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A NUTS AND BOLTS APPROACH TO LITIGATING THE SHAKEN BABY OR SHAKEN IMPACT SYNDROME

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“Did he fall, or has he suffered inflicted injury?” is a question faced frequently by clinicians caring for infants and toddlers with traumatic brain injury. Published court cases, with widely divergent medical opinions, illustrate the dilemma of distinguishing between inflicted and accidental causes, especially when there are no other signs of abuse but just an uncorroborated, alleged accident, often [a] fall. Although there has been resistance to diagnose abuse there may also be over enthusiasm to do so, although there is an increasingly prevalent opinion that short falls can never cause serious injury; this, too is still open to debate.¹

I. Introduction

One of the most difficult cases for counsel to litigate is one involving an infant or toddler alleged to have died as a result of violent, non-

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¹ Barry Wilkins, *Head Injury-Abuse or Accident?*, 76 ARCHIVES OF DISEASES IN CHILDHOOD 393 (1997).

accidental shaking or shaking in connection with some form of cranial impact. Often referred to as the “shaken baby syndrome”² (SBS) or “shaken impact syndrome”³ (SIS), these cases not only contain the emotional turmoil of a dead child, but must also be tried using evidence that is highly dependent on complex circumstantial medical data. Interpretation of this highly complex data is typically dependent on expert testimony and is extremely vulnerable to subjective interpretations. Consequently, practitioners often find themselves easily overwhelmed and in a highly-charged atmosphere where emotions and the personal agendas of the purported experts can run roughshod over logic, science, and the law.⁴

The purpose of this article is to provide trial and defense counsel with a basic foundation for use when preparing to litigate a case where SBS or SIS is alleged. A comprehensive guide covering every conceivable nuance of a SBS/SIS case is beyond the scope of this article. Instead, this article will define SBS/SIS as it is most commonly regarded by the medical and legal community, outline the medical terminology and definitions common to such cases, provide a framework for requesting expert assistance and using and challenging expert testimony at trial, and conclude with a discussion of several of the current controversies surrounding SBS/SIS.

II. The Starting Point

A review of recent military cases involving SBS/SIS reveals that it is most often one of the parents or primary caretakers, typically the male parent or caretaker, that is suspected and charged with perpetrating the

² John Caffey, *The Whiplash Shaken Infant Syndrome: Manual Shaking by the Extremities with Whiplash Intracranial and Intraocular Bleeding, Links with Residual Permanent Brain Damage and Mental Retardation*, 54 PEDIATRICS 396 (1974) [hereinafter Caffey, *Whiplash*] (Although Dr. Caffey actually referred to his theory as whiplash shaken infant syndrome, virtually all medical and legal practitioners drop the term whiplash and refer to it as shaken baby syndrome.); see also John Caffey, *On the Theory and Practice of Shaking Infants*, 124 AM. J. DISEASES IN CHILDHOOD 161 (1972) [hereinafter Caffey, *Theory and Practice*].

³ Ann-Christine Duhaime et al., *The Shaken Baby Syndrome, a Clinical, Pathological, and Biomechanical Study*, 66 J. NEUROSURGERY 409 (Mar. 1987).

⁴ James LeFaun, *Letter to the Editor-Patterns of Presentation of the Shaken Baby Syndrome*, 328 BRIT. MED. J. 767 (Mar. 27, 2004).

alleged abuse.⁵ Regardless of the alleged perpetrator's gender, the relationship between a parent or caretaker and a child is private in nature.⁶ As a result, it is not uncommon for there to be no witnesses, other than the accused parent or caretaker, to the suspected abuse.⁷ Absent any eyewitnesses, practitioners rely heavily on medical evidence (e.g., medical reports, autopsy reports, etc.), medical expert assistance and medical expert testimony (e.g., forensic neuropathologist, etc.) to either prove or disprove that traumatic brain injury was caused by SBS/SIS.⁸ Therefore, the first step for any practitioner is to become intimately familiar with the medical terminology found in such evidence. To assist the reader, a non-exhaustive list of medical terms frequently used by the medical and legal community when addressing cranial injuries or SBS/SIS is found at Appendix A.

In addition to being intimately familiar with the medical terms associated with these types of cases, the following hypothetical may also help the practitioner understand the information presented in this article:

Hypothetical: A Soldier presents his near comatose infant child at the emergency room. A computer tomography scan reveals a large subacute subdural hematoma. The child is placed on a respirator but dies two weeks later. A subsequent autopsy reveals diffuse axonal injury. There is nothing in the autopsy to suggest that the child suffered any form of recent blunt force trauma (i.e., no current contusions or external bleeding).

⁵ See *United States v. Buber*, No. 20000777 (Army Ct. Crim. App. Jan. 12, 2005) (unpublished) (finding father guilty of unpremeditated murder of his son by means of SBS; murder conviction overturned due to insufficient evidence); *United States v. Bresnahan*, 62 M.J. 137 (2005) (finding father guilty of involuntary manslaughter of his infant son by means of SBS); *United States v. Davis*, 53 M.J. 202 (2000) (finding father guilty of involuntary manslaughter of his daughter by means of SBS); *United States v. Wright*, No. 32089, 1998 CCA LEXIS 177 (A.F. Ct. Crim. App. Mar. 13, 1998) (unpublished) (finding mother guilty of negligent homicide of her infant son by means of SBS). Interestingly, in the *Bresnahan* case, the court allowed the trial counsel to question the defense's expert witness concerning two studies: one claiming that seventy-nine percent of SBS cases are perpetrated by males and another claiming that seventy percent of SBS cases are perpetrated by males. *Bresnahan*, 62 M.J. at 146.

⁶ John Plunkett, *Fatal Pediatric Head Injuries Caused by Short-Distance Falls*, 22 AM. J. FORENSIC MED. & PATHOLOGY 1 (2001).

⁷ *Id.*

⁸ See J.F. Geddes & John Plunkett, *The Evidence Base for Shaken Baby Syndrome*, 328 BRIT. MED. J. 719 (Mar. 27, 2004), available at <http://bmj.bmjournals.com/cgi/content/full/328/7442/719>.

The cause of death is cerebral edema. Because a subdural hematoma and diffuse axonal injury are found, the doctor concludes the infant was shaken to death. The father admits to briefly shaking the child one day prior to bringing him to the emergency room, but claims that he did not hit the child, nor did the child's head hit anything. The day the father shook the child is the same day he returned from being in the field for three weeks. Subsequent to the child's death, the child's sister admits that the week before she dropped the child in the porcelain bathtub while babysitting when "mommy was at work and daddy was in the field."

Should the government immediately file charges for unpremeditated murder or involuntary manslaughter against the Soldier in this case? The answer requires a close look at the available evidence.

III. Shaken Baby Syndrome/Shaken Impact Syndrome—What Is It?

*Guard well your baby's precious head; Shake, jerk and
slap it never; Lest you bruise his brain and twist his
mind; Or whiplash him dead forever.*⁹

Shaken Baby Syndrome/Shaken Impact Syndrome is generally defined as traumatic brain injury consisting of "a combination of subdural hematoma (brain hemorrhage), retinal hemorrhage, and diffuse axonal injury (diffuse injury of nerve cells in brain and/or spinal cord)"¹⁰ in infants and toddlers with little to no evidence of external cranial trauma, the effects of which cause death or significant physical injury.¹¹ Referred to within the medical community as the "triad of diagnostic criteria,"¹² medical practitioners who find at least two of these symptoms

⁹ Caffey, *Whiplash*, *supra* note 2, at 403 (quoting a proposed national educational campaign poem used by Dr. Caffey to close the referenced article).

¹⁰ Harold E. Buttram, Woodland Healing Research Center, *Shaken Baby/Impact Syndrome: Flawed Concepts and Misdiagnosis*, Sept. 3, 2002, <http://www.woodmed.com>.

¹¹ G.F. Gilliland & Robert Folberg, *Shaken Baby—Some Have No Impact Injuries*, 41 J. FORENSIC SCI. 114 (Jan. 1996).

¹² Buttram, *supra* note 10.

often conclude that the child has suffered intentional abuse as opposed to some form of accidental injury.¹³

IV. Shaken Baby Syndrome/Shaken Impact Syndrome—The Clash of the Experts

In recent years, the term battered baby has given way to the term shaken baby as a label for infants or young children who have apparently suffered inflicted injuries at the hands of parents, caregivers, or others. The assertion is broadly held by many physicians that the physical act of shaking an infant may, by itself, cause serious or fatal injuries but may be accompanied by impacts, referred to by some as the “shaken impact” syndrome Currently, there are wide differences of opinion regarding the supposed syndrome within the medical and legal communities.¹⁴

A. The Majority and Minority Views

There are generally two primary schools of thought concerning the degree and type of force needed to cause the above-mentioned injuries.¹⁵ The majority view believes shaking alone is sufficient to cause traumatic brain injury, whereas the minority view posits that shaking plus some form of cranial impact is required to cause traumatic brain injury.¹⁶ Military practitioners, however, should be aware that within the military justice system, the terms associated with each are sometimes used interchangeably despite their different implications.¹⁷ Such an

¹³ *Id.*

¹⁴ Jan Leestma, Case Analysis of Brain-Injured Admittedly Shaken Infants in 54 Cases, 1969–2001, 26 AM. J. FORENSIC MED. & PATHOLOGY 199 (Sept. 2005).

¹⁵ John Plunkett, *Letter to the Editor-Author’s Reply*, 101 AM. ACAD. PEDIATRICS 200 (Feb. 1998) (“The majority opinion (the specificity of retinal and subdural hemorrhage for inflicted trauma, non-lethality of short distance falls, and absence of lucid interval in ultimately fatal head injury) is certainly on their side. I wrote the article to encourage consideration of a minority view supported by biomechanical analysis and nontautologic reasoning.”).

¹⁶ *Id.*; Ronald Uscinski, *Shaken Baby Syndrome: Fundamental Questions*, 16 BRIT. J. NEUROSURGERY 217 (2002).

¹⁷ *See, e.g.*, United States v. Allen, 59 M.J. 515, 526 (2003) (noting government experts used both SBS and SIS as bases for their opinions—e.g., “Lastly, as for CPT Craig, she

oversimplification or generalization of an otherwise complex syndrome ignores the critical nuances of each view—nuances that may well determine the guilt or innocence of an accused.

1. *The Majority View—Shaking Alone*

The majority view holds that most adults possess sufficient strength to shake an infant or toddler to the point of causing intracranial injuries that can ultimately cause death or grievous bodily harm without any form of cranial impact or blunt force trauma.¹⁸ This view first gained a foothold within the medical community in 1974 when Dr. John Caffey postulated the “whiplash shaken baby syndrome” theory, stating that shaking alone could produce the forces sufficient to cause both subdural hematomas and retinal hemorrhages in small children.¹⁹ Dr. Caffey then took his theory one step further and opined that finding a subdural hematoma and retinal hemorrhages in an infant with no external signs of cranial trauma was pathognomonic²⁰ (i.e., absolutely and exclusively diagnostic) of child abuse.²¹

In order to support his theory, Dr. Caffey relied primarily on a 1968 biomechanical study conducted by Dr. Ayub Ommaya.²² In his study, Dr. Ommaya used primates strapped into a piston-activated rail chair to specifically simulate rear-end collision whiplash (i.e., no head impact)

too opined that CJ’s injuries were the direct result of shaken baby or shaken-impact syndrome.”).

¹⁸ Plunkett, *supra* note 15, at 200; Uscinski, *supra* note 16, at 217-18; Elaine W. Sharp, *The Elephant on the Moon*, WARRIOR MAG.-J. TRIAL LAW. C., Fall 2003, at 31 (“that another human being, by violently shaking a baby, can inflict one or more of the following injuries”).

¹⁹ Caffey, *Whiplash*, *supra* note 2, at 396.

²⁰ Mark Donohoe, *Shaken Baby Syndrome (SBS) and Non-Accidental Injuries (NAI)*, <http://www.whale.to/v/sbs.html> (last visited Sept. 11, 2006) (Dr. Donohoe states “The term pathognomonic implies a two-way relationship between the symptoms and signs on one hand, and the disease in question on the other hand. Pathognomonic symptoms or signs not only allow recognition of the disease, but differentiate it from all other diseases or disorders.”).

²¹ Caffey, *supra* note 2, at 397.

²² Ronald Uscinski, *The Shaken Baby Syndrome*, 9 J. AM. PHYSICIANS & SURGEONS 76 (Fall 2004); see Ayub K. Ommaya, *Whiplash Injury and Brain Damage: An Experimental Study*, 20 JAMA 285 (1968) (Dr. Ommaya’s tests were designed to determine what threshold or quantitative force (i.e., measurable amount of force) was necessary to cause certain types of internal brain injuries such as subdural hematomas.).

injuries.²³ Through this landmark study, Dr. Ommaya determined two things. First, he determined that when the primate's head was subjected to sufficient angular or rotational acceleration (e.g., whiplash) force, traumatic brain injury would occur regardless of whether or not skull impact occurred.²⁴ Second, he determined that traumatic brain injury, subdural hematomas, or diffuse axonal injury did not occur until the primate experienced approximately 155 gs²⁵ of acceleration force.²⁶ In other words, Dr. Ommaya "demonstrated the concept of an injury threshold for neural tissue."²⁷ In postulating his whiplash shaking theory, however, some experts argue that Dr. Caffey relied solely on Dr. Ommaya's finding that cranial injuries occurred without impact, while specifically ignoring the amount or degree of force Dr. Ommaya (i.e., 155 "g" forces) determined necessary to actually cause traumatic brain injury.²⁸

²³ Ommaya, *supra* note 22, at 285-86.

²⁴ *Id.*

²⁵ "The term g force or gee force refers to the symbol *g*, the force of acceleration due to gravity at the earth's surface" Wikipedia, The Free Encyclopedia, Acceleration Due to Gravity, <http://www.factbook.org/wikipedia/en/g/ge/gee.html> (last visited Sept. 11, 2006) ("The acceleration due to gravity denoted *g* (also *gee*) is a non-SI unit of acceleration defined as exactly 9.80665 m/s⁻² or 9.80665 m/s^{^2} (almost exactly 32.174 ft-s⁻²).") *Id.* (Gravity due to the earth is experienced the same as being accelerated upward with an acceleration of 1 g. The total g-force is found by vector addition of the opposite of the actual acceleration (in the sense of rate of change of velocity) and a vector of 1 g downward for the ordinary gravity (or in space, the gravity there.)) *Id.*

²⁶ Werner Goldsmith & John Plunkett, *A Biomechanical Analysis of the Causes of Traumatic Brain Injury in Infants and Children*, 25 AM. J. FORENSIC MED. & PATHOLOGY 89, 91 (June 2004) (stating that Dr. Ommaya measured force in units of angular acceleration using the formula radians per second-per second. Goldsmith and Plunkett convert this measurement to "g" forces which, arguably, is more recognizable by both legal practitioners and juries.).

²⁷ Uscinski, *supra* note 22, at 76-7.

²⁸ Faris Bandak, *Shaken Baby Syndrome: A Biomechanics Analysis of Injury Mechanisms*, 151 FORENSIC SCI. INT'L 71, 76 (2005) ("Caffey translated Ommaya's results without considering injury biomechanics, into an explanation for a confession of shaking."); Sharp, *supra* note 18, at 35.

Caffey concluded that just as acceleration-deceleration without an impact (i.e., free shaking or 'whiplash') damaged the monkeys' brains, this also explained how parents inflicted brain injuries on their babies. [Caffey] actually telephoned Ommaya to thank him for the article. Today, Ommaya is adamant that he told Caffey that acceleration-deceleration forces involved in the monkey experiment were much greater than he believed could be generated by a human.

Id.

For roughly the next fifteen years, Dr. Caffey's shaking-alone theory circulated through both the medical and legal communities and went virtually unchecked without the benefit of any significant peer review.²⁹ As a result, Dr. Caffey's theory became firmly ingrained as an accepted medical syndrome.³⁰

2. *The Minority View—Shaking Plus Impact*

It was not until approximately 1987 that the first skeptics began questioning the accuracy of Dr. Caffey's study and his theory.³¹ One of the first to question Dr. Caffey's theory was Dr. Ann-Christine Duhaime who observed that "[w]hile the term 'shaken baby syndrome' has become well entrenched in the literature of child abuse, it is characteristic of the syndrome that a history of shaking in such cases is lacking."³² As a result of her observation, Dr. Duhaime conducted a biomechanical study to determine whether an adult could, by means of shaking alone, exert sufficient force to produce traumatic brain injury in

²⁹ Sharp, *supra* note 18, at 35.

³⁰ Uscinski, *supra* note 22, at 76 ("Two further papers by Caffey over the next two years emphasized shaking as a means of inflicting intracranial bleeding in children. After publication of these papers, shaken baby syndrome became widely accepted as a clinical diagnosis for inflicted head injury in infants."); Letter from John Plunkett, M.D., forensic pathologist, Regina Medical Facility, to American Journal of Forensic Medicine and Pathology, *Shaken Baby Syndrome and Other Mysteries* (Spring 1998) (on file with author) [hereinafter Plunkett Letter].

I suspect that Caffey and others evaluating head injuries in the '40s, '50s and '60s asked a number of caretakers if the infant had been 'shaken' and were told 'yes' in at least some cases. The caretakers were never asked about an 'impact' because direct trauma was not part of the theory. Scientific theory was quickly accepted as scientific fact: Subdural hemorrhage and retinal hemorrhage in an unconscious or dead child is a shaken infant; there is no need to 'prove otherwise,' only a fall from a two story building or a motor vehicle accident could cause such an injury, if it was not due to shaking. Studies critically evaluating the biomechanics of rotational brain injury and a subdural hematoma, available from experiments performed for (among others) the automotive industry and the space program, were forgotten, not sought or ignored.

Id.

³¹ Duhaime et al., *supra* note 3, at 409, 414.

³² *Id.* at 409.

infants.³³ Using infant models, Dr. Duhaime and her team subjected proportionately correct models to a series of shaking events, some of which were followed by an impact.³⁴ Using Dr. Ommaya's 155 gs as the threshold for when traumatic brain injuries (e.g., subdural hematoma, retinal hemorrhages, diffuse axonal injury) manifest themselves, Dr. Duhaime observed that shaking alone produced at most only 9.3 gs³⁵ of force, a mere fraction of the force Dr. Ommaya determined was required to cause subdural hematomas, retinal hemorrhages, or diffuse axonal injury. However, when the "shakers" were asked to create an impact by "slamming" the models' heads into a fixed object, Dr. Duhaime observed that the force produced was equivalent to almost 428 gs, an increase fifty-times greater than that of shaking alone.³⁶ As a direct result, Dr. Duhaime and her team concluded that "severe head injuries commonly diagnosed as shaking injuries require impact to occur and that shaking alone in an otherwise normal baby is unlikely to cause the shaken baby syndrome."³⁷ As a result of this questioning, the minority view—the shaken-impact syndrome—emerged.³⁸

³³ *Id.*

³⁴ *Id.* at 409-11.

³⁵ *Id.* at 413.

³⁶ *Id.* at 413.

³⁷ *Id.* at 409.

It is our conclusion that the shaken baby syndrome, at least in its most severe acute form, is not usually caused by shaking alone. Although shaking may in fact be part of the process, it is more likely that such infants suffer blunt impact. The most common scenario may be a child who is shaken, then thrown into or against a crib or other surface, striking the back of the head and thus undergoing a large, brief deceleration. This child has both types of injuries-impact with its resulting focal damage, and severe acceleration-deceleration effects associated with impact causing shearing effects on the vessels and parenchyma.

Id. at 414.

³⁸ Ann-Christine Duhaime, et al., *Nonaccidental Head Injury in Infants-The "Shaken Baby Syndrome,"* 338 NEW ENG. J. MED. 1822 (1998) ("Thus, the term 'shaking-impact syndrome' may reflect more accurately than 'shaken-baby syndrome' the usual mechanism responsible for these injuries.").

B. The Emerging View—Shaking Without a Corresponding Neck Injury Proves Shaking Plus Impact

In recent years, numerous published medical studies have strongly supported the minority position.³⁹ In 2002, Dr. Ommaya published an article postulating that if it were possible for an infant to suffer traumatic brain injury by shaking alone, the infant would also suffer a significant corresponding neck injury.⁴⁰ He further concluded that the “[a]bsence of cervical spinal cord injury would indicate a component of impact in the presence of hemorrhagic brain lesions.”⁴¹ In February 2005, Dr. Bandak, using Dr. Ommaya’s injury threshold criteria, postulated that if an infant was shaken hard enough to cause traumatic brain injury, the infant would almost certainly have some form of significant neck injury.⁴² Or to put it plainly, absent a corresponding neck injury, the child was not shaken to the point of traumatic brain injury.⁴³

C. Why Practitioners Should Know the Divergent Views

Practitioners should be aware of the minority and emerging views for two primary reasons. First, an understanding of the medical literature in this area will assist practitioners in effectively questioning witnesses. Second, understanding the minority or emerging views may assist defense counsel in making a motion to request expert assistance, to disqualify a proffered government witness from being considered an expert, or to challenge the scientific basis upon which an alleged expert is relying.⁴⁴

³⁹ See Leestma, *supra* note 14; Bandak, *supra* note 28; Ayub Ommaya, Werner Goldsmith, & L. Thibault, *Biomechanics and Neuropathology of Adult and Pediatric Head Injury*, 16 BRIT. J. NEUROSURGERY 220 (2002).

⁴⁰ Ommaya et al., *supra* note 39, at 220-21.

⁴¹ *Id.* at 228-29 (“At these levels of inertial loading, induced impulsively without contact, the neck torque in the infant would cause severe injury to the high cervical cord and spine long before the onset of cerebral concussion.”).

⁴² Bandak, *supra* note 28, at 71 (“We have determined that an infant head subjected to the levels of rotational velocity and acceleration called for in the SBS literature, would experience forces on the infant neck far exceeding the limits for structural failure of the cervical spine.”).

⁴³ *Id.*

⁴⁴ See MANUAL FOR COURTS-MARTIAL, UNITED STATES, R.C.M. 703(d) (2005) [hereinafter MCM]; MANUAL FOR COURTS-MARTIAL, UNITED STATES, MIL. R. EVID. 702 (2002); see also *Daubert v. Merrell Dow Pharms.*, 509 U.S. 579 (1993); *United States v. Warner*, 62 M.J. 114 (2005); *United States v. Houser*, 36 M.J. 392 (C.M.A. 1993). These resources are the starting point for seeking expert assistance or expert witness testimony.

V. Types of Injuries Caused by SBS/SIS

Experts differ regarding the degree and type of force (i.e., shaking alone or shaking plus impact) necessary to trigger traumatic brain injury.⁴⁵ Regardless of their biases concerning injury thresholds, however, most experts agree on the types of injuries shaking or impact can inflict. These injuries are generally broken down into the following two categories: primary injuries and secondary injuries.⁴⁶

Primary cranial injuries consist of subdural hematomas, epidural hematomas, subarachnoid hemorrhage, retinal hemorrhages, and diffuse axonal injury.⁴⁷ In cases involving cranial impact, the following injuries may also be present: external scalp bruising under the point of impact, extravasted blood under the point of impact (i.e., blood within the epidural layer (scalp)), skull fracture(s), coup contusions (i.e., bruising or injury beneath the site of impact), and contra-coup contusions (i.e., bruising or injury directly opposite the impact).⁴⁸ Secondary injuries consist of brain hypoxia (i.e., insufficient oxygen flow to the brain), brain ischemia (i.e., insufficient blood flow to the brain), and cerebral edema (i.e., swelling of the brain).⁴⁹ With the exception of diffuse axonal injury, the primary injuries listed above usually do not cause death.⁵⁰ A significant primary injury, however, may trigger a secondary injury (e.g., such as cerebral edema), which *can* cause death.⁵¹

“Primary injury occurs at the time of impact, either by a direct injury to the brain parenchyma or by an injury to the long white matter tracts through acceleration-deceleration forces The secondary injury is represented by systemic and intracranial events that occur in response to the primary injury and further contribute to neuronal damage and cell death.”⁵² Put another way, a primary injury is the injury that is caused by or directly results from the act inflicting the trauma, whereas a secondary injury is the injury that results from or is the byproduct of the primary

⁴⁵ See Leestma, *supra* note 14; Plunkett, *supra* note 15; Uscinski, *supra* note 22; Goldsmith & Plunkett, *supra* note 26; Bandak, *supra* note 28.

⁴⁶ Lieutenant Colonel Kent Hymel, *Abusive Head Trauma? A Biomechanics-Based Approach*, 3 CHILD MALTREATMENT 116-17 (May 1998).

⁴⁷ *Id.*

⁴⁸ *Id.* at 117, 119; *see also infra* app. A.

⁴⁹ Bandak, *supra* note 28, at 79; *see also infra* app. A.

⁵⁰ Wilkins, *supra* note 1, at 394.

⁵¹ Hymel, *supra* note 46, at 118.

⁵² Arabela Stock, Emedicine-Access to the Minds of Medicine, *Head Trauma* (Sept. 15, 2004), <http://www.emedicine.com/ped/topic929.htm>.

injury. Consider the following example: Joe is punched in the face and his jaw is broken. As a result, Joe's mouth swells up and blocks his airway. The broken jaw is the primary injury which, in turn, caused the secondary injury of the blocked airway.

VI. Why the Lesson in Primary and Secondary Injuries?

The legal practitioner must be able to recognize and distinguish primary versus secondary injuries for two important reasons. First, primary injuries can be linked to their biomechanical origins (i.e., their direct causes),⁵³ whereas secondary injuries generally cannot.⁵⁴ Thus, certain injuries are indicative of specific acts, such as an epidural hemorrhage being specifically indicative of an impact.⁵⁵ A secondary injury, however, may have many different causes and is not indicative of any specific, telltale act, origin, or cause.⁵⁶ For example, cerebral edema is a secondary injury. Cerebral edema can occur with blunt force trauma, with whiplash, because a large subdural hematoma displaces the brain cutting off oxygen and causing it to swell, or from extended attachment to or reliance upon a respirator.⁵⁷ None of these examples, however, indicate the specific act or incident that caused the primary injury which, in turn, triggered the cerebral edema (the secondary injury).

Second, in addition to identifying the cause of the injury, primary injuries can, to a certain degree, often be used to date or time stamp when an injury occurred.⁵⁸

A subdural hematoma (SDH) is classified by the amount of time that has elapsed from the inciting event, if

⁵³ Ayub Ommaya, *Head Injury Mechanisms and the Concept of Preventive Management*, 12 J. NEUROTRAUMA, 527-28 (1995); Bandak, *supra* note 28, at 72.

⁵⁴ Bandak, *supra* note 28, at 72 ("Primary injuries are those caused directly by the mechanical insult and secondary injuries result as part of the pathophysiological progression following primary injury.").

⁵⁵ Telephone Interview with John M. Plunkett, Forensic Pathologist and Coroner, Regina Medical Facility (Dec. 4, 2005) [hereinafter Plunkett Telephone Interview].

⁵⁶ Bandak, *supra* note 28, at 72, 78-9.

⁵⁷ SBSDefense.com, "Shaken Baby Syndrome"- A Tutorial and Review of the Literature, http://www.sbsdefense.com/SBS_101.htm (last visited Sept. 12, 2006) [hereinafter SBSDefense.com] (noting that some experts claim prolonged use of a respirator can mask or mimic the finding of diffuse axonal injury).

⁵⁸ Grant Sinson & Tim Reiter, Emedicine, *Subdural Hematomas*, Jan. 12, 2002, <http://www.emedicine.com/med/topic2885.htm>.

known, to the diagnosis. When the inciting event is unknown, the appearance of the hematoma on [computed tomography or CT] scan or [magnetic resonance imaging or MRI] can help date the hematoma. Acute SDHs are less than 72 hours old and are hyperdense compared to the brain on CT scan. Subacute SDHs are 3-20 days old and are isodense or hypodense compared to the brain. Chronic SDHs are older than 20 days and are hypodense compared to the brain.⁵⁹

VII. Putting It All Together

Should the Soldier in the hypothetical be charged with the death of the child? When the medical evidence is applied to the facts, perhaps not. First, the child taken to the emergency room showed no current signs of cranial impact or neck injury. An expert subscribing to the minority or emerging view would likely state that the child was not shaken to the point of traumatic brain injury. One must also remember that several experts are of the opinion that prolonged use of a respirator can either mimic diffuse axonal injury or mask or taint a finding of diffuse axonal injury.⁶⁰ As such, a strong argument can be made that because of the respirator, the diffuse axonal injury is not conclusive (i.e., pathognomonic) of either the drop in the tub or the shaking.⁶¹ Thus, the diffuse axonal injury cannot indicate anything other than that the child's brain suffered some form of injury.⁶² Most experts, however, will agree as to the timing of a subdural hematoma.⁶³ In this hypothetical, the doctor concluded that the subdural hematoma was subacute, meaning between three and twenty days old.⁶⁴ Thus, since the father was in the field during this period, the evidence tends to suggest that the drop in the tub caused the fatal injury instead of the father's shaking of the child.

There is much more investigation and evidence collection that must occur, however, before a charging decision can be made in the above

⁵⁹ *Id.*

⁶⁰ SBSDefense.com, *supra* note 57.

⁶¹ Sharp, *supra* note 18, at 38 ("It's critical to note that in forensic medicine, the finding of axonal pathology is 'non-specific,' meaning that one cannot infer anything about its origin or cause.").

⁶² *See id.*

⁶³ Sinson & Reiter, *supra* note 58.

⁶⁴ *Id.*

hypothetical. For example, was the child displaying symptoms of a serious injury, such as lethargy or vomiting, after the drop in the tub? Based upon the above information, the practitioner should now be generally familiar with the signs to look for, questions to ask, evidence to collect, and issues to resolve before charging the Soldier with murder.

As can be seen from the hypothetical, understanding these nuances is essential to preparing a SBS/SIS case. Doing so allows the practitioner to critically review and challenge the purported experts' conclusions concerning both the causation of an injury and its respective timing. In addition, appreciating the differences between primary and secondary injuries and their respective timing will aid either the defense counsel in corroborating his client's version of the facts or the trial counsel in ascertaining the actual sequence of events.

VIII. Expert Assistance or Expert Consultation for the Defense

A. Acquiring Expert Assistance

Due to the medical complexities inherent in any case where SBS/SIS is alleged, both trial and defense counsel should consider retaining an expert consultant for "evaluating, identifying, and developing evidence" and "to test and challenge" the opposing party's case.⁶⁵ Further, because traumatic brain injuries can manifest themselves differently in children than in adults,⁶⁶ counsel should pursue the assistance of highly-

⁶⁵ United States v. Warner, 62 M.J. 114, 118 (2005).

One important role of expert consultants is to help counsel develop evidence. Even if the defense-requested expert consultant would not have become an expert witness, he would have assisted the defense in evaluating, identifying, and developing evidence. Another important function of defense experts is to test and challenge the Government's case.

Id.

⁶⁶ Due to the developing nature of children's brains and skulls, a head injury can manifest itself differently in a child when compared to the brain and skull of an adult. Also, practitioners should appreciate the differences between highly-specialized physicians and general practitioners. For example, a pediatrician is typically trained only to diagnosis and treat a child's injury. A forensic pediatrician, however, is trained to diagnose and treat the injury and to assess and determine the underlying causation and mechanics of the injury. Further, whereas a radiologist will have some basic knowledge of how to interpret a child's MRI or CT scan, a neuro-pediatric radiologist will have

specialized experts as opposed to generalists.⁶⁷ For example, counsel should consider using a forensic pediatrician instead of a general pediatrician or using a pediatric-neuro radiologist in lieu of a general radiologist.⁶⁸

For defense counsel, however, acquiring a government-funded expert consultant, much less a highly-specialized expert consultant, can be difficult and burdensome. The defense is not entitled to a government-funded expert consultant by merely “noting that the prosecution has employed expert assistance to prepare its case.”⁶⁹ Rather, as held by the Court of Military Appeals in *United States v. Robinson*, the “Equal Protection Clause, the Due Process Clause, and the Manual for Courts-Martial provide that servicemembers are entitled to expert assistance when necessary for an adequate defense.”⁷⁰ In elaborating on this entitlement, the Court of Appeals for the Armed Forces (CAAF) in *United States v. Bresnahan* stated:

An accused is entitled to an expert’s assistance before trial to aid in the preparation of his defense upon a demonstration of *necessity*. But necessity requires more than the mere possibility of assistance from a requested expert. The accused must show that a reasonable probability exists both that an expert would be of assistance to the defense and that denial of expert assistance would result in a fundamentally unfair trial.⁷¹

As the court stated in *Gonzalez*, “There are three aspects to showing necessity. First, why the expert assistance is needed. Second, what would the expert assistance accomplish for the accused. Third, why is the defense counsel unable to gather and present the evidence that the

specific, detailed training on neural imaging diagnostics in children and will be significantly better suited to interpreting an MRI or CT scan involving a child’s brain or head. See Plunkett Telephone Interview, *supra* note 55.

⁶⁷ See *United States v. McAllister*, 55 M.J. 270, 275 (2001) (noting that “[w]ith the growth of forensic-science techniques, it has become increasingly apparent that complex cases require more than generalized practitioners.”); see also *Warner*, 62 M.J. at 114 (discussing, among other things, the value of a specialist as opposed to a generalist).

⁶⁸ Plunkett Telephone Interview, *supra* notes 55, 66.

⁶⁹ *United States v. Washington*, 46 M.J. 477, 480 (1997).

⁷⁰ *United States v. Robinson*, 39 M.J. 88, 89 (C.M.A. 1989).

⁷¹ *United States v. Bresnahan*, 62 M.J. 137, 143 (2005) (emphasis added).

expert assistant would be able to develop.”⁷² When requesting expert assistance and in meeting this necessity test, counsel should, at a minimum, specifically address the following factors set forth by the court in *Allen*:

In particular, the defense must show what it expects to find, how and why the defense counsel and staff cannot do it, how cross-examination will be less effective without the services of the expert, how the alleged information would affect the government’s ability to prove guilt, what the nature of the prosecution’s case is, including the nature of the crime and the evidence linking him to the crime, and how the requested expert would otherwise be useful.⁷³

Within the realm of SBS/SIS, a defense counsel attempting to meet the necessity test outlined above could, by way of example, argue that expert assistance is needed to understand or rebut an autopsy report, to determine whether the medical evidence supports the medical examiner’s findings and conclusions, or to adequately evaluate medical records that the defense has neither the experience nor the expertise to properly assess.

A defense request for government-funded expert assistance should first be submitted to the convening authority and, at a minimum, should include a “complete statement of reasons why employment of the expert is necessary.”⁷⁴ Rule for Courts-Martial 703(d) does not specifically require the request to demonstrate how or why counsel feels the “necessity test” outlined in *Gonzalez* and *Allen*⁷⁵ has been met. It is good practice, however, to draft any request as if it was going before the court since “a request denied by the convening authority may then be renewed before the military judge who shall determine whether the assistance of the expert is necessary and, if so, whether the Government has provided or will provide an adequate substitute.”⁷⁶ Accordingly, tactical

⁷² *United States v. Gonzalez*, 39 M.J. 459, 461 (1994) (citing *United States v. Allen*, 31 M.J. 572, 623 (N.M.C.M.R.), *aff’d*, 33 M.J. 209 (C.M.A. 1991)).

⁷³ *United States v. Allen*, 31 M.J. 572, 623-24 (N.M.C.M.R.), *aff’d*, 33 M.J. 209 (C.M.A. 1991); MCM, *supra* note 44, R.C.M. 703(d).

⁷⁴ MCM, *supra* note 44, R.C.M. 703(d).

⁷⁵ *Gonzalez*, 39 M.J. at 461; *Allen*, 31 M.J. at 623-24.

⁷⁶ *United States v. Ndanyi*, 45 M.J. 315, 320 (1996) (citing MCM, *supra* note 44, R.C.M. 703(d)).

considerations notwithstanding, counsel should put forth his best necessity argument from the very beginning. Doing so should not jeopardize the defense theory of the case since communications between a lawyer and any expert consultant assigned to assist counsel in both preparing for trial or during trial are considered protected.⁷⁷

B. The Dreaded “Adequate Substitute” Rule—Not So Dreaded Anymore!

A “request for the services of a consultant differs from a request that a specific expert witness be produced for the defense” because the defense “has no right to demand that a particular individual be designated.”⁷⁸ That is, if the convening authority or court agrees that expert assistance is necessary for the defense, the Government may deny the specific requested expert “if [the government] provides an adequate substitute.”⁷⁹

The “Government in general, and . . . trial counsel in particular, . . . play key roles” in selecting and proffering an adequate substitute.⁸⁰ Thus, it is the government and not the defense who, for all intents and purposes, selects the adequate substitute. This “absence of . . . parity opens the military justice system to abuse” by providing the government an opportunity to “obtain an expert vastly superior to the defense’s.”⁸¹

United States v. Warner, a recent SBS/SIS case, dealt directly with this disparity issue.⁸² In *Warner*, the government secured the assistance of “one of the Air Force’s preeminent experts concerning shaken baby syndrome as its own witness.”⁸³ Both the convening authority and the military judge, however, denied the defense’s request for the appointment of a specific civilian expert consultant whom the defense

⁷⁷ MCM, *supra* note 44, MIL. R. EVID. 502; *see infra* pt. IX, § A.

⁷⁸ *United States v. Tornowski*, 29 M.J. 578, 579 (A.F.C.M.R. 1989) (citing *Ake v. Oklahoma*, 470 U.S. 68, 83 (1985) (holding a criminal defendant’s right to a competent psychiatrist does not include “a constitutional right to choose a psychiatrist of his own personal liking”)).

⁷⁹ *United States v. Warner*, 62 M.J. 114, 118 (2005) (quoting *United States v. Ford*, 51 M.J. 445, 455 (1999) (citing MCM, *supra* note 44, R.C.M. 703(d)).

⁸⁰ *Id.* at 120.

⁸¹ *Id.*

⁸² *Id.* at 114.

⁸³ *Id.* at 118.

felt had the requisite qualifications.⁸⁴ In his stead, the government proffered and the military judge appointed an alleged adequate substitute who, according to the defense, had some knowledge of SBS, but vastly inferior qualifications when compared to those of the government expert.⁸⁵

Agreeing with the defense, the CAAF found that the appointed adequate substitute was a “generalist with no apparent expertise” in the area of SBS, whereas the government had secured the “leading shaken baby expert for the prosecution team.”⁸⁶ The government, however, argued it had met its due process obligation of providing an adequate substitute, asserting that all it is required to provide the defense is a competent, not “comparable,” expert.⁸⁷

Disagreeing with the government, the CAAF noted that while “[p]roviding the defense with a ‘competent’ expert satisfies the Government’s due process obligations . . .”, doing so, however, “may nevertheless be insufficient to satisfy Article 46 if the Government’s expert concerning the same subject matter area has vastly superior qualifications”⁸⁸ Relying on the plain wording of Article 46 of the Uniform Code of Military Justice (UCMJ),⁸⁹ the court went on to hold “Article 46 requires that an ‘adequate substitute’ . . . have qualifications reasonably similar to those of the Government’s expert”⁹⁰

Although the court did not define what it meant by “reasonably similar” qualifications, it did offer some parameters counsel should consider when seeking a comparable expert. Specifically, the court noted:

Article 46 is a clear statement of congressional intent against Government exploitation of its opportunity to obtain an expert vastly superior to the defense’s. Requiring that an “adequate substitute” for a defense

⁸⁴ *Id.* at 117.

⁸⁵ *Id.*

⁸⁶ *Id.* at 117-18.

⁸⁷ *Id.* at 119.

⁸⁸ *Id.*

⁸⁹ *Id.* at 115 (citing UCMJ art. 46 (2005), which states in part “trial counsel, defense counsel, and the court-martial shall have equal opportunity to obtain witnesses and other evidence”).

⁹⁰ *Id.* at 119.

requested expert have professional qualifications at least reasonably comparable to those of the Government's expert is a means to carry out that intent where the defense seeks an expert dealing with subject matter similar to a Government expert's area of expertise and where the defense expert is otherwise adequate for the requested purpose.⁹¹

The CAAF's holding in *Warner* is a shot across the bow for any trial counsel or military judge who attempts to leave the "defense without the adequate tools to analyze and possibly challenge or rebut the opinion" of a government expert.⁹² Accordingly, when submitting a request for expert assistance, defense counsel, in addition to addressing the *Gonzalez* necessity test,⁹³ should consider explaining why their requested expert has "reasonably comparable qualifications" when compared to the government expert. Providing this explanation may secure the services of the requested expert instead of a government selected adequate substitute. At a minimum, by including a "reasonably comparable qualifications" argument in the initial request for expert assistance, counsel may convince either the convening authority or the military judge that only a specialist, as opposed to a generalist, will suffice as an adequate substitute.⁹⁴

IX. Expert Witnesses

As this article has demonstrated, complex medical evidence is an indispensable part of litigating a SBS/SIS case. Accordingly, the use of an expert witness at trial may assist counsel in explaining or presenting these complexities to the fact-finder or, for the defense, in presenting an alternate theory of the case. When acquiring and using expert witnesses, counsel should consider the following two important issues: how to request an expert witness and how to introduce testimony from that expert witness.

⁹¹ *Id.* at 120.

⁹² *See id.* at 123.

⁹³ *United States v. Gonzalez*, 39 M.J. 459, 461 (1994).

⁹⁴ *United States v. Warner*, 62 M.J. 114, 118-19 (2005).

A. Acquiring Expert Witnesses

The methodology for requesting an expert witness is virtually identical to requesting an expert consultant. There are, however, two critical distinctions worth noting. First, as with an expert consultant, the government has the opportunity to offer an “adequate substitute” for the defense requested expert witness.⁹⁵ In doing so, however, the proffered “adequate substitute” must not only have “similar professional qualifications” as that of the requested expert, but must also be able “to testify to the same conclusions and opinions” as the defense requested expert.⁹⁶ “[W]here there are divergent scientific views, the Government cannot select a witness whose views are very favorable to its position and then claim that this same witness is ‘an adequate substitute’ for a defense-requested expert of a different viewpoint.”⁹⁷ Second, unlike an expert consultant, there is no privileged or protected communication between counsel and their expert witness,⁹⁸ meaning an expert witness is subject to interview and cross-examination by the opposing counsel.⁹⁹

B. Introducing the Testimony of Expert Witnesses

Prior to an expert being permitted to testify, the judge must be satisfied that the testimony is both relevant and reliable to the proceedings. There are numerous Military Rules of Evidence (MRE) to consider when determining relevance and reliability.

The primary rules governing the relevance and reliability of expert witnesses are Military Rules of Evidence (MRE) 104, 401, 402, 403, 702, 703, and 704. MRE 401 defines relevant evidence, MRE 402 states that relevant evidence is admissible, and MRE 403 establishes the test for balancing the probative value of

⁹⁵ United States v. Guitard, 28 M.J. 952-53 (N.M.C.M.R. 1989).

⁹⁶ *Id.* at 954 (citing United States v. Robinson, 24 M.J. 649, 652 (C.M.A. 1989) (citing Ake v. Oklahoma, 470 U.S. 68 (1985))).

⁹⁷ United States v. Van Horn, 26 M.J. 434, 439 (N.M.C.M.R. 1988); *see also* Major Christopher Behan, *Expert Testimony & Expert Assistance*, in THE JUDGE ADVOCATE GENERAL'S SCHOOL, 54TH GRADUATE COURSE CRIMINAL LAW DESKBOOK A-21 (2005) (citing United States v. Robinson, 24 M.J. 649, 652 (N.M.C.M.R. 1987) and United States v. Van Horn, 26 M.J. 434 (N.M.C.M.R. 1988)).

⁹⁸ United States v. True, 28 M.J. 487-88 (C.M.A. 1989).

⁹⁹ *Id.* at 488-89; *see also* United States v. McAllister, 55 M.J. 270, 273 (2001).

evidence against its prejudicial impact. MRE 702 has three requirements for expert testimony: 1) the testimony must be based upon sufficient facts or data; 2) the testimony must be the product of reliable principles and methods; and 3) the expert must have applied the principles and methods reliably to the facts of the case. MRE 703 discusses the basis for an expert's testimony and MRE 704 establishes the scope of the testimony.¹⁰⁰

The thrust of any expert analysis, however, is the second or reliability prong of MRE 702. When determining if the proffered testimony is the product of reliable scientific principles and methods, counsel must validate the expert's qualifications by establishing the following six factors from *United States v. Houser*:

(1) the qualifications of the expert; (2) the subject matter of the expert testimony; (3) the basis for the expert testimony; (4) the legal relevance of the evidence; (5) the reliability of the evidence; and (6) that the probative value of the expert's testimony outweighs the other considerations outlined in M.R.E. 403.¹⁰¹

Concerning the first *Houser* factor, MRE 702 specifically states that an expert may be qualified by his or her "knowledge, skill, experience, training, or education,"¹⁰² allowing a person to qualify as an expert under numerous foundational bases (e.g., work experience, professional memberships, publications).¹⁰³ The key to the second *Houser* factor—the subject matter of the expert testimony—"is whether or not the testimony would assist or be helpful to the fact finder."¹⁰⁴ The third *Houser* factor "concerns itself with the expert's methods as applied to the facts of the case."¹⁰⁵ That is, the expert must have an adequate basis (e.g., "is this the type of information that other experts in the field rely on," etc.) to render an opinion, as opposed to "just a bare opinion with no

¹⁰⁰ Major Christopher Behan, *Determining Admissibility of Expert Testimony* (2005) (working paper on file with Criminal Law Department, The Judge Advocate General's School and Legal Center).

¹⁰¹ *United States v. Billings*, 61 M.J. 163, 166 (2005) (citing *United States v. Houser*, 36 M.J. 392, 397-00 (C.M.A. 1993)).

¹⁰² MCM, *supra* note 44, MIL. R. EVID. 702.

¹⁰³ *See* Behan, *supra* note 100.

¹⁰⁴ *Id.*

¹⁰⁵ *Id.*

relationship to the facts of the case.”¹⁰⁶ With regard to the fourth *Houser* factor, “before expert testimony is admitted, the military judge must determine that the evidence is relevant . . . to the case at hand.”¹⁰⁷ In other words, the evidence “must have a connection to the theory of the case.”¹⁰⁸

The fifth *Houser* factor requires the military judge to conduct a reliability analysis to determine if the expert’s “testimony is the product of reliable principles and methods.”¹⁰⁹ The reliability analysis is contingent on the type of expert proffered—nonscientific¹¹⁰ or scientific. The Supreme Court in *United States v. Daubert* provided the following nonexclusive list of factors the judge should consider when evaluating the reliability of scientific evidence:¹¹¹

(1) whether the theory or technique can be or has been tested; (2) whether the theory or technique has been subjected to peer review and publication; (3) the known or potential rate of error in using a particular scientific technique and the standards controlling the technique’s operation; and (4) whether the theory or technique has been generally accepted in the scientific field.¹¹²

As noted, these factors are nonexclusive.¹¹³ The military judge, as the “gatekeeper” of the evidence, has a great deal of discretion in

¹⁰⁶ *Id.*

¹⁰⁷ *Id.*

¹⁰⁸ *Id.*

¹⁰⁹ MCM, *supra* note 44, R.C.M. 702.

¹¹⁰ *Kumho Tire v. Carmichael*, 526 U.S. 137 (1999).

Daubert’s general holding—setting forth the trial judge’s general “gatekeeping” obligation—applies not only to testimony based on “scientific knowledge,” but also to testimony based on “technical” and “other specialized” knowledge. We also conclude that a trial court may consider one or more of the more specific factors that *Daubert* mentioned when doing so will help determine that testimony’s reliability. But, as the Court stated in *Daubert*, the test of reliability is “flexible,” and *Daubert*’s list of specific factors neither necessarily nor exclusively applies to all experts or in every case.

Id. at 141.

¹¹¹ *Daubert v. Merrell Dow Pharms. Inc.*, 509 U.S. 579 (1993).

¹¹² *United States v. Billings*, 61 M.J. 163, 168 (2005).

¹¹³ *Daubert*, 509 U.S. at 593.

conducting the reliability analysis and can generally use any factor that will help determine the expert's reliability.¹¹⁴ This broad discretion may help those counsel seeking to introduce expert testimony, while hindering those counsel seeking to exclude testimony.

The sixth and last *Houser* factor states that “[l]ogically relevant and reliable expert testimony ‘may be excluded if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the members.’”¹¹⁵ A deceptively simple argument, counsel seeking to exclude damaging expert testimony should not dismiss or overlook this factor.

X. Using MRE 702 and *Daubert* to Question the “Reliability” of the Scientific Evidence Upon which SBS/SIS is Premised

*If the law has made you a witness, remain a man of science. You have no victim to avenge, no guilty or innocent person to ruin or save. You must bear witness within the limits of science.*¹¹⁶

As amended, MRE 702 requires “expert testimony be the product of reliable principles and methods that are reliably applied to the facts of the case.”¹¹⁷ To determine the reliability of the proffered testimony, the “[C]ourt in *Daubert* set forth a non-exclusive checklist for trial courts to use in assessing the reliability of scientific expert testimony.”¹¹⁸ Thus, in an SBS case, the question for the court is whether or not the majority view of SBS is based upon reliable scientific principles and means.

Recent military caselaw seems to support the majority view of SBS.¹¹⁹ Consider, for example, the CAAF's recent assertion in *United*

¹¹⁴ See *supra* text accompanying note 110.

¹¹⁵ *United States v. Houser*, 36 M.J. 392, 400 (C.M.A. 1993) (citing MCM, *supra* note 44, MIL. R. EVID. 403).

¹¹⁶ John Plunkett, *Shaken Baby Syndrome and the Death of Matthew Eappen*, 20 AM. J. FORENSIC MED. & PATHOLOGY 17 (1999) (quoting Paul H. Broussard, Chair of Forensic Medicine, Sorbonne, 1897).

¹¹⁷ STEPHEN SALTZBURG ET AL., MILITARY RULES OF EVIDENCE MANUAL 185 (4th ed. 1997 & Supp. 2002); see also *supra* notes 100-02.

¹¹⁸ SALTZBURG, *supra* note 117, at 181; see also *supra* notes 111-14.

¹¹⁹ See generally *United States v. Westbrook*, ACM 35615, 2005 CCA LEXIS 378 (A.F. Ct. Crim. App. Nov. 9, 2005) (unpublished) (finding child's injury due to SBS, not a short fall); *United States v. Stanley*, 62 M.J. 622 (2004) (finding child's death due to

States v. Stanley: “[T]he specific diagnosis was shaken baby syndrome (SBS). This is an established medical diagnosis typically involving very small children who are violently shaken. According to experts who testified at trial, SBS involves a constellation of injuries to the bones, eyes, and brain.”¹²⁰ In light of the published material that significantly undermines the shaking alone theory,¹²¹ however, it is difficult to ascertain why the SBS majority view still prevails to the exclusion of other more current and sound medical theories.

The persistence of the majority view as the prevailing view may be explained by the military’s penchant for providing an adequate substitute, which typically translates into a military expert who is a generalist instead of the requested civilian expert who typically is a specialist.¹²² The continued reliance on generalist experts may limit practitioners’ exposure to the minority and emerging views. Although the holding in *Warner* will open the doors to equalizing this disparity,¹²³ one can still argue that the use of adequate substitutes with less experience or exposure than specialists has resulted in the military courts being slower to embrace the minority or emerging views of SBS/SIS. As noted by Dr. Plunkett, perhaps this is because “scientific theories die slowly.”¹²⁴

Regardless of possible explanations, the military community’s acceptance of the majority view can be problematic for the defense when attempting to introduce either the minority or emerging view as an alternate theory of the case. Counsel seeking to introduce the minority or emerging view of SBS/SIS, however, should recognize that MRE 702 and *Daubert* are as much tools for the defense as they are for the government. Under *Daubert*, the judge, as the gatekeeper, must conduct a “reliability assessment” in each case where counsel seeks to introduce expert scientific testimony.¹²⁵ Thus, a defense counsel well versed in the minority and emerging views may be able to use the *Daubert* hearing as

shaking as defined by SBS); *United States v. Allen*, 59 M.J. 515 (N.M.C.M.R. 2003) (noting how expert “indicated that shaken baby syndrome was the only reasonable explanation” for the child’s injuries).

¹²⁰ *Stanley*, 62 M.J. at 622-23 (2004).

¹²¹ *See supra* pt. IV, §§ A2, B.

¹²² *United States v. Warner*, 62 M.J. 114, 117-19 (2005).

¹²³ *Id.* at 119.

¹²⁴ Plunkett Letter, *supra* note 30.

¹²⁵ *Daubert v. Merrell Dow Pharms. Inc.*, 509 U.S. 579, 594 (1993); *see also supra* notes 109-14 and accompanying text.

a means to preclude a government expert who strictly adheres to the majority view of SBS.

Recall that the first *Daubert* prong asks whether or not the preferred scientific theory has been tested.¹²⁶ A review of the medical studies presented herein calls into debate whether or not the majority view of SBS actually meets this threshold. To the contrary, armed with the biomechanical studies of the minority and emerging views,¹²⁷ counsel could demonstrate that the underlying scientific basis or premise of the shaking alone theory (i.e., that humans have sufficient strength to shake an infant to the point of traumatic brain injury) is “falsifiable.”¹²⁸ Remember, as demonstrated by Dr. Duhaime in her landmark study, when Dr. Caffey’s theory was tested, it was falsified.¹²⁹

The second *Daubert* prong asks whether or not the theory has been published in peer-reviewed journals.¹³⁰ The majority view, and more recently the minority and emerging views, have all enjoyed moderate to widespread publication.¹³¹ Publication, however, belies two critical points with regard to the majority view. First, “it is significant that in all four previously cited original papers regarding the hypothesis of shaking, both Guthkelch and Caffey refer to a single paper by Ommaya published in 1968 as biomechanical justification for this concept.”¹³² The implication, of course, is that the cornerstone upon which the majority theory is premised is flawed. A theory built on a flawed premise is itself flawed regardless of the number of times it has been published. Second, as noted by the court in *Daubert*, “publication is not the sine qua non of admissibility; it does not necessarily correlate with reliability.”¹³³ To the

¹²⁶ *Daubert*, 509 U.S. at 593.

¹²⁷ *See supra* pt. IV, §§ A2, B.

¹²⁸ Genie Lyons, *Shaken Baby Syndrome: A Questionable Scientific Syndrome and a Dangerous Legal Concept*, 2003 UTAH L. REV. 1109, 1115; *see also Daubert*, 509 U.S. at 593 (“The criterion of the scientific status or theory is its falsifiability, or refutability, or testability.”). Falsifiable is defined as capable of being tested (verified or falsified) by experiment or observation. WordReference.com, English Dictionary, <http://www.wordreference.com/definition/falsifiable> (last visited Sept. 13, 2006).

¹²⁹ Duhaime et al., *supra* note 3, at 409, 414.

¹³⁰ *Daubert*, 509 U.S. at 593.

¹³¹ *See generally supra* pt. IV& V.

¹³² Uscinski, *supra* note 22, at 76-7 (referring to the following studies that are considered the genesis of the shaking alone theory: Annan Guthkelch, *Infantile Subdural Hematoma and Its Relationship to Whiplash Injuries*, 2 BRIT. MED. J. 430 (1971); John Caffey, *The Parent-infant Traumatic Stress Syndrome*, 114 AM. J. ROENTGENOLOGY 217 (1972); Caffey, *Whiplash*, *supra* note 2; Caffey, *Theory and Practice*, *supra* note 2).

¹³³ *Daubert*, 509 U.S. at 593.

contrary, “submission to the scrutiny of the scientific community is a component of ‘good science’ in part because it increases the likelihood that substantive flaws in methodology will be detected.”¹³⁴ Arguably, the present situation is just the type of “scrutiny” the court in *Daubert* envisioned, with the minority and emerging views pointing out and critically addressing the “substantive flaws” in the majority view.¹³⁵

The third *Daubert* factor inquires as to the “potential rate of error” regarding a proffered scientific theory.¹³⁶ Other than the separate biomechanical studies performed by Doctors Ommaya,¹³⁷ Duhaime,¹³⁸ Goldsmith, Plunkett,¹³⁹ and Bandak,¹⁴⁰ which support the minority and emerging views, there are virtually no other quantifiable studies from which to deduce an error rate. In an attempt to determine the quality of the science supporting SBS, Dr. Mark Donohoe conducted an exhaustive review of the SBS literature from 1968 to 1998.¹⁴¹ Dr. Donohoe “found the scientific evidence to support a diagnosis of shaken baby syndrome to be much less reliable than generally thought.”¹⁴² More precisely, Dr. Donohoe opined that “the evidence for shaken baby syndrome appears analogous to an inverted pyramid, with a very small database (most of it poor quality original research, retrospective in nature, and without appropriate control groups) spreading to a broad body of somewhat divergent opinions.”¹⁴³ As such, defense could argue that the lack of an error rate means that the majority view of SBS fails this *Daubert* prong.

The fourth *Daubert* prong asks if the proffered theory is generally accepted within the scientific field.¹⁴⁴ Granted, the majority view of SBS is generally accepted; however, “respect for precedent does not require courts to ignore flaws in logic. The law must adapt when prior scientific theories are undermined by scientific logic.”¹⁴⁵ The minority and

¹³⁴ *Id.*; Lyons, *supra* note 128, at 1129.

¹³⁵ Lyons, *supra* note 128, at 1129.

¹³⁶ *Daubert*, 509 U.S. at 594.

¹³⁷ Ommaya, *supra* note 22.

¹³⁸ Duhaime et al., *supra* note 3.

¹³⁹ Goldsmith & Plunkett, *supra* note 26.

¹⁴⁰ Bandak, *supra* note 28.

¹⁴¹ Geddes & Plunkett, *supra* note 8, at 719.

¹⁴² *Id.*

¹⁴³ *Id.* at 719-20 (citing Mark Donohoe, *Evidence-Based Medicine and the Shaken Baby Syndrome, Part I: Literature Review: 1966-1998*, 24 AM. J. FORENSIC MED. & PATHOLOGY 239 (2003)).

¹⁴⁴ *Daubert v. Merrell Dow Pharms. Inc.*, 509 U.S. 579, 594 (1993).

¹⁴⁵ Lyons, *supra* note 128, at 1132.

emerging views have clearly undermined the scientific logic of the premise upon which the majority view of SBS is based.¹⁴⁶ The more these theories gain a foothold within the medical community, the more opportunities counsel have to argue that the majority view of SBS has lost its “general acceptance” within the medical community.

Understanding the experts’ biases is critical. In this article’s hypothetical, a government expert adhering to the majority view would likely opine that it was the shaking that either caused or significantly aggravated the subdural hematoma, which then caused the brain to swell and the child to die. Defense counsel, however, would want to contest the expert’s opinion since such testimony would put his client at the scene of the crime at the time the government is likely to allege the incident causing the traumatic brain injury occurred. Faced with this challenge, counsel need not capitulate when confronted with a government expert who strictly adheres to the majority view of SBS to the exclusion of other sound theories. Instead, counsel can seek to disallow an expert who refuses to consider either the minority or emerging view by demonstrating how the majority view of SBS may fail each of the *Daubert* criteria and, consequently, the reliability prong of MRE 702.

XI. Current Controversies within the Realm of SBS

There are numerous sub-controversies within the realm of SBS that cannot be neatly pigeonholed into the majority, minority, or emerging views. Such controversies include, but are not limited to the following: whether falls from short-distances can be fatal; whether diffuse axonal injury can be caused by events other than SBS/SIS (i.e., can being on a respirator for a prolonged period cause, mimic, or mask diffuse axonal injury); whether a preexisting, yet benign subdural hematoma, can re-bleed and turn fatal due to a subsequent, yet minor head injury; and whether certain vaccinations can mimic those injuries normally associated with SBS/SIS.¹⁴⁷ Two of these sub-controversies merit further discussion: whether short falls can or do kill and whether a preexisting

¹⁴⁶ See *supra* pt. IV.

¹⁴⁷ SBSDefense.com, Forensic Truth Foundations, Shaken Baby Syndrome for Beginners: Shaken Baby Syndrome-Questions and Controversies, <http://www.sbstruth.com/Questions%20and%20controversies.htm> (last visited Sept. 14, 2006) [hereinafter SBSDefense.com Controversies].

or chronic subdural hematoma can re-bleed due to a subsequent or second impact.

Some experts assert that traumatic brain injury cannot be caused by short falls (e.g., fall out of a crib, fall off of a swing, fall off a kitchen stool, etc.).¹⁴⁸ Rather, a repeated theme proffered by these experts is that traumatic brain injury can only be caused by “significant force . . . such as major motor vehicle crashes, falls from a second-story window, or inflicted severe blunt force trauma.”¹⁴⁹ Any expert subscribing to this theory would automatically dismiss or discredit any alternate theory of a case where the defendant is claiming the injury occurred because of some form of short fall. In recent years, however, several credible studies have been published that question the theory that traumatic brain injury cannot be caused by short falls.¹⁵⁰ In one such study, “the author reviewed the January 1, 1988 through June 30, 1999 United States Consumer Product Safety Commission database for head injuries associated with the use of playground equipment.”¹⁵¹ The author’s stated objective was to determine if there were any “witnessed or investigated fatal short-distance falls that were concluded to be accidental.”¹⁵² The study noted eighteen head injury fatalities from falls off of playground equipment ranging in height from “0.6 to 3 meters (2–10 feet).”¹⁵³ Of the eighteen fatal falls, twelve were “directly observed by a noncaretaker” witness.¹⁵⁴ As a result, the author concluded “that an infant or child may suffer a fatal head injury from a fall of less than 3 meters (10 feet).”¹⁵⁵ Armed with this information, traumatic brain injury resulting from a drop in the tub certainly seems more plausible than previously thought.

Another controversy surrounding SBS is the “re-bleed” or “second impact” theory. The re-bleed theory purports that an otherwise non-

¹⁴⁸ Plunkett, *supra* note 6, at 1-2, tbl. 1.

¹⁴⁹ United States v. Buber, No. 20000777, at 8 (Army Ct. Crim. App. Jan. 12, 2005) (unpublished); Goldsmith & Plunkett, *supra* note 26, at 95 (“There has been sworn testimony in courts of law by expert witnesses who state that trauma caused by shaking is equivalent to a fall from a two-story (or higher) window on to the pavement. . . . This analogy of a “shaking” injury to a two-story fall is not justifiable.”).

¹⁵⁰ SBSDefense.com Controversies, *supra* note 147; Goldsmith & Plunkett, *supra* note 26, at 95-96.

¹⁵¹ Plunkett, *supra* note 6, at 1.

¹⁵² *Id.* at 2.

¹⁵³ *Id.*

¹⁵⁴ *Id.*

¹⁵⁵ *Id.*

lethal previous head injury may be exacerbated by a second, yet trivial, head injury, which leads to death.¹⁵⁶ A practical application of this theory would, for example, be a case where a child falls and suffers a minor subdural hematoma. Before the minor subdural hematoma either dissipates or is reabsorbed by the body, the child suffers another minor head injury. This second injury aggravates the preexisting subdural hematoma causing it to re-bleed, resulting in a fatal secondary injury (e.g., cerebral edema).¹⁵⁷ The crux of this theory is not whether re-bleeds occur, but what amount of force is needed to cause the re-bleed,¹⁵⁸ and whether the subsequent or second impact has to be proximate to the original subdural hematoma.¹⁵⁹ That is, does the force have to be extreme, indicating violence or a non-accident, or can it be from something as simple as a parent and child bumping heads while playing a game of football?¹⁶⁰ Several experts believe “there is no evidence to support the concept that re-bleeding of an older subdural hematoma can result from trivial injury and cause an infant to suddenly collapse and die.”¹⁶¹ The emerging re-bleed theory, however, reasons that subsequent trauma does not have to be proximate to the original subdural hematoma¹⁶² and that the amount of force required to initiate a re-bleed can be de minimus.¹⁶³ Applying the re-bleed theory to the hypothetical, if the drop in the tub caused a subdural hematoma, then perhaps the father’s brief shaking of the child caused the original subdural hematoma to re-bleed. The question for the court then becomes whether or not the father’s actions were in any way criminally negligent. For example, did he shake the child forcefully and violently such that it could be considered an assault, or did he softly shake the child (e.g., playing or trying to wake child up, etc.) in such a manner that no reasonable person would have expected an injury to occur.

¹⁵⁶ United States v. Buber, No. 20000777, at 9 (Army Ct. Crim. App. Jan. 12, 2005) (unpublished); SBSDefense.com Controversies, *supra* note 147.

¹⁵⁷ See “edema” *infra* app. A.

¹⁵⁸ SBSDefense.com Controversies, *supra* note 147.

¹⁵⁹ Goldsmith & Plunkett, *supra* note 26, at 97.

¹⁶⁰ *Buber*, No. 20000777, at 9 (noting that “testimony from the government experts failed to exclude the reasonable possibility that Ja’lon might have accidentally suffered a previous head injury during a fall down the stairs, which was exacerbated by a second injury, caused while playing football.”). *Id.*

¹⁶¹ Robert M. Reece & Robert H. Kirschner, *Shaken Baby Syndrome/Shaken Impact Syndrome*, http://dontshake.com/Audience.aspx?categoryID=9&PageName=SBS_SIS.htm (last visited Sept. 14, 2006).

¹⁶² Goldsmith & Plunkett, *supra* note 26, at 97.

¹⁶³ SBSDefense Controversies, *supra* note 147.

As has been demonstrated through the hypothetical, there are no clear-cut answers in cases where SBS/SIS is alleged. As such, understanding these controversies may help counsel in shaping the theory of their case, in challenging an opposing expert during a *Daubert* hearing, or both.

XII. Conclusion

*If the issues are much less certain than we have been taught to believe, then to admit uncertainty sometimes would be appropriate for experts. Doing so may make prosecution more difficult, but a natural desire to protect children should not lead anyone to proffer opinions unsupported by good quality science. We need to reconsider the diagnostic criteria, if not the existence, of shaken baby syndrome.*¹⁶⁴

Should one automatically conclude that a child who shows symptoms of traumatic brain injury without any form of external cranial trauma is suffering from SBS? Does the average adult have sufficient strength to shake a child to the point of causing traumatic brain injury? Or, are there other sound medical explanations for a child who has traumatic brain injury but no corresponding external cranial trauma? The answers to these questions are nebulous and, as demonstrated, have divided the best minds of the medical community. As such, it is incumbent upon military practitioners faced with a potential SBS/SIS case to fully and independently educate themselves on the controversies surrounding SBS so as to ensure the administration of justice is based on fact and vetted scientific theories, instead of conjecture merely masked as such. As succinctly noted by Dr. Uscinski, “[W]hile the desire to protect children is laudable, it must be balanced against the effects of seriously harming those who are accused of child abuse solely on the basis of what is, at best, unsettled science.”¹⁶⁵

¹⁶⁴ Geddes & Plunkett, *supra* note 8, at 720.

¹⁶⁵ Uscinski, *supra* note 22, at 77.

Appendix A

When familiarizing themselves with the medical terms defined below, practitioners should pay particular attention to the specific causation element or triggering mechanism of each type of injury.

Coup Contusion: “Coup contusions occur beneath a site of cranial impact. Skull imbedding from cranial impact may cause direct injury to the brain and its surface. Brain contusions may occur at multiple sites remote from the point of cranial impact under some circumstances.”¹⁶⁶

Contra-coup Contusion: “Contra Coup injuries occur when there is an injury to the opposite side of the head from the impact site. Contra coup injuries are generally thought to be an indicator of a moving head hitting a stationary, unyielding force or object.”¹⁶⁷ A contra-coup injury is a contusion directly opposite the impact.

Diffuse Axonal Injury:

[S]evere primary diffuse brain injury may manifest clinically as immediate loss of consciousness with prolonged traumatic coma without mass lesions. This clinical presentation is frequently associated with widespread structural damage to the axons – a condition known as diffuse axonal injury. Diffuse axonal injury is the result of deep acceleration strain within the brain parenchyma. Histological evidence of diffuse axonal injury includes axonal swelling and axonal retraction balls.¹⁶⁸

[Diffuse axonal injury] is a type of diffuse brain injury, meaning that damage occurs over a more widespread area than in focal brain injury. Diffuse axonal injury, which refers to extensive lesions in white matter tracts, is one of the major causes of unconsciousness and persistent vegetative state after head trauma (Wasserman, 2004). The major cause of damage in diffuse axonal injury is the tearing of axons, the neural

¹⁶⁶ Hymel, *supra* note 46, at 119.

¹⁶⁷ SBSDefense.com, *supra* note 57.

¹⁶⁸ Hymel, *supra* note 46, at 120.

processes that allow one neuron to communicate with another.¹⁶⁹

Edema (cerebral): “[G]eneralized swelling caused by changes in vascular permeability and autoregulation.”¹⁷⁰

Cerebral edema is an increase in brain volume caused by an absolute increase in cerebral tissue water content. Diffuse cerebral edema may develop soon after head injury. Cerebral herniation may occur when increasing cranial volume and ICP overwhelms the natural compensatory capacities of the CNS. Increased ICP may be the result of posttraumatic brain swelling, edema formation.¹⁷¹

In layman’s terms, swelling of the brain can cause death by starving the brain of oxygen or blood, or by herniating the brain by pushing it through the brain stem.¹⁷² (see “Herniation” for a description of the relationship between edema and herniation).

Epidural Hematoma: “Epidural hematoma is a traumatic accumulation of blood between the inner table of the skull and the stripped-off dural membrane. The inciting event often is a focused blow to the head, such as that produced by a hammer or baseball bat.”¹⁷³

Extravasted Blood: “Bruising and/or free blood within the epidural layer (scalp).”¹⁷⁴ Not as serious as an epidural hemorrhage; usually attributable to some form of impact (can occur from minor trauma).¹⁷⁵

¹⁶⁹ Wikipedia, The Free Encyclopedia, Diffuse Axonal Injury, http://en.wikipedia.org/wiki/Diffuse_axonal_injury (last visited Sept. 14, 2006).

¹⁷⁰ Mary E. Case et al., *Position Paper on Fatal Abusive Head Injuries in Infants and Young Children*, 22 AM. J. FORENSIC MED. & PATHOLOGY 112, 118 (2001).

¹⁷¹ Library of the National Medical Society, Brain Edema and Cerebra Edema, http://www.medical-library.org/journals2a/brain_edema.htm (Oct. 2, 2005).

¹⁷² Plunkett Telephone Interview, *supra* note 55.

¹⁷³ Daniel Price & Sharon Wilson, *Epidural Hemorrhages*, EMEDICINE, <http://www.emedicine.com/EMERG/topic167.htm> (Jan 13, 2004).

¹⁷⁴ Brain Injury Association of America, Types of Brain Injury, http://www.biausa.org/Pages/types_of_brain_injury.html (last visited Sept. 14, 2006) [hereinafter BIAA].

¹⁷⁵ Plunkett Telephone Interview, *supra* note 55.

Fractures (skull):

Skull fractures are caused by a deformation of the skull due to impact of some kind. The likelihood that a child will suffer a skull fracture depends on the force, location of the impact, age of the child, and biologic/mechanic characteristics/properties of the skull at the point of impact. Children with open sutures and more flexible skulls are not as likely to fracture in short falls as are older children with fully developed enclosed skulls.¹⁷⁶

Herniation:

A brain herniation is the displacement of brain tissue, cerebrospinal fluid, and blood vessels outside the compartments in the head that they normally occupy. A herniation can occur through a natural opening at the base of the skull (called the foramen occipitalis) or through surgical openings created by a craniotomy procedure. Herniation can also occur between compartments inside the skull, such as those separated by a rigid membrane called the ‘tentorium’. A brain herniation occurs when pressure inside the skull (intracranial pressure) increases and displaces brain tissues. This is commonly the result of brain swelling from a head injury. . . . Brain herniations are the most common secondary effect of expanding masses in the brain.¹⁷⁷

Hypoxia: “A hypoxic brain injury results when the brain receives some, but not enough, oxygen.”¹⁷⁸

Ischemia: “Hypoxic ischemic brain injury, also called stagnant hypoxia or ischemic insult-brain injury occurs because of a lack of blood flow to the brain because of a critical reduction in blood flow or blood pressure.”¹⁷⁹

¹⁷⁶ SBSDefense.com, *supra* note 57.

¹⁷⁷ University of Pennsylvania Health System, Encyclopedia, Brain Herniation, <http://pennhealth.com/ency/article/001421.htm> (last visited Sept. 14, 2006).

¹⁷⁸ BIAA, *supra* note 174.

¹⁷⁹ *Id.*

Second Impact Syndrome:

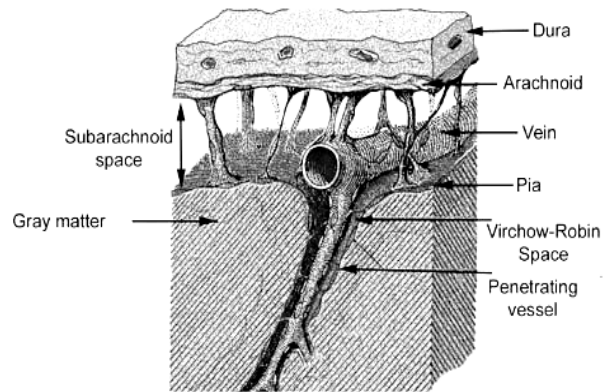
Second Impact Syndrome, also termed ‘recurrent traumatic brain injury,’ can occur when a person sustains a second traumatic brain injury before the symptoms of the first traumatic brain injury have healed. The second injury may occur from days to weeks following the first injury. Loss of consciousness is not required. The second impact is more likely to cause brain swelling and widespread damage. Because death can occur rapidly, emergency medical treatment is needed as soon as possible.¹⁸⁰

Subdural Hematoma:

Is a collection of blood that pools under the dura. The dura is a relatively tough connective tissue (collagenous) membrane, about the thickness of parchment paper. It is firmly attached to the under surface of the skull and in the spinal canal it is separated from the bony structure by a layer of fatty tissue. The inner underside of the dura is applied to a much thinner, transparent membrane, the arachnoid, that overlies the brain and subarachnoid space. This interface is easily separated, forming the subdural space. The subdural space is referred to as a “potential space” because a space is not generally created unless a subdural hematoma or another space occupying mass is formed. When a subdural hematoma forms, it is generally an indicator of a broken vein on the underlying surface of the brain. If one or more of these veins that “bridge” the dura are injured, bleeding occurs into the subdural “space” causing a subdural hematoma (clot).¹⁸¹

¹⁸⁰ *Id.*

¹⁸¹ SBSDefense.com, *supra* note 57.



Subdural Hematomas, Types Of (acute, sub-acute, and chronic):

A subdural hematoma (SDH) is classified by the amount of time that has elapsed from the inciting event, if known, to the diagnosis. When the inciting event is unknown, the appearance of the hematoma on CT scan or MRI can help date the hematoma. *Acute SDHs* are less than 72 hours old and are hyper-dense compared to the brain on CT scan. *Subacute SDHs* are 3-20 days old and are isodense or hypodense compared to the brain. *Chronic SDHs* are older than 20 days and are hypodense compared to the brain.¹⁸²

When the dura is cut and removed a subdural hematoma may be seen. This blood will appear bright red if it is “acute” and the color of port wine or “crank case oil” if it is older. The pathologist should note if the blood is red/black, brownish, yellowish-orange, ‘machine oil’ or straw colored (or combinations of all of these). The pathologist should weigh (volume), sample and photograph this blood. “Chronic” or old subdurals will be darker in color and may leave an iron stain on the dura the color of port wine, brown or yellow.¹⁸³

¹⁸² Sinson & Reiter, *supra* note 58 (emphasis added).

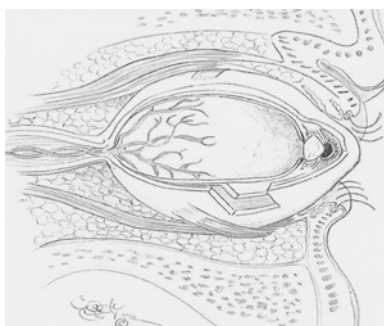
¹⁸³ SBSDefense.com, *supra* note 57.

Subarachnoid Hemorrhage:

Subarachnoid hemorrhage arises from tearing of arachnoid vessels at the same time bridging veins are torn, because the bridging veins are surrounded by an arachnoid sheath as they cross the subdural space to enter the inner dural layer and finally the dural sinuses. Tearing of bridging veins usually produces both subdural and subarachnoid hemorrhages.¹⁸⁴

Retinal Hemorrhages:

Retinal Hemorrhages are small hemorrhages on the back of the eye. Most experts do not agree as to the pattern, number, location, or type of retinal hemorrhages that point to a diagnosis of SBS or other non-accidental trauma. The mechanism(s) behind retinal hemorrhages in infancy in the context of alleged head trauma are unknown. Most research points to a mechanism involving rapid increases in intracranial pressure, cerebral venous spasm or increased venous pressure, and possibly hypoxia. . . . Sometimes the retinal hemorrhages are accompanied by nerve sheath damage or bleeding in the subdural space of the optic nerve. This finding has been considered an indicator of a greater degree of damage. . . .¹⁸⁵



¹⁸⁴ Case et al., *supra* note 170, at 116.

¹⁸⁵ SBSDefense.com, *supra* note 57.

Appendix B

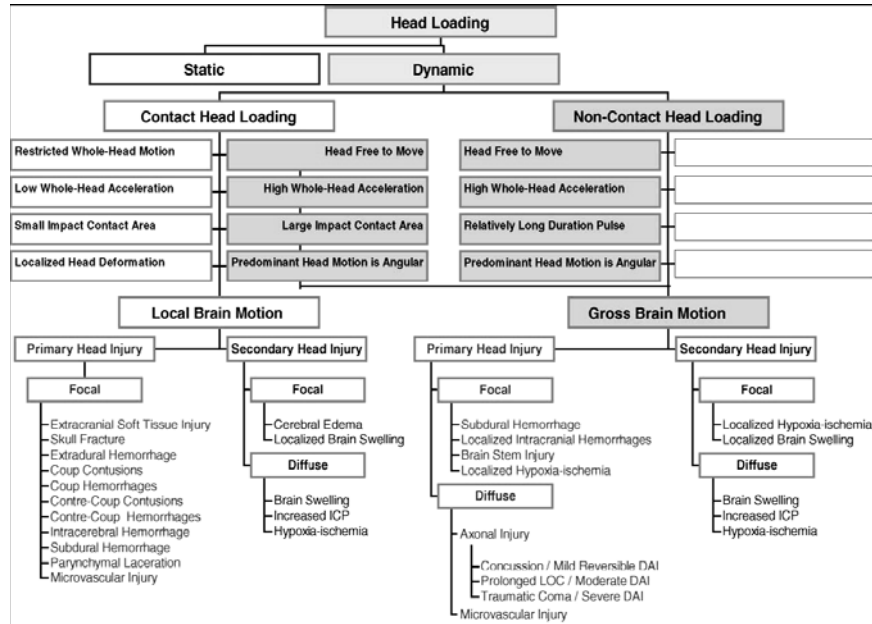


Fig. 1. Biomechanical classification of head injuries.¹⁸⁶

¹⁸⁶ Bandak, *supra* note 28, at 73.