PEDIATRIC ABUSIVE HEAD TRAUMA

INTRODUCTION

Pediatric abusive head trauma – once commonly known as the shaken baby syndrome – is a form of child abuse that results in traumatic brain injury. The peak incidence of pediatric abusive head trauma appears to be in children between the ages of 2 to 4 months; the exact incidence of this injury is not known. Pediatric abusive head trauma often results in severe and permanent neurological damage, and the associated mortality rate is very high. It is often characterized by a diagnostic triad of encephalopathy, subdural hemorrhage, and retinal hemorrhage and other serious injuries may be seen, as well.

The traditional explanation for pediatric abusive head trauma is that it is caused by violent shaking that results in shearing and breaking of blood vessels in the brain. However, shaking alone likely does not – and cannot – account for the damage seen in cases of pediatric abusive head trauma, the exact mechanism of injury is not known, and the term shaken baby syndrome is no longer accepted by the medical community. Detection of pediatric abusive head trauma can be very difficult, but detection rates can probably be improved with education and vigilant screening.

This course provides an overview of the recognition and prevention of pediatric abusive head trauma. Specific topics include etiology and risk factors, the clinical characteristics, detection and diagnosis, working with the family or caregivers and the prevention of pediatric abusive head trauma.

OBJECTIVES

When the learner has finished this module, she/he will be able to:

1. Identify risk factors for pediatric abusive head trauma.
2. Identify commonly reported signs of pediatric abusive head trauma.
3. Identify consequences of pediatric abusive head trauma.
4. Identify the mechanism of injury of pediatric abusive head trauma.
5. List characteristics of infant anatomy that contribute to pediatric abusive head trauma.
6. Identify a secondary mechanism of injury in pediatric abusive head trauma.
7. List circumstances that would indicate the need for an assessment for pediatric abusive head trauma.
8. Identify two consultants that should be contacted if pediatric abusive head trauma is identified or suspected.
9. List diagnostic tests that should be performed and/or may be useful if pediatric abusive head trauma is identified or suspected.
10. Identify why pediatric abusive head trauma can be difficult to detect.
**EPIDEMIOLOGY**

Head trauma is the most common cause of death in children who are physically abused, but the exact incidence of pediatric abusive head trauma is not known. It has been estimated that there are 14 to 30 cases per 100,000 children but there is convincing evidence that the incidence could be much, much higher because these cases are un-witnessed, parents do not voluntarily report the abuse, and because of differing evaluation and reporting criteria for reporting pediatric abusive head trauma.

**ETIOLOGY AND RISK FACTORS**

Childhood development issues and family and individual characteristics can all contribute to, and be risk factors for pediatric abusive head trauma.

- **Crying:** As mentioned previously, the peak incidence of pediatric abusive head trauma appears to be in children between the ages of 2 to 4 months. This is a period of time in which inconsolable infant crying is relatively common. The crying can be prolonged, unpredictable, accompanied by other behaviors that can be upsetting to caretakers, and the infant cannot be consoled. Several authors have found that this inconsolable crying is an important causative factor for pediatric abusive head trauma.

  **Learning Break:** Inconsolable crying is a normal part of infant development. The infant has prolonged crying spells that do not appear to be triggered by an obvious stimulus, the infant appears to be in pain, and the infant cannot be consoled. This crying pattern can be very difficult for the parent because of the length and intensity of the crying (some infants will cry for hours), the crying continues day after day, it starts and stops unexpectedly, and nothing the parent or caretaker does will appease the infant.

- **Gender:** Male children appear to be the majority of the victims of pediatric abusive head trauma (one study notes that male children accounted for 60.3% of all cases). Males have been identified as more likely to be the perpetrators, and the injuries the victims suffer when a male is the perpetrator are more serious. However, reporting bias may account for the higher reported incidence of male perpetrators, and male perpetrators appear to be more likely to confess and more likely to be prosecuted and convicted.

- **Caretaker-victim relationship:** Fathers appear to be the most common perpetrators of pediatric abusive head trauma. Boyfriends of the mother appear to the next most common, followed by babysitters and mothers.

- **Perpetrator characteristics:** Parental or caretaker problems with substance abuse or psychiatric disorders have been linked to pediatric abusive head trauma. If there is a single parent and unrelated adults living in the house, it appears that the risk for abuse (from the unrelated adult) is much higher. Other possible risk factors
include young parents, low socioeconomic status, unstable family situations, and a child with a disability or a premature child.\textsuperscript{21}

**CLINICAL CHARACTERISTICS OF PEDIATRIC ABUSIVE HEAD TRAUMA**

Encephalopathy, subdural or subarachnoid hemorrhage, and retinal hemorrhage have traditionally been considered to be the hallmarks of pediatric abusive head trauma.\textsuperscript{22,23}

- **Encephalopathy:** Encephalopathy is defined as a disorder or disease of the brain. Children who have sustained abusive head trauma present with a wide range of behavioral and neurological problems. Some of these are relatively minor; the child might be irritable or lethargic. Others are very severe; the victims of pediatric abusive head trauma may suffer from epilepsy, seizures, motor weakness, and visual, cognitive, and sensory impairments\textsuperscript{24}, and one author estimated that neurological damage sustained as a result of pediatric abusive head trauma was permanent in more than 80% of the victims.\textsuperscript{25} It is also possible that a child who has suffered pediatric abusive head trauma may appear to be normal and the trauma is found after CT or MRI scanning.\textsuperscript{26,27}

- **Subdural hemorrhage:** Subdural hemorrhage is a common consequence of pediatric abusive head trauma, and cerebral edema and hypoxic injury are possible.\textsuperscript{28} Subarachnoid hemorrhage can also be seen.\textsuperscript{29}

**Learning Break:** A subdural hemorrhage is a collection of blood between the dura mater and the arachnoid mater. The dura mater is the outermost of the three meninges (fibrous membranes) that surround the brain and the spinal cord, and the arachnoid mater in the middle meninge. A subarachnoid hemorrhage is a collection of blood between the arachnoid meninge and the innermost meninge, the pia mater.

- **Retinal hemorrhage:** Retinal hemorrhage is seen in more than 85% of all victims of pediatric abusive head trauma.\textsuperscript{30} Often there are numerous retinal hemorrhages, but they may not be abundant and a severe brain injury does not always mean that the number of the retinal hemorrhages will be high or that they will be severe. There are numerous causes of retinal hemorrhages in infants, and it is important for the ophthalmic findings to be considered along with the other clinical findings and the story of the case. If the infant has massive retinal hemorrhages in many ocular layers and a retinoschisis cavity in the macula, these findings are thought to be almost certainly caused by abusive head trauma.\textsuperscript{31} (Note: The term retinoschisis means a splitting of the retina)

Other reported clinical characteristics of pediatric abusive head trauma include apnea, rib fractures, long bone fractures, skull fractures, and head and neck bruises.\textsuperscript{32} Unfortunately, in some cases of pediatric abusive head trauma there may not be obvious injuries such as bruises, lacerations, etc.
HOW DOES PEDIATRIC ABUSIVE HEAD TRAUMA HAPPEN? THE MECHANISMS BEHIND THE TRAUMA

The traditional term for pediatric abusive head trauma – shaken baby syndrome – was first used in 1984. Ludwig and Warman described a case series of 20 infants who had suffered physical abuse, and they (along with several other authors who had written previously on the subject) identified shaking as the mechanism of injury for pediatric abusive head trauma.33 This term – and the presumption that shaking was a form of physical abuse that caused a specific mechanism of injury – was apparently accepted by the medical community at large for some time.

This is no longer the case. There is considerable controversy as to whether shaking can mechanistically explain the damage of pediatric abusive head trauma, or if shaking plus impact are needed.34 The shaken baby syndrome postulated that intense shaking caused rotational acceleration and deceleration of the head and because of an infant’s proportionally large head and relatively weak neck muscles, the violent movement of the brain in the cranial cavity caused shearing of blood vessels.

However some authors feel that shaking alone cannot be the sole explanation for pediatric abusive head trauma35, and Squier states unequivocally that “... shaking is no longer a credible mechanism for non-accidental head injury.” 36 Shaking is definitely a common form of physical abuse, and it may well contribute the trauma of pediatric abusive head trauma, However, the exact mechanisms for pediatric abusive head trauma are not known, ‘... all the models and theories (of pediatric abusive head trauma have known limitations ...”,37 and in 2009 the American Academy of Pediatricians advised that the term shaken baby syndrome no longer be used.

Regardless of the exact mechanism of injury, there are specific features of the infant brain and anatomy that contribute to the brain injury associated with pediatric abusive head trauma.38

- An infant’s head is relatively large and unstable: This feature of infant anatomy can mean that if an infant is vigorously shaken, the head – and the brain – will experience rapid acceleration and deceleration

- An infant’s brain matter is relatively soft and has a high water content.

- An infants’ skull is soft and pliable, so force is more easily transmitted to the brain.

- The base of an infant’s skull is relatively flat and this allows for more brain movement inside the skull.

- An infant’s neck muscles are relatively weak and this allows for greater movement of the head in response to force.

Once the initial, primary injury from mechanical forces has occurred, secondary mechanisms of injury such as hypoxia-ischemia, inflammation, or hypoperfusion may begin.39,40 These secondary mechanisms of injury appear to be more common in inflicted
DETECTION AND DIAGNOSIS OF PEDIATRIC ABUSIVE HEAD TRAUMA

Child abuse and pediatric abusive head trauma appear to be relatively common, but the detection rate of these problems by health care facilities is presumed to be very low. Differentiating between accidental injuries and inflicted trauma is difficult, and detecting abuse is also very difficult in the absence of obvious signs and symptoms and/or a confession by a parent or a caretaker. Even when health care professionals have been trained to use systematic screening tools, it appears that detection rates are low.

Detecting and diagnosing pediatric abusive head trauma is critically important. Detection and diagnosing this problem and can save lives and prevent significant morbidity, and accurately diagnosing the absence of pediatric abusive head trauma can protect parents or caretakers who have not abused a child. But there is no clear definition of pediatric abusive head trauma to guide clinicians, non-intentional injuries and neurological and perinatal complications can cause a subdural hematoma, there are many possible causes of retinal hemorrhage, and there are multiple medical problems that can be mistaken for pediatric abusive head trauma.

Pediatric abusive head trauma is detected and diagnosed through a combination of awareness/suspicion of the possibility in a given circumstance, a carefully taken history and a carefully performed physical exam, consultations (e.g., neurology, ophthalmology), characteristic physical findings, and appropriate diagnostic testing.

Detection starts by identification of parts of the history that indicate the possibility of abuse. Consider an assessment for pediatric abusive head trauma: a) if the child has an acute or a chronic illness or injury and there is no adequate explanation or an inconsistent explanation, b) if the child has a severe head injury that is reported to have happened because of a short fall or minor trauma, c) if there is an unexplained head injury in a child who had previously been well, and/or d) if the child has a subdural hematoma, rib fractures, retinal hemorrhages, or fractures of the long bones. Other warning signs include an abnormal mental status, apnea, hypoxic ischemic cerebral injury, head and neck bruising, seizures, or the need for CPR outside of the hospital.

**Learning Break:** Parents or caretakers may say that the child sustained the injuries from a fall. This is possible, but it is very unlikely that a fall could occur to a child in the age group that typically suffers pediatric abusive head trauma and that fall would cause a serious injury to the head. However, it is unlikely the scenario of a short fall resulting in serious head trauma is not impossible.

If the injury and the explanation – or lack of explanation – indicate possible pediatric abusive head trauma, a CT or an MRI should be performed; this is mandatory. Plain x-rays should be done as part of a skeletal survey. These should include x-rays of the skull, cervical spine, thorax, lumbar sacral spine, abdomen, the humeri, forearms, hands, femurs, lower legs, and feet. An ophthalmologist and a neurologist should examine the child, and it may be helpful to consult with a pediatric trauma surgeon.
full blood count should be performed to check for blood loss and coagulation studies should be done to see if a coagulation disorder has caused, or contributed to the injuries.

WORKING WITH THE FAMILY OR CARETAKERS IN CASES OF PEDIATRIC ABUSIVE HEAD TRAUMA

If child abuse and/or pediatric abusive head trauma is diagnosed, there are very serious consequences for the family or the caretakers who are involved and for the victim, as well. If there is a strong suspicion that an infant has suffered abusive head trauma, but there is no confirmation of this (e.g., a confession, reliable witnesses), the adults involved will have to be formally interviewed. The protection of the child and other children in the family is the most important priority, but the tone of the interview should be respectful and non-accusatory.

This process would not be a nursing responsibility and if pediatric abusive head trauma is suspected, a physician should be notified immediately; pediatric abusive head trauma would be considered a reportable event, and legal authorities must be notified. Also, these cases are typically managed with a multi-disciplinary team involving psychologists, social workers, and other health care professionals.

However, nurses are often the first health care professional to examine an infant who may have been physically abused and the first health care professionals to speak to family members or caretakers about these cases. In these circumstances, documentation is obviously critically important. A careful physical evaluation of the child should be done, and if there are any obvious injuries make note of their location, description, size, etc. Illustrations can be helpful and some triage forms have ready-made illustrations/charts of the human form that allow the triage nurse to mark the location of the injuries. Photographs are often used and may be required. If photographs are used, they should be carefully marked with the date, time, and the names of the people present when the photographs were taken.

When interviewing family or caretakers, it is best to ask simple questions and allow them to answer. Do not make suggestions about what has happened (e.g., did your child fall down the stairs?) as this could be considered to be influencing the interviewee. When you are documenting, use quotation marks to indicate direct statements from a parent or a caretaker. The nurse should be non-judgmental and objective.

PREVENTION OF PEDIATRIC ABUSIVE HEAD TRAUMA

Pediatric abusive head trauma may be likely to happen in certain circumstances, and there are risk factors that appear to increase the possibility of its occurrence. But even if these circumstances and risk factors are present, pediatric abusive head is not inevitable, prevention programs are a key part of the approach to the problem, and there is evidence that preventions programs can reduce the incidence of pediatric abusive head trauma. The Period of Purple Crying® is a prevention program that provides parents with educational material that is delivered to parents by health care professionals. Purple is an acronym that describes the features of inconsolable crying: Peak of crying (the pattern slowly reaches a peak), Unexpected crying, Resists soothing, Pain-like face (the infant appears to be in pain), Long-lasting (the crying can last for 5 hours or more), and
Evening (the infant typically cries in the evening or at night). The program creates awareness about inconsolable crying and the problem of pediatric abusive head trauma, and it appear to be well accepted and effective.56

SUMMARY

Pediatric abusive head trauma is a serious form of child abuse, many children who have this injury inflicted on them suffer permanent neurological damage, and the mortality rate associated with pediatric abusive head trauma has been reported to be as high as 30%.57 Pediatric abusive head trauma has traditionally been characterized by the diagnostic triad of encephalopathy, subdural hematoma, and retinal hemorrhage, but there are other serious injuries that are commonly seen, as well. This injury was once called shaken baby syndrome because the mechanism of injury was presumed to be violent shaking of the infant by a parent or caretaker, but this explanation is no longer thought to be true and the term shaken baby syndrome is no longer used. The exact mechanism of injury is not known – it is probably a combination of shaking and impact trauma – but the damage occurs from the initial mechanical force and then subsequent ischemia, hypoxia, and/or inflammation. Most of the victims and most of the perpetrators are male and inconsolable crying is thought to be an important trigger for this type of abuse. Detection of pediatric abusive head trauma can be very difficult because there may not be any obvious injuries, the abuse is often not witnessed, and parents or caretakers typically do not confess.

REFERENCES


