first-line evaluation of abusive head injury. MR imaging technology is changing rapidly, and newly developed sequences may give increasing information about the pathophysiology and evolution of injury.[75]

MR imaging and CT can be useful for determining age of hematomas. As a general rule on CT, acute blood appears hyperdense compared with cerebrospinal fluid (CSF) from time of injury to about 7–10 days; isodense collections indicate subacute blood between 7–10 days and 2–3 weeks; and chronic subdural collections are hypodense and occur from about 3 weeks onward.[83] The finding of mixed density lesions may indicate acute on chronic blood from either ongoing microhemorrhaging or reinjury (an important distinction). However, it is also recognized that because of tears in the arachnoid membrane and differential mixing and settling of blood components, heterogeneous, mixed density blood can be seen in the setting of acute injury, even in the very early hours after trauma.[84] For this reason, practitioners should avoid over-interpretation and reliance on imaging studies to date hematomas. Timing of injury can have important forensic implications, and efforts to estimate when a child was hurt should start with historical information regarding symptoms, severity of injury, and imaging studies with input from radiology colleagues. It should be understood that, even under the best circumstances, specifics about timing of injury may not be possible.

MANAGEMENT

An unrecognized insult to the brain, or one in which care is delayed, may result in decreased level of consciousness, hypoventilation, elevated intracranial pressure, seizure, or respiratory arrest.[85] Airway and ventilatory management are essential for optimizing conditions to limit progressive damage. However, much of the brain damage may occur early on in the disease process, caused by the cytotoxic effects of traumatic neuronal injury, hypoxia and cerebrovascular dysregulation.[85] In hospitalized children with injuries that are ultimately fatal, it is unclear whether any intervention significantly alters the outcome.[35] However, children with less severe injuries may benefit from aggressive intervention, which may limit damage. As mentioned, this intervention includes appropriate early recognition of more severe injuries; children who fail to show crying or grimacing typically have severe cortical injury.[36] Seizures are common and may be subclinical, so early intervention with anticonvulsants is generally recommended. Surgical intervention, including hemicraniectomy, has been advocated by some authors, particularly in the setting of predominantly unilateral injuries.[34,37]

OUTCOMES

Outcome studies regarding patients with abusive head injury have been historically difficult because of small sample sizes and methodologic issues, including a high loss to follow-up. Monitoring of outcome data has improved over the last decade and previously reported suspicions regarding prognosis have been confirmed. Overall, there is significant morbidity seen in survivors of abusive head injuries; outcomes range from mild learning disability to more severe physical or cognitive abnormalities and death.

Mortality ranges from 11% to 33% and almost two thirds of patients will have some neurologic sequelae.[86] Prognosis tends to correlate with the radiological severity of injury.[87] When comparing inflicted head injury with accidental head injury, patients in the abuse category have longer hospital stays, are more likely to have seizures, and more likely to have poor outcomes.[11,88] Neurologic manifestations of injury include heimplegia, quadriplegia, sight and hearing impairment, microcephaly, hydrocephalus and epilepsy.[86] Poor visual outcome is correlated with severe neurologic injury, and visual impairment is more often the result of brain injury than the presence of retinal hemorrhages.[66] Long-term behavioral, developmental and cognitive sequelae are also seen.[89]

PREVENTION

Prevention strategies include both general and specific approaches. Examples of general approaches include parenting support, which can be offered throughout childhood. At pediatric health supervision and immunization visits, health care providers can elicit concerns about behavior and offer age-appropriate anticipatory guidance. Parents can benefit from supportive community resources before abuse occurs.

Secondary prevention strategies focus on identifying high-risk families. When family dysfunction becomes apparent, early therapeutic intervention may be more effective than later intervention during adolescence. Early identification of mental health, family violence, and substance abuse issues is paramount. A broader view of child protection to include building on family strengths and youth mentoring may provide support that families need. In the event of fatal child abuse, state fatality review teams can assist communities in identifying specific needs.[90]

Unfortunately, few coordinated, evidence-based approaches to the prevention of abusive head trauma child abuse have been studied; however, one area of investigation has demonstrated positive effects. Neonatal education programs addressing new parent coping skills that focus on the stresses of infant crying have been shown to decrease the incidence of inflicted head injury.[7] More research is needed to see if this approach can be replicated. Preventive and therapeutic interventions need to be explored to find the most cost effective and humane strategies to approach the problem of child abuse. The results of such a strategy can only be evaluated by providing long-term follow-up for families. These approaches may be costly, but the cost of not protecting children may be higher.[10,11]

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