NEUROSURGERY CLINICS OF NORTH AMERICA

Neurosurg Clin N Am 13 (2002) 247–257

Inflicted head injury: future directions and prevention

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Interest in the concept of inflicted or abusive head injuries in children has increased dramatically over the past quarter century since Caffey's [1] original description of the whiplash shaken infant syndrome in 1974. A Medline search using the terms *shaken baby*, *shaken impact*, and *inflicted head injury* disclosed an exponential increase in the number of scientific articles dealing with the subject (Fig. 1). Despite the explosion of interest and the clarification of certain features, many unanswered questions remain. Some of the answers to these questions are difficult or even impossible to obtain, because the medical facts are, by nature, uncertain or unreliable in many cases.

Unfortunately, the uncertainties surrounding some of these issues have been hotly debated and in some cases exploited within our adversarial legal system, with expert witnesses expressing opposing viewpoints in their interpretation of the existing literature. Although some questions, by their nature, may never be answerable, we can at least address some areas with further scientific research in the hope of generating better and more reliable data.

This article examines several diverse issues, including the medical definition of inflicted head injury; the scope of the problem and the need for adequate tracking mechanisms; current concepts of the biomechanics of inflicted injuries; the concept of the "lucid interval" and its relationship to the timing of the injuries; the appearance of certain radiographic features and their importance in timing of injuries; newer diagnostic modalities that hold promise for identifying and further quantifying the degree of injuries; and what impact, if any, educational and interventional programs might have in preventing inflicted injuries. Each section briefly reviews what is currently known and what is not, and poses questions for further study.

Identification and nomenclature

The association of subdural hemorrhages (SDH) with abusive injuries was first described by Guthkelch [2] in 1971. Caffey [1] in 1974, however, is generally credited with the introduction of the term *whiplash shaken infant syndrome* to describe the association of SDH and retinal hemorrhages in the absence of external signs of physical trauma. This term was later shortened to *shaken baby syndrome*, which despite the shortcomings of the name, is currently the term most commonly used.

In 1987, Duhaime et al [3] introduced the term *shaken impact syndrome* after reporting a series of inflicted head injured children, many of whom had radiographic or autopsy evidence of impact injuries (skull fractures, subgaleal hemorrhages, or scalp bruising). In addition, their biomechanical models of both shaking and impact suggested that shaking alone may not produce forces sufficient to cause SDH and diffuse axonal injury (DAI). The term *shaken impact syndrome* has been criticized by others in part on the grounds that it does not identify who is being injured. Moreover, although Duhaime has stated publicly that her study was never intended to eliminate shaking as a potential mechanism for brain or retinal injuries, the paper

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PII: S1042-3680(01)00009-2

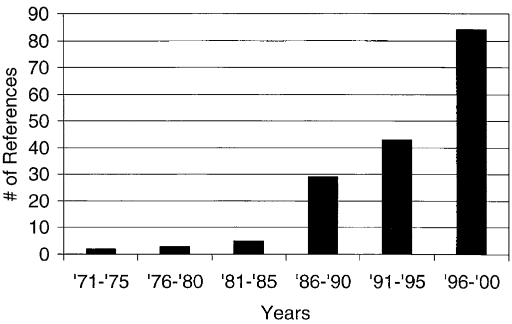

Fig. 1. Exponential growth in publications dealing with shaken baby syndrome and inflicted childhood head injuries.

has been commonly misused by defense attorneys (in cases where there is no evidence of impact injury) to suggest that shaking alone can never cause the injuries ascribed to shaken baby syndrome. Although admittedly imperfect from a purely scientific standpoint, the confessions of many perpetrators to having shaken an infant without an impact mechanism suggest that shaking alone can indeed cause some or even all of the components of shaken baby syndrome. In 1998, the author coined the term *infant shaken impact syndrome* both to identify the infant being injured and acknowledge the contributions of both shaking and impact in various cases [4]. Hadley et al [5] noted cervical spinal cord injuries in a subset of these infants, and coined the term *infant whiplash-shake injury syndrome*. Finally, a number of other, more general terms have arisen during the past quarter century including abusive, nonaccidental, intentional, and inflicted injury to acknowledge a number of different mechanisms including shaking, translational or rotational acceleration with impact, and direct blunt force trauma. Hymel et al [6] recently constructed an algorithm for both defining and categorizing the mechanism of inflicted head injuries, and the interested reader is referred to their excellent monograph on this subject.

Although the proper naming and universal use of a particular eponym might, at first glance, seem to be an innocuous exercise, it does raise a number of problems. First, literature searches are more difficult because, depending on which search terms are used, one can obtain different references. Conducting a Medline search using the term *shaken baby syndrome* retrieved 149 references. On the other hand, using the term *shaken impact syndrome*' yielded only 18 references, all of which had been obtained during the prior search. Finally, using the terms *inflicted head injury* and *abusive head injury* uncovered several additional references that had not been identified previously, but missed many references that had been obtained in the two prior searches.

Of even greater importance, both the name and its implications as to the biomechanics and mechanisms of injury become medicolegal issues, which are discussed later in the section on biomechanics. Although it seems a trivial matter, the implications of the syndrome name and the angst and heated debate that it has generated for over a quarter century suggest the need for a consensus panel to find common ground.

Incidence and demographics

How one categorizes the mechanism of injury also defines and characterizes the incidence and demographics of these cases. A number of questions arise in this regard. For example, should one include children with all types of inflicted head injuries (both intracranial and extracranial), or should one exclude those with, for example, isolated soft tissue head injuries but without skull fracture or intracranial injuries? Should one include only those infants whose injuries (diffuse SDH, retinal hemorrhage, and so forth) suggest a rotational accelerational mechanism, such as shaking (with or without impact), and exclude those whose injuries suggest battering (e.g., a blow by a fist or other object)? How does one define those cases whose injuries are suspicious for, but inconclusive of, inflicted injury, or those in which the perpetrator is ultimately judged in the legal system to be "not guilty" even though the medical evidence is incontrovertible? How does one categorize childhood head injuries that are accidental but incidental to an episode of directed spousal abuse? Finally, does one include only inflicted injuries that are inflicted by those charged with the care of the child (parents, boyfriends, relatives, babysitters), or does one also count injuries sustained by other individuals? For example, one baby for whom the author cared was torn from his mother's arms and flung against a wall during an assault on the mother by an angry upstairs neighbor. Again, one needs to arrive at some consensus regarding who is counted in the statistics, and some attempt to categorize injuries by injury mechanism should be made, as was suggested by Hymel et al [6].

Given these unanswered questions, and the fact that there is no database that tracks cases of inflicted head injuries, it is no surprise that the incidence of inflicted head trauma is not known with certainty. The most comprehensive data are that of Barlow and Minns [7] from Wales and England, who estimate the incidence to be 24 cases per 100,000 infants less than 1 year of age per year. In the United States, an estimated 1000 to 1400 deaths per year are attributed to inflicted head injuries [8]; using an average mortality rate of approximately 25% yields an incidence of 5600 reported cases per year. Other reports have expressed the incidence in terms of the number of cases seen per hospital per year. Studies before 1992 suggested a figure of four to nine cases per hospital per year, whereas studies since 1992 estimate 5.8 to 28.8 cases per hospital per year (reviewed in reference [9]). Whether this reflects a true increase or more widespread identification and reporting is unknown.

The eight-county region of western New York, including the Buffalo metropolitan area, includes approximately 1.2 million people with an average of 17,500 live births per year. The region is served by a single tertiary care facility, the Children's Hospital of Buffalo, with essentially no other pediatric neurosurgical presence in the region, providing an excellent opportunity to estimate the incidence of inflicted head injuries. From 1993 to 1998 inclusive, the author identified 42 cases of inflicted head trauma with intracranial injury, an average of 7.0 cases (range, four to eight) per year. This represents 0.58 cases per 100,000 population, or 41 cases per 100,000 live births for the western New York region. This should be considered a minimum incidence, because it includes only admissions to Children's Hospital of Buffalo, and excludes less severely injured infants who could potentially have been managed at outlying hospitals. Other cases may have gone unrecognized or unreported, or be misdiagnosed as other conditions (sudden infant death syndrome, accidental injury, and so forth).

Clearly, from a medical, scientific, legal, legislative, and prevention standpoint, there is a need to (1) better identify and categorize the definitions of inflicted head injury, and (2) develop state-wide and national databases that can measure the scope of the problem adequately, so that the success (or lack thereof) of prevention and other efforts can be tracked successfully.

Biomechanics of inflicted head injuries

A crucial aspect of caring for the child with an inflicted head injury, and one that distinguishes it from all other types of neurosurgical care, is the request from the legal justice system that the physician provide an estimate (within some degree of medicolegal certainty) that the injuries are inflicted, or nonaccidental. In some cases, the injuries are obvious and rendering an opinion of inflicted injury is straightforward. In others, the circumstances are suspicious for inflicted injury, but do not reach a degree of medical certainty needed to prosecute or intervene; these cases are personally agonizing for the author as a clinician.

A number of studies have indirectly addressed the issue of the amount of force required to produce certain types of injuries. For example, many studies (reviewed in reference [9]) have examined the types of injuries from falls of various heights and with various mechanisms (e.g., falls from caretakers' arms, falls off of beds while in the hospital, falls down steps, falls in infant walkers, and falls from windows), and almost all conclude that serious or life-threatening intracranial injuries other than expanding epidural hematomas are extremely uncommon following accidental injuries from heights of less than 4 ft (Table 1).

A recent study by Plunkett [10] of fatal pediatric head injuries caused by short-distance falls on playground equipment has received particular attention in the courts, because it purports to show that fatal head injuries can occur from relatively short-distance falls. This paper identified 18 children with fatal head injuries from a review of more than 75,000 playground injuries reported to the United States Consumer Product Safety Commission National Injury Information Clearinghouse database. Two of the children had other identifiable reasons for their fatal injuries: one had thrombocytopenia–absent radius syndrome and the other an arteriovenous malformation on the side ipsilateral to a SDH. A third child died from delayed cerebral infarction from vertebral artery occlusion 2 days following an injury. The remaining 15 children (six injured following falls from swings and nine following falls from fixed heights) represent an incidence of fatal head injuries following short falls from playground equipment of less than 0.012% (roughly 1 death per 10,000 injuries). The true mortality rate is likely much less than this considering the much larger number of infants injured on playground equipment that are unreported. This paper also shows that, although fatal head injuries are possible following short falls, they are extremely rare.

The forces necessary to produce retinal hemorrhages are not known with certainty, although a number of other studies have examined the incidence of retinal hemorrhages following both

Table 1
Cranial injuries from falls

Reference	No. of patients	Age (y)	Height and mechanism	Injuries and deaths
Short falls				
Helfer (1977)	176	<6	Home: sofa, bed, etc.	2 skull fx
Helfer (1977b)	85	<6	Hospital: bed, crib	1 skull fx
Nimityongsakul (1987)	76	<16	Hospital: bed, crib	1 skull fx
Kravitz (1969)	336	<2	Home: changing table	1 skull fx, 1 SDH
Williams (1991)	44	<3	<10 ft	3 skull fx (depressed)
Lyons (1993)	207	<7	Hospital: bed, crib	1 skull fx
Selbst (1990)	68	<6	Bunkbeds	7 fx, 1 SDH
Levitt (unpublished)	336	<2	<8 ft	9 SDH, 7 RH (7 SBS)
Chadwick (1991)	165	<18	<10 ft	7 deaths, 7 SDH, 7 edema, 5 RH, 5 SAH (7 SBS)
Total	1493			
Stairway falls				
Ludwig (1988)	363	<19	24 walker, 10 fell from adult arms	6 skull fx
Chiavello (1994)	69	<5	Stairway falls	
Levitt (unpublished)	156	<2	75 walkers	2 SDH/RH
Total	588			
Falls ≥1 story				
Williams (1991)	62	<3	>10 ft	1 death (70 ft)
Barlow (1983)	62	<3	>1 story	14 deaths (>3 stories)
Smith (1975)	42	<15	>1 story	2 deaths (4 stories)
Chadwick (1991)	118	<18	>10 ft	1 death (10–45 ft)
Musemeche (1991)	70	<15	>10 ft	No deaths
Lehman (1993)	134	<16	Windows, balconies, rooftops	1 death
Total	487			19 deaths (18 >3 stories)

Abbreviations: fx, fracture; RH, retinal hemorrhage; SBS, shaken baby syndrome; SDH, subdural hemorrhage.

(*From* Alexander RC, Levitt CJ, Smith WL. Abusive head injury. In: Reece RM, Ludwig S, editors. *Child abuse: medical diagnosis and management*. 2nd edition. Philadelphia: Lippincott Williams and Wilkins, 2001. p. 65; with permission.)

accidental and nonaccidental injuries and conclude that only 3% of retinal hemorrhages can be attributed to accidental mechanisms, and when present, the source of the trauma (e.g., a high-speed automobile accident) is almost always obvious [11]. A few papers have described retinal hemorrhages following minor head injuries. For example, Plunkett [10] cites four children with retinal hemorrhages, three of which were described as "extensive." Piatt [12] describes another child with benign extra-axial collections of infancy and a SDH with retinal hemorrhages following a witnessed short-distance fall and no other evidence of abuse. In contrast to the rarity with which retinal hemorrhages are seen following accidental trauma, retinal hemorrhages are common following inflicted head injury (about 80% of cases, averaging a number of different series).

From a biomechanical standpoint, the most important question is, "What magnitude and properties of force are necessary to produce the clinical injuries that are seen in inflicted head injuries"? Perhaps the most widely quoted, and the most controversial, study of the forces generated during shaking and impact is by Duhaime et al [3]. The study is divided into two parts. In the first part, 63% of 48 infants with inflicted head injury, and all 13 fatalities, were found to have evidence of impact injury (scalp bruising, subgaleal or cephalohematoma, skull fracture, or other extracranial injuries), suggesting that many infants with inflicted head injuries are struck against, or by, another object. The second part of the study used various doll models that were either shaken or struck against an object; both the period and velocity of the maneuver, and the resultant acceleration of the dolls' heads, were recorded. These forces were compared with known thresholds necessary for concussion, SDH, and DAI that were derived from a model that used adult primates subjected to nonimpact trauma. The forces generated by shaking alone in Duhaime et al's [3] study were far less than the thresholds for SDH or DAI obtained in the experimental primate studies; only impact against a fixed object could produce such forces. The authors' concluded that it was unlikely that shaking alone could produce these types of injuries, and that impact was also likely involved in many cases.

This simplistic model, however, fails to account for a number of other variables. For example, as Duhaime et al [3] has pointed out, brain deformation is dependent on both the amplitude of an acceleration and the time interval over which the acceleration occurs (for repetitive accelerations, such as shaking, this becomes the periodicity of the shaking). This can change both the degree and type of injury; for example, short cycle times (or periods) produce SDH, whereas longer periods produce DAI [13]. Inherent in Duhaime et al's [3] model is the assumption that any brain deformation that occurs in response to a single shaking cycle has completely resolved by the time the second cycle is initiated (i.e., that there is no cumulative effect on brain deformation in response to repeated cycles of violent shaking). This may not be true; the brain may well not have returned to its resting state between cycles, leading to cumulative deformations (and injury) from repeated cycles of angular acceleration during the course of a single shaking episode.

Moreover, the model assumes that there is no change in the threshold for deformation of the brain tissue (and hence injury) during a shaking episode. This may also be untrue. It could be proposed that, once even a small focus of injury is initiated within the brain, the biomechanical ability of this injured tissue to resist further deformation in subsequent acceleration cycles may change significantly. With each ensuing cycle, the inherent strength of the tissue, and its ability to withstand gliding moments of one part past another, must eventually change. In the extreme, parts of the shaken brain liquefy and the ability to withstand deformation is significantly reduced. The question then becomes, can the inherent ability of brain to withstand deformation (its shear modulus) change significantly during a clinical shaking event?

Finally, the concept of the innate harmonic or resonant frequency of the infant brain may be another important biomechanical variable in the response to violent shaking. Might there be a particularly injurious frequency of violent infant shaking that imparts greater deformation (and damage) to the brain? All of these biomechanical variables may interact in complex ways that we do not yet understand, and may well explain the apparent paradox of the infant with a fatal brain injury and a confessed pure shaking mechanism. Much more research is needed to define better the contribution of these variables in the biomechanical responses of the infant brain to shaking.

Other research has focused on the histologic changes and biochemical responses of the infant brain to inflicted trauma. For example, a series of more recent pathologic studies have suggested that traumatic DAI in inflicted head injury may be limited to the lower brainstem, cervicomedullary junction, and rostral spinal cord, and has led to the intriguing proposal that the cervicomedually junction by virtue of its greater mobility is at particular risk for traumatic injury, and that the consequent apnea leads secondarily to more global hypoxic-ischemic brain injuries [14–16]. Cervical spine injuries have been recognized both by MRI and at autopsy by others [5,17]. This provides another mechanism whereby pure shaking might inflict greater injury than is expected by pure biomechanical forces alone, and may also partly explain the variability in the extent of global injuries, based on the degree to which brainstem compromise leads to secondary hypoxic-ischemic damage.

Other recent research has focused on the roles of secondary metabolic cascades and free radical formation in inflicted head injuries [18–20]. For example, Ruppel et al [19] have demonstrated markedly elevated levels of excitatory amino acids, such as glutamate and glycine, in inflicted head injuries, much higher than those following severe accidental injuries with similar clinical states. Could this exciting research hold the promise of perhaps ultimately providing a test that reliably identifies nonaccidental head injuries?

It is a widely held belief that the infant is more susceptible to the effects of shaking than is the older child or adult's brain. Certain features of the infant have been said to explain this susceptibility, including (1) a disparity in size of an adult perpetrator and an infant, (2) a large infant head relative to the body, (3) weak neck musculature, (4) an increased water content and correspondingly decreased myelin content of the infant brain, and (5) perhaps a different secondary metabolic response of the infant brain. Intuitively, however, there is currently no direct evidence that the infant brain is innately more susceptible to shaking. In fact, some experimental data suggest that a smaller brain is less susceptible to the injurious effects of traumatic deformation, and there is at least a single report of shaken adult syndrome having all of the characteristic features of inflicted head injuries of infants [21]. Is the infant brain intrinsically more susceptible to violent shaking? Can one quantify the degree of biophysical injury to brain tissue at various ages to a standardized shaking paradigm? Further research is clearly needed; the author hopes to address these questions in a laboratory setting.

Finally, computer modeling may hold the key to unlocking the effects of various forces in deforming the brain. The author is developing a virtual mesh model of an infant brain, based on MRI data and making certain assumptions about the physical properties of brain tissue, that it is hoped will allow one to analyze the effects of various forces on brain deformation. A similar model has already been developed to support the belief that children with benign extra-axial collections of infancy are more susceptible to subdural hemorrhage following minor head trauma [22].

Radiography and the timing of inflicted head injuries

The proper timing of injuries is of critical importance in identifying a likely perpetrator. A study by Starling et al [23] demonstrated that, in 36 (97%) of 37 cases in which the perpetrator had confessed to shaking, the infant was in the presence of the perpetrator when the symptoms began. The onset of clinical features, such as coma or apnea [24], may help define the timing of the abuse. In one study of 138 fatal accidentally head-injured children, all but three children (two dying from epidural hematomas and a third from abdominal injuries with only minor head injuries) had moderate or severe Glascow Coma scores at the scene of the injury [25]. Many authors [25–28] have expressed the belief that once injured, infants with fatal or serious abusive head injuries also do not act normally, although this concept has been challenged by others [29,30].

Radiography provides another clue to the timing of inflicted injuries. Unfortunately, until recently the appearance and evolution of radiographic abnormalities following inflicted head injury had never been studied systematically; assumptions about the timing of injury based on various intracranial abnormalities was based on the evolution of these abnormalities in other disorders. For example, the appearance of chronic SDH in infants with inflicted injury was extrapolated from the known evolution of acute to chronic SDH in adults. Similarly, the timing of appearance of parenchymal hypodensities following inflicted head injury was derived from the known evolution following near drowning and other ischemic-anoxic injuries. Although the inherent problems of such approaches are obvious, these were the best data available.

More recently, the author undertook a systematic study of radiographic changes among 33 infants with inflicted head injuries by calculating the time between the reporting of the injury (in cases where the time could be determined accurately within reason) and the time on each serial CT scan. This study demonstrated that (1) SDH is the most common intracranial abnormality, and is present in 85% of cases; (2) SDH most commonly resolves with time, and does not progress to chronic SDH; (3) chronic SDH most commonly appears 3 to 12 days after the injury, but a CT picture consistent with chronic SDH (and maybe representing a mixture of blood and cerebrospinal fluid) can develop within 19 hours of the injury; and (4) parenchymal hypodensities, and even "big black brain" commonly develop within 3 to 4 hours of the reporting of the injury [4]. Although hampered by a small sample size and the problems inherent with relying on historical data and potentially inaccurate histories from providers, this study provides the best data yet available regarding the timing and evolution of intracranial abnormalities in inflicted head injuries. It is hoped that future studies with larger numbers of children will substantiate and further expand on the understanding of this vital information. In addition, a similar analysis that uses MRI rather than CT may give additional (and potentially much more valuable) information on the timing of injury based on an MRI appearance of hemorrhage.

Prevention of inflicted head injuries

Preventing inflicted brain injuries, rather than treating them after the fact, is certainly preferable in anyone's mind, and is the goal for which the guardians of children must strive. The importance of prevention was recognized by Caffey [1] in his sentinel paper:

> Hark ye, good parents, to my words true and plain,
> When you are shaking your baby, you could be bruising his brain,
> So, save the limbs, the brain, even the life of your tot,
> By shaking him never, never and not.

Unfortunately, although many prevention efforts have been implemented, substantiating the effects of such prevention efforts on reducing the incidence of child abuse has been elusive. Prevention efforts should ideally (1) raise people's awareness of the subject, (2) change their attitudes about the subject, and most importantly (3) change their behavior. Unfortunately, raising awareness and changing attitudes are easier to accomplish than changing behavior, as witnessed by safety prevention programs, such as those advocating seatbelts and bicycle helmets. Experience has shown that behaviors are unlikely to change without laws that mandate these changes in behavior, with penalties for noncompliance.

In theory, several approaches to child abuse prevention can be (and have been) undertaken:

1. Media coverage of isolated cases of inflicted trauma.
2. Nontargeted educational campaigns, such as those that use billboard advertisements, and television and radio public service announcements.
3. Educational and support initiatives that target specific at-risk groups, such as home visitation programs for low-income or other at-risk families.
4. Educational programs that target parents while still in the hospital.

To date, only home nurse visitation programs have proved effective in reducing child abuse and neglect [31,32]; whether home visitation has a specific effect in reducing inflicted head injuries is unknown. Considering that the US birth rate is currently 4.2 million per year, that 20% of the population is considered to be at risk, and the average costs of home visitation are estimated at $2200 per family (range, $1500 to $3500), the costs of home visitation in the United States are approximately $1.8 billion per year. Considering that the direct and indirect costs of child abuse in the United States are estimated at over $90 billion per year (statistics obtained from the Prevent Child Abuse America website), home visitation is worthwhile if it can reduce child abuse by as little as 2% to 3%.

In December 1998, the Children's Hospital of Buffalo began a program in Western New York, currently ongoing and in its third year, with several assumptions and hypotheses:

1. Unlike other forms of abuse, inflicted head injuries may more likely reflect a momentary loss of control and are not as premeditated.
2. Most perpetrators are parents, and specifically fathers or father figures (stepfathers and boyfriends); in a study of 21 cases in Western New York in which a perpetrator could be identified, 76% were parents (mothers, fathers, stepfathers, or mother's boyfriend) and 52% were fathers or father figures (M.S. Dias, unpublished data). Similarly, in Starling et al's [23] study, 74% of perpetrators were parents, and 61% were fathers or father figures.
3. Although previous studies [33,34] suggested that half of American adults and adolescents had not received information about the dangers of violent infant shaking, media coverage of this issue over the past several years has greatly increased public awareness of this problem. The goal is not to educate, but to remind both parents (and especially fathers and father figures) at the appropriate time: on the birth of their child, and before they leave the hospital. This is a time during which it is hoped they are focused on their newborn infant, and when they will soon be exposed to the frustrations of being a parent of a new infant.
4. Educated and informed parents can act as advocates by passing on this information to others who care for their child, such as relatives and friends, babysitters and nannies, and other child care providers.

The program has the stated goals of educating every parent of every child born in the eight-county region of western New York about the dangers of violent infant shaking before they leave the hospital. The program involves the dissemination of both written materials (a leaflet on preventing shaken baby syndrome published by the American Academy of Pediatrics [Fig. 2]) that parents are asked to read, and an 11-minute video that parents are asked to view. Finally, both parents (whenever possible) are asked to sign a statement acknowledging that they received and understood this information (Fig. 3). These commitment statements are collected by each hospital and returned to the study coordinator, where they are tracked.

In the first two years of the program, 16 of 17 regional hospitals that provide maternity services participated in some fashion; one hospital and one ward at another hospital did not participate to any extent. Two other hospitals provided information but did not disseminate affidavits for at least part of the program. Commitment statements were received for 47% of the live births in the region during this 2-year period, and from 59% of the births at hospitals

Prevent Shaken Baby Syndrome

Shaken baby syndrome describes the serious injuries that can occur when an infant or toddler is severely or violently shaken. These children, especially babies, have very weak neck muscles and do not yet have full support for their heavy heads. When they are shaken, their fragile brains move back and forth within their skulls. This can cause serious injuries such as:

- blindness or eye damage
- delay in normal development
- seizures
- damage to the spinal cord (paralysis)
- brain damage
- death

Shaken baby syndrome usually occurs when a parent or other caregiver shakes a baby because of anger or frustration, often because the baby would not stop crying. Shaken baby syndrome is a serious form of child abuse. Parents should be aware of the severe injuries that shaking can cause. Remember, it is never okay to shake a baby.

If you or your caregiver severely or violently shakes your baby because of anger or frustration, the most important step is to get medical care right away. Immediately take your child to the pediatrician or emergency room. Don't let embarrassment, guilt, or fear get in the way of your child's health or life.

If your baby's brain is damaged or bleeding inside from severe shaking, it will only get worse without treatment. Getting medical care right away may save your child's life and prevent serious health problems from developing.

When Your Child Cries, Take a Break—Don't Shake!

Taking care of an infant can be challenging, especially when an end to the crying seems nowhere in sight. If you have tried to calm your crying child but nothing seems to work, it's important to stay in control of your temper. Remember, it's never okay to shake, throw, or hit your child. If you feel as though you could lose control:

- Take a deep breath and count to 10.
- Take time out and let your baby cry alone.
- Call someone close to you for emotional support.
- Call your pediatrician. There may be a medical reason why your child is crying.

Be sure to tell your pediatrician or other doctor if you know or suspect that your child was shaken. A doctor who is not aware that a child has been shaken may assume the baby is vomiting or having trouble breathing because of an illness. Mild symptoms of shaken baby syndrome are very much like those of infant colic, feeding problems, and fussiness. Your pediatrician should have complete information so that he or she can treat your child properly.

The information contained in this publication should not be used as a substitute for the medical care and advice of your pediatrician. There may be variations in treatment that your pediatrician may recommend based on individual facts and circumstances.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

Fig. 2. American Academy of Pediatrics leaflet on preventing shaken baby syndrome provided to all parents of newborn infants. Reprinted with permission.

during the time that they were disseminating the affidavits. The incidence of inflicted head injuries was closely monitored during the program.

The results of the first 2 years were presented at the Joint Section on Pediatric Neurological Surgery Meeting of the American Association of Neurological Surgeons/Congress of Neurological Surgeons (AANS/CNS) in San Diego in December 2000. During the first 2 years of the program, the annual incidence of inflicted head injuries in the eight-county region declined from 7.0 (during the 6 years preceding the study) to 2.5 cases per year (during the 2 years of the study). Of the five cases identified during the 2 years of the study, two were

KALEIDA HEALTH

The Children's Hospital of Buffalo

STRONG HEALTH

Strong Memorial Hospital

Children's Hospital at Strong

Patient ID Area

Prevent Shaken Baby Syndrome!

Please help us to track the effectiveness of our program!

I have received information about Shaken Baby Syndrome, and have been asked to voluntarily sign a commitment statement acknowledging that I have received, read, and understand this information. I have also been asked to voluntarily provide a phone number where the study coordinators may call me in approximately 9 months to ask me a few questions regarding my recollections about the information I received today. I can refuse to participate in this project, and neither the medical care for myself nor my baby will be affected in any way. All information I provide is confidential. The collective results from all of the participants in this study will be presented at scientific meetings, but no identifying information about any individual will be disclosed. I am free to withdraw from the project at any time. I have read this information, my questions have been answered, and I consent to participate in this project. If I have further questions I can call either of the study coordinators, Dr. Mark Dias (716) 878-7386, or Dr. Linda Barthauer (716) 275-7815.

I have received the educational material about Shaken Baby Syndrome, and I understand that violent shaking is harmful and potentially deadly to a baby. I agree to participate in this study.
(Do not sign for your spouse; they should sign themselves!)

Mother's Name ________ **Signature** ________

Father's Name ________ **Signature** ________

Witness Name ________ **Signature** ________

Baby's Date of Birth ____/____/____ **Hospital where baby was born** ________

In what city or town will the baby live? ________ **Zip Code** ________

What is your age? Baby's Mother ______ Baby's Father ______

What is your highest education?

	Baby's Mother	Baby's Father
Some high school	☐	☐
High school graduate, no college	☐	☐
Some college	☐	☐
College graduate	☐	☐
Post-college degree (Masters, PhD)	☐	☐

What best describes the baby's home situation?

- Mother and father are married and living together, with the baby ☐
- Single mother, living with the baby and the father of the baby ☐
- Single mother, living with a man who is not the father of the baby ☐
- Single mother living with the baby's grandparents ☐
- Single mother, living alone ☐
- Other ________

What type of medical insurance do you have (check all that apply)?

- ☐ None
- ☐ Medicaid, Medicaid sponsored HMO, or other government sponsored program (Medisource, Family Health Plus, etc.)
- ☐ Private Insurance or HMO
- ☐ Unsure / Don't know

Was the information you received helpful to you? ☐ Yes ☐ No

Is this the first time you've heard that shaking a baby is dangerous? ☐ Yes ☐ No

Would you recommend this information be given to all new parents? ☐ Yes ☐ No

May we call you in 9 months to ask about your recollections of this information? ☐ Yes ☐ No

If you answered yes, please provide a phone number where we may reach you (____) ____-______

Any comments about our program?

____

Fig. 3. Commitment statement parents are asked to sign voluntarily after reviewing educational materials.

actually born before the study began; of the remaining three cases, one was born at a nonparticipating hospital, one had a signed affidavit by the perpetrator (the father), and the third was born at a participating hospital but there was no returned affidavit. The study is ongoing and now in its third year, and has expanded to involve 17 counties in upstate New York.

Financially, the costs of such an education are estimated to be approximately $164,000 for the 17,500 annual births in the eight-county region of upstate New York, or approximately $10 per child; if one considers this form of education to be a vaccination against inflicted head injuries, the costs compare very favorably with other inoculations.

Summary and conclusions

Although described only a quarter century ago, progress in this area is rapid and increasing at an accelerated rate. As a group, neurosurgeons, and particularly pediatric neurosurgeons, potentially have a lot to offer, both in the hospital, the courtroom, and the laboratory. As practitioners who see large numbers of brain injuries, both accidental and inflicted, they can provide a unique perspective to child abuse colleagues; unfortunately, neurosurgeons shy away from doing so for a variety of reasons: (1) they are too busy with clinical practice and cannot afford to devote the (largely uncompensated) time involved in keeping up with the literature on the subject, reviewing the case files in detail, and testifying in court; (2) they are reluctant to take the stand and potentially be subjected to the ridicule (and even abuse) hurled by attorneys in the defense of their clients; (3) they are uncertain in their minds about the validity of the evidence in some cases, especially when the evidence is not iron-clad; and (4) they perhaps fear later retribution from people they have helped convict for these crimes.

Whatever the reasons, neurosurgeons need to be more involved in these cases and to be both knowledgeable and reasonable in assessments of the cause of injury. In no other area of neurosurgery is the truth so critical, because the lives of the infants for whom they care, and those who might be accused unjustly of perpetrating a crime that they did not commit, hang in the balance. Neurosurgeons must be unerringly accurate in obtaining and recording clinical information and physical findings. When asked, they must not shy away from providing an answer, but only if well enough versed in the literature to be capable of so doing, because to provide false or inaccurate information is a disservice; to do so may condemn an innocent person to prison, or an innocent infant to death. If there is uncertainty, it is probably in the best interests of the child to have the case analyzed and represented by an expert who knows the literature well; there are many excellent and objective child abuse experts who can do this.

Finally, the author believes that this should be a much more active area of research for neurosurgeons. Although there has been much progress, there are also a number of uncertainties that remain to be answered, only a few of which have been touched on here. There is much to be done in this important field; neurosurgeons must concentrate on finding adequate answers for those questions that remain.

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