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OUTSIDE THE ECHO CHAMBER: A RESPONSE TO THE "CONSENSUS STATEMENT ON ABUSIVE HEAD TRAUMA IN INFANTS AND YOUNG CHILDREN"

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† In drafting this article, the authors consulted with physicians from several specialties (e.g., emergency medicine, forensic pathology, pediatrics, and radiology) to ensure the article uses medical terminology accurately and canvasses the relevant medical literature sufficiently. But, as this paper discusses, the issues surrounding the SBS/AHT controversy matter principally for legal, not medical, purposes. Lawyers present and debate the evidence regarding the diagnosis in court cases; judges decide whether, given the controversy, such evidence is sufficiently reliable to be admitted; and judges and jurors must evaluate testimony based on the diagnosis and decide what weight to give to it. Although the terminology and medical concepts can be daunting to lawyers and judges new to the subject, persons with legal training are fit to evaluate the evidence underlying the diagnosis and, ultimately, judges are obligated to determine what role the controversial diagnosis may play in legal proceedings.

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I. INTRODUCTION

Several serious and growing controversies surround a field of medicine known as child abuse pediatrics.[1] One such controversy involves a diagnosis known as Shaken Baby Syndrome (SBS) or Abusive Head Trauma (AHT). The diagnosis is based on specific internal findings in a baby or young child's head and eyes, which, when present, supposedly indicate that the child was violently shaken or otherwise subjected to inflicted head trauma. Within child abuse pediatrics, the diagnosis is endowed with a nearly iconic status and hailed as a critical discovery in our ability to identify abuse in very young children.

But outside of child abuse pediatrics, the SBS/AHT diagnosis is very controversial.[2] In fact, the scientific, medical, and legal literature

1. *See, e.g.*, Patrick Barnes, *Child Abuse—Nonaccidental Injury (NAI) and Abusive Head Trauma (AHT)—Medical Imaging: Issues and Controversies in the Era of Evidence-Based Medicine*, 50 U. MICH. J.L. REFORM 679 (2017); Maxine Eichner, *Bad Medicine: Parents, the State, and the Charge of "Medical Child Abuse,"* 50 U.C. DAVIS L. REV. 205 (2016); Steven C. Gabaeff, *Exploring the Controversy in Child Abuse Pediatrics and False Accusations*, 18 LEGAL MED. 90 (2016).

2. *See, e.g.*, Gimenez v. Ochoa, 821 F.2d 1136, 1145 (9th Cir. 2016) (observing that there is "a vigorous debate about [SBS's] validity within the scientific community"); Del Prete v. Thompson, 10 F. Supp. 3d 907, 958 (N.D. Ill. 2014) (granting habeas relief and suggesting that SBS may be "more an article of faith" than a proposition of science); Commonwealth v. Doe, 68 N.E.3d 654, 656 n.3 (Mass. Ct. App. 2016) ("As noted in two recent opinions of the Supreme Judicial Court, shaken baby syndrome has been the subject of heated debate in the medical community."); People v. Ackley, 870 N.W.2d 858, 864 (Mich. 2015) (referring to "the prominent controversy within the medical community regarding the reliability of

overflow with challenges to the diagnosis' reliability. And these challenges are not at the margins. Rather, the problems with the diagnosis may be so fundamental as to raise the specter of wrongful convictions and unfair destruction of families beyond anything comparable in the modern history of the American justice system.

One might assume that if the diagnosis is medically unsound, then physicians would abandon it. But SBS/AHT is not a typical medical diagnosis. It is a medical diagnosis in the sense that physicians make it based on certain physical findings. But its dominant function is forensic. It is not a diagnosis made for treatment, but rather to identify abuse—specifically, that the child has been violently shaken or subjected to other severe "acceleration-deceleration" head trauma. Given that the diagnosis serves principally legal functions, and given the split about the diagnosis within the scientific and medical communities, the primary forum at this point for resolving debates about the diagnosis' reliability is, for better or worse, in the courts.

Against this backdrop, several leading figures in child abuse pediatrics, joined by a law professor who advocates on SBS/AHT issues from

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SBS/AHT diagnoses"); *In re* Yarbrough Minors, 885 N.W.2d 878, 890 (Mich. Ct. App. 2016) ("The science swirling around cases of shaken baby syndrome and other forms of child abuse is highly contested."); People v. Bailey, 999 N.Y.S.2d 713, 725-26 (Monroe Cty. Ct. 2014) ("Nevertheless, the credible evidence adduced at the Hearing, which was supported by expert testimony from different disciplines and specialties – pediatrics, radiology, pathology, ophthalmology, and biomechanical engineering – established by a preponderance of the evidence that key medical propositions relied upon by the Prosecution at Trial were either demonstrably wrong, or are now subject to new debate."), *aff'd*, 41 N.Y.S.3d 625 (App. Div. 2016); *In re* Rihana J.H., 54 Misc. 3d 1223(A) (N.Y. Fam. Ct. 2017) ("The science of the causation of childhood head injuries of the type seen in this case has changed substantially in the past ten years. There is now significant scholarly debate and some consensus that these injuries were over-diagnosed as resulting from abuse."); State v. Edmunds, 746 N.W.2d 590, 599 (Wis. Ct. App. 2008) (granting a new trial in an SBS case based on the emergence of "a legitimate and significant dispute within the medical community as to the cause" of the SBS findings); STEPHEN GOUDGE, *Policy and Recommendations*, *in* INQUIRY INTO PEDIATRIC FORENSIC PATHOLOGY IN ONTARIO—REPORT 527 (2008) (concluding that "one of the deepest controversies surrounding pediatric forensic pathology concerns shaken baby syndrome"), https://www.attorneygeneral.jus.gov.on.ca/inquiries/goudge/report/index.html [hereinafter Goudge Report]; Evan Matshes et al., *Shaken Infants Die of Neck Trauma, Not of Brain Trauma*, 1 ACAD. FORENSIC PATHOLOGY 82 (2011) ("However, in the forensic and legal communities, there is ongoing controversy about the definition, diagnosis, and even the very existence of SBS."); *see also* Cindy W. Christian et al., Comm. on Child Abuse and Neglect of the AAP, *Abusive Head Injury in Infants and Children*, 123 PEDIATRICS 1409, 1410 (2009) [hereinafter 2009 AAP Statement] ("Few pediatric diagnoses engender as much debate as AHT, in part because of the social and legal consequences….Controversy is fueled because the mechanisms and resultant injuries of accidental and abusive head injury overlap, the abuse is rarely witnessed, … and there is no single or simple test to determine the accuracy of the diagnosis …."). For a detailed discussion of the nature and extent of the SBS/AHT controversy, see RANDY PAPETTI, THE FORENSIC UNRELIABILITY OF THE SHAKEN BABY SYNDROME § 4.1 (Christopher Milroy ed. 2018).

a prosecutorial perspective, recently authored a document titled: "Consensus Statement on Abusive Head Trauma in Infants and Young Children" (hereinafter the "Statement").[3] The Statement was published in an influential medical journal, Pediatric Radiology, and notes that it is "supported by" the Society for Pediatric Radiology (SPR), the American Academy of Pediatrics (AAP), and other pediatric medical organizations.[4] But as made clear in the Statement and in papers published in conjunction with it, courts are the Statement's primary intended audience.[5] The Statement is the latest in a series of statements, papers, and surveys produced by leading figures in child abuse pediatrics as part of a campaign to assure courts that the controversy enveloping SBS/AHT is without substance.

In reality, there is no consensus on SBS/AHT. The Statement claims that consensus exists within the medical and scientific communities, but this is because the Statement labels those who question SBS/AHT as child abuse "denialists"[6]—and, on that basis, dismisses their viewpoints as worthless. Similarly, the substantive medical and scientific discussion in the Statement emphasizes literature and viewpoints from only one side of the debate, creating a misleading impression about the nature and depth of the controversy. The lopsidedness is unsurprising given that the Statement's fifteen authors (with at most one exception) do not include anyone who is not a well-known figure in child abuse pediatrics.[7] Accordingly, the most that can be said about the Statement is that it succinctly summarizes the consensus views of one side to the controversy.

This response to the Consensus Statement is necessary because the substantive concerns about SBS/AHT are not adequately presented in the Statement, rendering it misleading. The concerns about SBS/AHT are not grounded in any denialism about child abuse, but rather concerns about SBS/AHT's reliability, concerns grounded in the medical and scientific literature.

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3. *See* AK Choudhary et al., *Consensus Statement on Abusive Head Trauma in Infants and Young Children*, 48 PEDIATRIC RADIOLOGY 1048 (2018) [hereinafter *Consensus Statement*].

4. *See id.* at 1049.

5. *See id.* at 1049-50; Sandeep K. Narang, *Combating Misinformation About Abusive Head Trauma: AAP Endorses New Report*, AAP NEWS (June 1, 2018), http://www.aappublications.org/news/2018/06/01/headtrauma060118.

6. *Consensus Statement*, *supra* note 3, at 1059 ("The denialists have tried to create a medical controversy where there is none.").

7. At least fourteen of the fifteen authors have previously published on SBS/AHT to defend the hypothesis and/or attack its critics. *See* Keith A. Findley et al., *Feigned Consensus: Usurping the Law in Shaken Baby Syndrome / Abusive Head Trauma Prosecutions* 18 n.53 (U. Wis. L. Sch., Legal Studies Research Paper No. 1461, Feb. 5, 2019), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3328996 [hereinafter *Feigned Consensus*].

If one accepts that medical diagnoses used for forensic purposes must be scientifically reliable, then many SBS/AHT diagnoses do not belong in court. The SBS/AHT diagnosis is premised on certain biomechanical and pathophysiological assumptions and beliefs, nearly all of which have been shown to be unreliable. As accurately summarized in a leading forensic neuropathology treatise: "Virtually all the hallowed tenets of SBS have been challenged on the basis of scientific principles and been found wanting or wrong."[8] Numerous studies and papers, including the only study undertaken by a scientific body, have demonstrated that the evidence base supposedly validating SBS/AHT is of very low quality and riddled with methodological flaws and biases.[9] A 2018 book written by one of the authors of this article examines the SBS/AHT controversy and finds the key SBS/AHT beliefs—beliefs which, again, have led to thousands of criminal convictions and family court determinations taking children from their parents—to be so unreliable that in most cases they should be excluded from the courtroom.[10] The answer to such criticisms—that courts should reject them because a consensus of child abuse specialists still believe SBS/AHT is reliable—is a response that, for the reasons set forth in this article, courts should evaluate with great caution.

II. THE SHAKEN BABY SYNDROME

The SBS diagnosis stems from a set of beliefs about the dangers and physical consequences of shaking an infant. One paramount belief is that shaking or similar acceleration-deceleration trauma will often leave a virtually unique physical trail, from which knowledgeable physicians can reliably identify such abuse. But, over time, almost all these beliefs have proven to be uncertain, overstated, or altogether false.

A. The Original Hypothesis

Historically, physicians found reasons to avoid getting involved in potential cases of child abuse. Even though they frequently treated children with suspicious injuries, they viewed child abuse as a family, social service, or police issue, and so they rarely identified a child as abused in their medical records and even more rarely reported suspected abuse to authorities.

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8. JAN E. LEESTMA, FORENSIC NEUROPATHOLOGY 642 (3d ed. 2014).

9. *See, e.g.*, SWEDISH AGENCY FOR HEALTH TECHNOLOGY ASSESSMENT AND ASSESSMENT OF SOCIAL SERVICES, REP. NO. 255E, TRAUMATIC SHAKING: THE ROLE OF THE TRIAD IN MEDICAL INVESTIGATIONS OF SUSPECTED TRAUMATIC SHAKING – A SYSTEMATIC REVIEW (Joan Bevenius trans., 2016) [hereinafter Swedish Report], http://www.sbu.se/en/publications/sbu-assesses/traumatic-shaking--the-role-of-the-triad-in-medical-investigations-of-suspected-traumatic-shaking/.

10. *See* PAPETTI, *supra* note 2.

This mindset changed after an influential 1962 article titled "The Battered-Child Syndrome."[11] In that article, prominent pediatric physicians urged that physicians have a duty to their young patients to identify and report suspected abuse and to, in the words of the article's abstract, "guarantee that no expected repetition of trauma will be permitted to occur."[12] The article and the attention it received dramatically altered society's and the medical profession's awareness of child abuse. Soon, legislatures adopted laws requiring physicians to report suspected abuse.[13] Physicians, in turn, began to specialize in child abuse-related issues; medical organizations created child abuse committees and working groups; hospitals assembled standing child abuse evaluation teams; and medical literature about what physical findings are suspicious for abuse increased exponentially.[14]

As part of this surge in child abuse literature, A. Norman Guthkelch, a British pediatric neurosurgeon, published a paper in 1971 titled "Infantile Subdural Haematoma and its Relationship to Whiplash Injuries."[15] Guthkelch sought to explain cases where infants had a subdural hematoma, a pooling of blood outside the brain, which he assumed were caused by head trauma, yet the child's head showed no sign of impact. Guthkelch suggested that shaking an infant could result in subdural bleeding and thus explain how infants might have such hematomas despite no external evidence of head trauma.[16] John Caffey, a prominent American radiologist and textbook writer, promptly picked up on Guthkelch's hypothesis.[17] Caffey echoed Guthkelch that shaking would explain how infants presented without obvious evidence of head trauma (e.g., skull fracture or scalp bruising), yet had subdural hematoma and, in many cases, brain injury and/or rib fractures. Caffey also argued that shaking would explain the retinal hemorrhages found in many abused children, which he speculated were caused by "traction stresses" within the eye as the vitreous and the retina move at different speeds during a shaking episode and shear against one another.[18]

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11. C. Henry Kempe et al., *The Battered-Child Syndrome*, 181 JAMA 17 (1962).

12. *Id*.

13. *See, e.g.*, Margaret H. Meriwether, *Child Abuse Reporting Laws: Time for A Change*, 20 FAM. L.Q. 141, 142 (1986); Mark A. Small, *Policy Review of Child Abuse and Neglect Reporting Statutes*, 14 J.L. & POL'Y 129, 130 (1992).

14. *See, e.g.*, PAPETTI, *supra* note 2, at 12-14.

15. A. Norman Guthkelch, *Infantile Subdural Haematoma and its Relationship to Whiplash Injuries*, 2 BRIT. MED. J. 430 (1971).

16. *Id.*

17. *See* John Caffey, *The Parent-Infant Traumatic Stress Syndrome; (Caffey-Kempe Syndrome), (Battered Babe Syndrome)*, 114 AM. J. ROENTGENOLOGY 218 (1972) [hereinafter Caffey I]; John Caffey, *On the Theory and Practice of Shaking Infants*, 124 AM. J. DISEASES OF CHILD. 161 (1972) [hereinafter Caffey II].

18. *See* Caffey II, *supra* note 17, at 169.

Caffey's theory that shaking can cause subdural and retinal hemorrhage and brain injury was initially referred to as the Whiplash-Shaken Infant Syndrome[19] and, by the early 1980s, as Shaken Baby Syndrome. Although Caffey admitted having "manifestly incomplete" evidence to support his theory,[20] the belief that shaking is a frequent cause of such internal findings soon became widely accepted in pediatric medicine.[21]

B. SBS Becomes Diagnostic

In its initial formulation as articulated by Guthkelch and Caffey, SBS was relatively non-controversial.[22] There was no obvious reason for physicians or researchers to question Guthkelch's and Caffey's guidance that babies are vulnerable and that shaking can seriously hurt them. But by the late 1970s, the original warning that shaking can cause (1) subdural hemorrhage, (2) retinal hemorrhages, and (3) brain injury began morphing into rather categorical medical dogma that such findings almost always mean SBS.[23] The internal SBS findings had effectively become diagnostic of child abuse.[24]

This progression occurred as the child abuse literature increasingly urged that each of the three primary SBS findings are nearly always the result of significant trauma, typically associated with rotational or shearing forces. It has long been understood that subdural hemorrhage, especially in infancy, has multiple causes—some traumatic, but others having nothing to do with trauma.[25] Nevertheless, the child abuse literature came to advise that a finding of subdural hemorrhage in a young child should trigger a presumption of child abuse. This presumption of abuse became official AAP policy. In 1993 and again in 2001, the AAP's

19. *See* John Caffey, *The Whiplash Shaken Infant Syndrome: Manual Shaking by the Extremities With Whiplash-Induced Intracranial and Intraocular Bleedings, Linked with Residual Permanent Brain Damage and Mental Retardation*, 54 PEDIATRICS 396, 397 n.3 (1974) [hereinafter Caffey III].

20. *Id.* at 403.

21. *See, e.g.*, Ronald H. Uscinski, *Shaken Baby Syndrome: An Odyssey*, 46 NEUROLOGIA MEDICO CHIRURGICA 57, 58 (2006) ("[T]he mechanism of shaking and the so named syndrome gained immediate acceptance and enormously widespread popularity, with no real investigation or even question as to its scientific validity.").

22. *See, e.g.*, DEBORAH TUERKHEIMER, FLAWED CONVICTIONS: "SHAKEN BABY SYNDROME" AND THE INERTIA OF INJUSTICE 2-4 (2015).

23. *See, e.g.*, PAPETTI, *supra* note 2, at § 2.3.

24. *See id.*; *see also* Deborah Tuerkheimer, *The Next Innocence Project: Shaken Baby Syndrome and the Criminal Courts*, 87 WASH. U. L. REV. 1, 5 (2009) ("In its classic formulation, SBS comes as close as one could imagine to a medical diagnosis of murder ….").

25. *See, e.g.*, A. N. Guthkelch, *Subdural Effusions in Infancy: 24 Cases*, 1 BRIT. MED. J. 233 (1953); Franc D. Ingraham & Donald D. Matson, *Subdural Hematoma in Infancy*, 24 J. PEDIATRICS 1, 3 (1944).

Committee on Child Abuse and Neglect issued highly influential statements on SBS.[26] These statements advised that the presence of any "intracranial injury" in a child under one year of age, the most common form of which they identified as subdural hemorrhage, should give rise to a "presumption of child abuse."[27] The 2001 AAP Statement provided: "Although physical abuse in the past has been a diagnosis of exclusion, data regarding the nature and frequency of head trauma consistently support the need for a presumption of child abuse when a child younger [one] year of age has intracranial injury."[28] Thus, for decades, the policy of the leading pediatric medical organization in the world was that physicians should presume child abuse merely upon a finding of subdural hemorrhage in infancy.[29]

The second internal finding said to be characteristic of SBS and abuse was retinal hemorrhages. The child abuse literature often described retinal hemorrhages as even more probative of abuse than subdural hemorrhage. Emergency room personnel were taught to look for such hemorrhages whenever abuse might be a possibility. For example, a 1994 paper stated: "It must be embedded in the minds of the pediatric emergency room residents that retina[l] hemorrhage is associated with child abuse until proven otherwise."[30] A 1998 treatise on child maltreatment similarly emphasized: "Retinal hemorrhages in an infant without a history of severe accidental trauma constitute child abuse until proven otherwise."[31] Although the phraseology varied between describing retinal hemorrhages specifically as proof of shaking or more generally as proof of abuse, the prevailing explanation was that retinal hemorrhages are so probative of abuse because they reflect shaking or other whiplash forces.[32] For example, a 2001 treatise on SBS advised that the "presence

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26. Am. Acad. of Pediatrics, Comm. on Child Abuse & Neglect, *Shaken Baby Syndrome: Inflicted Cerebral Trauma*, 92 PEDIATRICS 872 (1993) [hereinafter 1993 AAP Statement]; Am. Acad. of Pediatrics, Comm. on Child Abuse & Neglect, *Shaken Baby Syndrome: Rotational Cranial Injuries – Technical Report*, 108 PEDIATRICS 206 (2001) [hereinafter 2001 AAP Statement].

27. 2001 AAP Statement, *supra* note 26, at 206; 1993 AAP Statement, *supra* note 26, at 872.

28. 2001 AAP Statement, *supra* note 26, at 206.

29. *See, e.g.*, *id.*; Ivan Blumenthal, *Shaken Baby Syndrome*, 78 POSTGRADUATE MED. J. 732, 732 (2002) ("Families of children with subdural haemorrhages should be thoroughly investigated by social welfare agencies."); Andrew P. Sirotnak & Richard D. Krugman, *Physical Abuse of Children: An Update*, 15 PEDIATRICS IN REVIEW 394, 396 (1994) ("Most subdural hematomas in infancy are assumed to be caused by abuse until proven otherwise.").

30. Norman M. Rosenberg et al., *Retinal Hemorrhage*, 10 PEDIATRIC EMERGENCY CARE 303, 303 (1994).

31. James A. Monteleone, *Identifying, Interpreting, and Reporting*, *in* CHILD MALTREATMENT 1, 15 (James A. Monteleone & Armand E. Brodeur et al. eds., 1998).

32. *See, e.g.*, Shervin R. Dashti et al., *Current Patterns of Inflicted Head Injury in Children*, 31 PEDIATRIC NEUROSURGERY 302, 305-06 (1999) ("The increased incidence of retinal hemorrhage in abused children is a function of the unique mechanisms of injury involved. The

of retinal hemorrhages is virtually diagnostic of the violently shaken infant in the absence of severe accidental trauma."[33] A 2002 U.S. Department of Justice guide on investigating child abuse, still available online, advises: "According to all credible studies in the past several years, retinal hemorrhages in infants is, for all practical purposes, conclusive evidence of shaken baby syndrome in the absence of a good explanation,"[34] with the only "good" explanations listed in the guide as severe auto accidents and falls from several stories onto a hard surface.[35] Child abuse committees or working groups of major medical organizations, such as the AAP and the American Academy of Ophthalmology (AAO), issued statements identifying retinal hemorrhages as a characteristic or cardinal feature of SBS.[36]

The third finding deemed to indicate SBS was present in more serious cases, when the patients presented to the hospital with brain damage or dysfunction. This might take the form of cerebral edema (brain swelling), neurologic collapse, or other neurologic compromise.[37] Over time, proponents of the SBS diagnosis attributed the brain swelling and dysfunction to axonal and tissue tears within the brain, which, they reasoned, reflected shearing forces the brain sustained during violent shaking or other severe acceleration-deceleration trauma.[38]

It was common, particularly in more serious cases, for all three findings to be found together.[39] Given that each finding individually was

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vitreous of the young eye is firmly attached to the retinal capillary and to the lens. Shaking with sudden head deceleration is thought to shift the lens-vitreous complex sufficiently back and forth to pull on the retina and to tear the vascular attachments.").

33. Kenneth W. Reichert & Meic Schmidt, *Neurologic Sequelae of Shaken Baby Syndrome*, *in* THE SHAKEN BABY SYNDROME: A MULTIDISCIPLINARY APPROACH 79, 83 (Stephen Lazoritz & Vincent J. Palusci eds., 2001).

34. ROB PARRISH, U.S. DEP'T OF JUST., BATTERED CHILD SYNDROME: INVESTIGATING PHYSICAL ABUSE AND HOMICIDE 8 (4th ed. 2002) [hereinafter DOJ BATTERED CHILD SYNDROME GUIDE].

35. *Id.*

36. *See, e.g.*, 1993 AAP Statement, *supra* note 26, at 873; *See* Am. Acad. of Ophthalmology, *Abusive Head Trauma/Shaken Baby Syndrome* (2015), https://www.aao.org/clinical-statement/abusive-head-traumashaken-baby-syndrome.

37. *See, e.g.*, 2001 AAP Statement, *supra* note 26, at 208 (stating that shaking tears nerve fibers within the brain, causing diffuse axonal injury and brain swelling); David L. Chadwick et al., *Shaken Baby Syndrome – A Forensic Pediatric Response*, 101 PEDIATRICS 321 (1998) (arguing that SBS causes "swelling of the brain (cerebral edema) secondary to severe brain injury"); C. Y. Chen et al., *Neuroimaging in Child Abuse: A Mechanism-Based Approach*, 41 NEURORADIOLOGY 711, 713 (1999) ("[Shaken] infants typically have retinal haemorrhages, subdural and/or subarachnoid haemorrhage, and/or diffuse cerebral oedema with or without cerebral contusions.").

38. *See, e.g.*, National Association of Medical Examiners, Ad Hoc Comm. on Shaken Baby Syndrome, *Position Paper on Fatal Abusive Head Injuries in Infants and Young Children*, 22 AM. J. FORENSIC MED. & PATHOLOGY 112, 114, 120 (2001) [hereinafter NAME Position Paper].

39. *See, e.g.*, Chen, *supra* note 37, at 713.

thought to be so probative of significant trauma and SBS, when a child presented with all three (or even just subdural and retinal hemorrhage) the differential diagnosis basically was SBS or major accidental trauma akin to an unrestrained automobile crash or multi-story fall onto a hard surface.[40] Moreover, if the caregiver said the child had not been involved in any trauma or that the child had suffered accidental trauma such as a household fall, that meant the caregiver had given a false history.[41] That the caregiver had lied was regarded as further proof that abuse had occurred.[42]

By the 1990s, the child abuse literature routinely referred to SBS as a clearly defined medical diagnosis, defined by a "constellation" of injuries,[43] including (1) subdural and/or subarachnoid intracranial hemorrhage, (2) retinal hemorrhages sometimes accompanied by other retinal

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40. *See, e.g.*, Jeffrey M. Jentzen, *Pathological Findings in Fatal Shaken Impact Syndrome*, *in* THE SHAKEN BABY SYNDROME: A MULTIDISCIPLINARY APPROACH, *supra* note 33, at 199, 201 (stating that the "classical findings of retinal hemorrhages, subdural hematoma, and brain swelling cannot be fully explained by any other medical entity"); Reichert, *supra* note 33, at 84 ("For all practical purposes, however, retinal hemorrhages in association with acute subdural hemorrhaging means that a violent shaking with our without impact occurred."); *see also* Brian K. Holmgren, *Prosecuting the Shaken Infant Case*, *in* THE SHAKEN BABY SYNDROME: A MULTIDISCIPLINARY APPROACH, *supra* note 33, at 319 ("The expert who acknowledges the classic findings of SBS include subdural hematoma, retinal hemorrhage and edema, but chooses to ignore this constellation of findings in favor of an alternative hypothesis will appear foolish.").

41. *See, e.g.*, 2001 AAP Report, *supra* note 26, at 206 ("The constellation of these injuries does not occur with short falls . . . ."); DOJ BATTERED CHILD SYNDROME GUIDE, *supra* note 34, at 4 ("[S]tudies show that children do not die in falls from simple household heights; they do not even suffer severe head injuries from such falls."); *id*. at 7 ("Investigators must be aware that children do not die of simple falls.") (emphasis in original); Carole Jenny et al., Reply to Letters to the Editor, *Recognizing Abusive Head Trauma in Children*, 282 JAMA 1421, 1422 (1999) ("An extensive body of literature about injuries sustained in witnessed pediatric falls leads us to the conclusion that substantial force and distance are required to seriously injure children.").

42. *See, e.g.*, David L. Chadwick, *The Timing of Clinical Presentation after Inflicted Childhood Neurotrauma – Response*, *in* INFLICTED CHILDHOOD NEUROTRAUMA 76 (Robert M. Reece & Carol E. Nicholson eds., 2003) ("In fact, the gross discrepancy between the injury history (if any) and the observed pathology is usually the basis for the medical diagnosis of child abuse."); Rainer G. Gedeit, *Medical Management of the Shaken Infant*, *in* THE SHAKEN BABY SYNDROME: A MULTIDISCIPLINARY APPROACH, *supra* note 33, at 157 ("The Shaken Baby Syndrome is diagnosed by obtaining a history that does not fit the clinical findings in an infant who presents with significant neurological abnormalities."); Heather Keenan, *Nomenclature, Definitions, Incidence, and Demographics of Inflicted Childhood Neurotrauma*, *in* INFLICTED CHILDHOOD NEUROTRAUMA, *supra*, at 6-7 (identifying "History given is inconsistent with physical findings or no history of trauma given" as an example of "Probable Inflicted Injury"); Ann-Christine Duhaime et al., *Head Injury in Very Young Children: Mechanisms, Injury Types, and Ophthalmologic Findings in 100 Hospitalized Patients Younger than 2 Years of Age*, 90 PEDIATRICS 179, 184 (1992) ("Most determinations of nonaccidental injury are based on the notion of 'history insufficient to explain injuries,' " and creating an algorithm that identified when child abuse should be suspected or presumed when a history is given that the baby sustained no trauma or a short fall but has intracranial injury.).

43. *See, e.g.*, 2001 AAP Statement, *supra* note 26, at 209; Jentzen, *supra* note 40, at 200.

lesions, and (3) brain swelling and/or dysfunction.[44] A 1998 letter published by seventy-two leading child abuse specialists in Pediatrics, the AAP's journal, summarized the diagnostic criteria:

> The shaken baby syndrome (with or without evidence of impact) is now a well-characterized clinical and pathological entity with diagnostic features in severe cases virtually unique to this type of injury—[1] swelling of the brain (cerebral edema) secondary to severe brain injury, [2] bleeding within the head (subdural hemorrhage), and [3] bleeding in the interior lining of the eyes (retinal hemorrhages).[45]

The three SBS findings were often referred to as the SBS "triad."[46] As the 1997 edition of the then-leading treatise on child maltreatment explained: "SBS usually produces a diagnostic triad of injuries that includes diffuse brain swelling, subdural hemorrhage, and retinal hemorrhages. This triad must be considered virtually pathognomonic of SBS in the absence of documented extraordinary blunt force such as an automobile accident."[47]

C. SBS Diagnoses Become a Basis for Indictments, Dependency Actions, and Petitions to Sever Parental Rights

By the 1980s, based on guidance in the child abuse literature about the forensic specificity of the triad findings, prosecutors and child protection agencies began to bring SBS-based cases.[48] It is impossible to know how many such cases have since been brought, but the total is in the thousands.[49] That is, thousands of individuals have been prosecuted for child abuse or homicide crimes or had their children taken away from

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44. *See* PAPETTI, *supra* note 2, § 2.7.3, at 37.

45. Chadwick, *Forensic Pediatric Response*, *supra* note 37, at 321.

46. *See, e.g.*, Rob Parrish, *Executive Summary of the Third National Conference on Shaken Baby Syndrome* 1 (2000) ("Often referred to as the 'triad,' the consensus appears to be that a collection of (1) damage to the brain, evidenced by severe brain swelling and/or diffuse traumatic axonal injury; (2) bleeding under the membranes which cover the brain, usually subdural and/or subarachnoid bleeding; and, (3) bleeding in the layers of the retina, often accompanied by other ocular damage, when seen in young children or infants, is virtually diagnostic of severe, whiplash shaking of the head."), http://www.dontshake.org/media/k2/attachments/2000-SaltLakeCityProgram.pdf.

47. Robert A. Kirschner, *The Pathology of Child Abuse*, *in* THE BATTERED CHILD, 272-73 (Mary E. Helfer et al. eds., 5th ed. 1997).

48. *See, e.g.*, PAPETTI, *supra* note 2, at 27-29, 36; Tuerkheimer, *supra* note 24, at 2-7.

49. In 2013, the Medill Justice Project of Northwestern University, staffed by students studying investigative journalism, publicized a database that compiled over 3,000 cases in which a parent or caretaker had been criminally accused of SBS in the United States. *See* U.S. SHAKEN-BABY SYNDROME DATABASE, http://www.medilljusticeproject.org/u-s-shaken-baby-syndrome-database/ (last updated May 20, 2015). This figure is an estimate of criminal prosecutions and thus does not include the almost certainly greater number of family and juvenile court actions based in whole or in part on SBS.

them based on SBS diagnoses.[50]

Until recently, caretakers stood little chance in these cases. Beyond the normal challenges facing caretakers in child abuse cases, the forensic power physicians attributed to the triad findings was immense. Moreover, leading figures in child abuse pediatrics successfully enlisted the aid of prosecutors in advocating and promoting the forensic reliability of SBS.[51] For example, a chapter in a 2001 SBS text written by a leading child abuse prosecutor stated: "The expert who acknowledges the classic findings of SBS include subdural hematoma, retinal hemorrhage and edema, but chooses to ignore this constellation of findings in favor of an alternative hypothesis will appear foolish."[52]

As SBS-based prosecutions ramped up, and occasionally were met with effective defenses, it seems clear that prosecutors and child abuse specialists refined the diagnosis specifically to undermine those defenses. For example, the early guidance, including from Caffey, was that even seemingly harmless, low-force shaking could cause SBS-related brain injury.[53] The idea that non-violent shaking could cause SBS posed a problem towards establishing a criminal mens rea in some prosecutions.[54] Influential prosecutors and pediatric physicians openly expressed frustration and concern that other prosecutors, physicians, social workers, judges and juries did not view shaking as necessarily criminally culpable.[55] In 1993 and 2001, the AAP's Committee on Child

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50. *See id.*

51. *See, e.g.*, PAPETTI, *supra* note 2, at 36, 256; TUERKHEIMER, *supra* note 22, at 35-36, 39.

52. Holmgren, *supra* note 40, at 319.

53. *See* HOWARD A. DAVIDSON ET AL., CHILD ABUSE AND NEGLECT LITIGATION: A MANUAL FOR JUDGES 13 (1981) (defining what was then called the Whiplash-Shaken Infant Syndrome as follows: "Injury to an infant or child that results from that child having been shaken, usually as a misguided means of discipline. The most common symptoms, *which can be inflicted by seemingly harmless shakings*, are bleeding and/or detached retinas and other bleeding inside the head.") (emphasis added); Caffey II, *supra* note 17, at 161 (describing dangerous shakings as those that are "generally considered innocuous by both parents and physicians"); *id.* at 162 (noting that parents and physicians failed "to appreciate the grave significance of whiplash-shaking"); *id.* at 168 ("The pathogenicity of ordinary, casual, habitual, customary, repeated shaking of infants is generally unrecognized by physicians and parents.").

54. *See* Holmgren, *supra* note 40, at 282 ("Two recent decisions have overturned [SBS] convictions concluding that the evidence did not establish the defendant knew his actions would result in death."); *see also* O'Neill v. State, 681 S.W.2d 663, 668 (Tex. Ct. App. 1984) ("Although 'murder' and its various derivatives are certainly crimes, 'death' in and of itself is not. In fact, it appears that almost by definition, 'infant shake syndrome' lacks the requisite intent for the crime of murder as defined within the laws of this state. From the medical testimony introduced at trial, infant shake syndrome is an abnormal response to what is all too frequently a typical reaction to parental frustration. Merely shaking a child, without any additional aggravating facts, would generally be insufficient to prove the intent to cause death or even serious bodily injury necessary for murder.").

55. *See* Barbara A. Eagan et al., *The Abuse of Infants by Manual Shaking: Medical, Social and Legal Issues*, 72 J. FLA. MED. ASS'N 503, 503-04 (July 1985) (complaining that

Abuse and Neglect, a society of pediatric physicians, weighed in on the mens rea issue and abandoned the prior guidance that even seemingly innocuous shaking could cause the SBS findings.[56] The AAP Committee advised that "the act of shaking" capable of causing SBS "is so violent that individuals observing it would recognize it as dangerous and likely to kill the child."[57] The U.S. Department of Justice was even more descriptive about what the triad findings revealed about the nature of the perpetrator's conduct: "Experts say that an observer watching the shaking would describe it 'as hard as the shaker was humanly capable of shaking the baby' or 'hard enough that it appeared the baby's head would come off.'"[58] Physicians testifying for prosecutors were encouraged to utilize such analogies to drive home the amount of violence supposedly necessary to cause the SBS findings. For example, the chapter by the prosecutor in the SBS text urged that physicians "can testify that the forces the child experiences [during shaking] are the equivalent of a [fifty to sixty] m.p.h. unrestrained motor vehicle accident, or a fall from three to four stories onto a hard surface."[59] The case law confirms that medical experts indeed frequently testified with such analogies when explaining the diagnostic significance of the triad findings.[60] When defendants challenged the analogies, prosecutors responded that they were necessary to convey the violence of the caregiver's conduct.[61]

III. SBS BECOMES CONTROVERSIAL

The Statement makes no serious effort to describe why SBS/AHT became controversial. It instead warns courts that "denialism of child abuse has become a significant medical, legal and public health policy

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agency workers and prosecutors too often viewed shaking-inflicted injuries as reflecting parental ignorance rather than serious culpability).

56. 2001 AAP Statement, *supra* note 26, at 206; 1993 AAP Statement, *supra* note 26, at 872.

57. 2001 AAP Statement, *supra* note 26, at 206.

58. DOJ BATTERED CHILD SYNDROME GUIDE, *supra* note 34, at 9; *see also id.* ("The shaking necessary to cause death or severe intracranial injury is never an unintentional or nonabusive action.").

59. Holmgren, *supra* note 40, at 307. Holmgren emphasized that such expert testimony helps prove "the *mens rea* requirements for the charge." *Id.*

60. *See, e.g.*, People v. Evers, 12 Cal. Rptr. 2d 637, 640 (Ct. App. 1992) (Dr. Chadwick testified that "Michael's head injuries would have required a substantial impact, equivalent at least to a 10 foot drop and possibly a 20 to 30 foot fall."); Jones v. State, 439 S.E.2d 645, 647 (Ga. 1994) (The prosecution medical expert testified "that these injuries could be caused if the child were dropped; however, the fall would have to be from a third or fourth floor of a building."); State v. Ojeda, 810 P.2d 1148, 1151 (Idaho Ct. App. 1991) ("The doctor stated that this particular injury could be caused by either a motor vehicle accident, a fall from fourteen feet, or rapid shaking of the head.").

61. *See, e.g.*, People v. Martinez, 74 P.3d 316, 325 (Colo. 2003) ("The prosecution and amici have expounded on the necessity of accident scenarios [i.e., references to unrestrained automobile crashes and multi-story falls] to establish a defendant's mens rea.").

problem,"[62] that "[t]he denialists have tried to create a medical controversy where there is none,"[63] and that "defense attorneys and the medical witnesses who testify for them have been disseminating inaccurate and dangerous messages that are often repeated by the news media."[64] But the controversy has nothing to do with any "denialism" about child abuse or any campaign to misinform the public.

Here is a summary of the developments that have exposed serious flaws in SBS/AHT and rendered the diagnosis so controversial.

A. Mistaken Biomechanical Premises

1. Shaking Produces Low Acceleration-Deceleration Forces

Biomechanics is the study of how forces affect the human body. Physicians often describe SBS in biomechanical terms—i.e., via references to "acceleration-deceleration," to "rotational" forces purportedly involved in shaking and how these forces affect babies, and with analogies to extraordinary biomechanical trauma such as occurring in automobile accidents and multi-story falls. Indeed, the central premise of SBS is biomechanical: that shaking generates forces sufficient to rip veins emerging from the brain, damage retina, and shear brain tissue. Pediatric doctors, however, are not biomechanical experts. They have little or no training or experience in measuring the forces a human endures during particular trauma (e.g., shaking or a fall onto one's head), or predicting what injuries can or will result from such trauma.

SBS and its corollary biomechanical beliefs became accepted without any biomechanical validation. In 1987, which was after the SBS diagnosis had become well-established in both medicine and the courtroom, Ann-Christine Duhaime et al. constructed models of infants with various neck and head properties in order to measure the forces created by shaking and impact.[65] They had volunteers vigorously shake the models while they measured the forces generated. But no matter how hard the volunteers shook the models, the shaking did not generate acceleration measurements anywhere near those estimated as necessary to tear cortical bridging veins and cause subdural hemorrhage or other intracranial injury.[66] By contrast, when the volunteers impacted the models' heads against a metal bar or even a padded surface the impacts exceeded the thresholds for subdural hemorrhage and brain injury.[67] This

62. *Consensus Statement*, *supra* note 3, at 1050.
63. *Id.* at 1059.
64. *Id.* at 1050.
65. Ann-Christine Duhaime et al., *The Shaken Baby Syndrome: A Clinical, Pathological, and Biomechanical Study*, 66 J. NEUROSURG. 409 (1987).
66. *Id.* at 411-14.
67. *Id.*

led the researchers to conclude shaking alone is unlikely to cause the injuries associated with shaken baby syndrome and, instead, impact is necessary.[68] This led some physicians to start diagnosing "shaking-impact" or to use the term "Shaken-Impact Syndrome" rather than SBS.[69]

Since the Duhaime study, several other biomechanical studies have similarly concluded that even violent shaking fails to generate biomechanical conditions that exceed estimated tolerance levels for subdural hemorrhage and intracranial injury.[70] These studies further establish that shaking produces biomechanical conditions nowhere near those present in motor vehicle accidents or multi-story falls.[71] A study by Michael T. Prange et al. found that human shaking generates biomechanical conditions roughly equivalent to a one-foot fall onto carpet.[72] The motor vehicle and multi-story fall analogies, which filled the child abuse literature and courtrooms for decades (and are still believed and utilized by many pediatric physicians), were without basis. And while the biomechanical findings do not mean that shaking can never tear cortical veins or inflict brain injury, the testing, at a minimum, indicates that shaking should not be expected to cause those injuries other than perhaps in rare or extreme circumstances.

In passing, the Statement acknowledges that "[t]here still remains discussion over whether shaking alone or shaking with blunt trauma is necessary for the injuries of these abused children."[73] This extraordinary acknowledgement about the uncertainty of the shaking hypothesis comes more than thirty years after physicians and prosecutors began convicting caretakers based on SBS. If consensus exists that one cannot reliably

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68. *Id.* at 413-14.

69. *See* Derek A. Bruce & Robert A. Zimmerman, *Shaken Impact Syndrome*, 18 PEDIATRIC ANNALS 482, 492-94 (1989) ("In light of this study (the only one to attempt to examine the forces that can be produced by shaking), we can conclude that severe acute brain trauma cannot be produced in the infant by shaking alone, and that the mechanism of injury should more appropriately be referred to as shaking *impact* injury.").

70. *See, e.g.*, Michael D. Jones et al., *Development of a Computational Biomechanical Infant Model for the Investigation of Infant Head Injury by Shaking*, 55 MED. SCI. L. 291, 292, 296-97 (2015); John Lloyd et al., *Biomechanical Evaluation of Head Kinematics During Infant Shaking Versus Pediatric Activities of Daily Living*, 2 J. FORENSIC BIOMECHANICS 1 (2011); 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, 94 (2004). For a fuller discussion of the biomechanical literature, see PAPETTI, *supra* note 2, § 3.1.1.

71. *See* PAPETTI, *supra* note 2, at 87 ("The clear implication of this research is that even violent shaking does not generate acceleration-deceleration or rotational forces anywhere close to those in an unrestrained car accident or multi-story fall. The car crash and multi-story fall comparisons that were so ubiquitous in 2001 (and for several years thereafter) were not based on, and appear contrary to, science.").

72. Michael T. Prange et al., *Anthropomorphic Simulations of Falls, Shakes, and Inflicted Impacts in Infants*, 99 J. NEUROSURG. 143 (2003).

73. *Consensus Statement*, *supra* note 3, at 1051.

diagnose shaking from the internal findings, as the Statement grudgingly seems to accept, then it remains unclear why the Statement so confidently advises that children with the findings were nevertheless "abused."

2. Short Falls Can Cause the Triad Findings and Death

Until the late 1980s, medical literature frequently recognized the potential of infants and young children to suffer subdural and retinal hemorrhage, brain injury, and, occasionally, death after relatively short falls and other similar household accidents.[74] Even Caffey observed that "children have developed severe subdural hematomas, often, after falls of only [two or three] feet."[75] In 1991, however, a paper by David L. Chadwick, a leading child abuse pediatrician, advised that these past reports should be viewed skeptically and suggested that the reports of fatal short falls likely were missed cases of abuse.[76] Following Chadwick's paper, leading figures in child abuse pediatrics began categorically advising that an infant or young child's subdural or retinal hemorrhages, brain injury, or death could not be explained by a short fall.[77] The 2001 AAP Statement on SBS flatly advised that the "constellation of these injuries does not occur with short falls."[78] The Department of Justice similarly guided that "studies show that children do not die from simple household heights; they do not even suffer severe head injuries from such falls."[79] Prosecution experts frequently testified that a household fall or similar accident could not explain subdural or retinal hemorrhage,

74. *See, e.g.*, Nobuhiko Aoki & Hideaki Masuzawa, *Infantile Acute Subdural Hematoma*, 61 J. NEUROSURGERY 273 (1984) (reporting on twenty-six infants who suffered subdural and retinal hemorrhage from short falls or household accidents, including two deaths); *see also* John R. Hall et al., *The Mortality of Childhood Falls*, 29 J. TRAUMA 1273 (1989) (reporting on eighteen childhood deaths from falls sustained while running or from falls of less than three feet, including two that happened while the infant was under medical supervision). As clarified later by Hall, *see* Letter to the Editor, *Short Falls Can Be Lethal*, 121 PEDIATRICS (Aug. 13, 2009) [hereinafter Hall's Letter to the Editor], of the eighteen children who died, two were carried by parents who fell on ice, five fell while playing, eight fell off an object, three fell down steps, fifteen had subdural hemorrhage.

75. *See* John Caffey, *Significance of the History in the Diagnosis of Traumatic Injury to Children*, 67 J. PEDIATRICS 1008, 1014 (1965) ("[C]hildren have developed severe subdural hematomas, often, after falls of only a short distance of 2 or 3 feet.").

76. David L. Chadwick et al., *Deaths from Falls in Children: How Far is Fatal?*, 31 J. TRAUMA 1353 (1991).

77. *See, e.g.*, *supra* note 41 and accompanying text; Robert M. Reece, *Controversies in Shaken Baby/Shaken Impact Syndrome*, *in* THE SHAKEN BABY SYNDROME: A MULTIDISCIPLINARY APPROACH, *supra* note 33, at 380 ("The conclusion from all of these studies is that short falls do not cause life-threatening serious injuries of the kind seen in SBS/SIS.").

78. 2001 AAP Statement, *supra* note 26, at 206.

79. DOJ BATTERED CHILD SYNDROME GUIDE, *supra* note 34, at 4.

let alone brain injury or death.[80]

In 2001, a paper by John Plunkett reported on eighteen children's deaths from corroborated accidents on play equipment.[81] Although the children were not infants (age range twelve months to thirteen years), one of the cases involved a videotaped fall of a twenty-three-month old toddler in the carpet-covered garage of her home.[82] While being filmed by her grandmother, she was playing on a platform of a plastic play structure when she climbed and fell over the rail, which was about forty-two inches above the ground.[83] Despite trying to break her fall with her outstretched arms, she hit her head on the floor.[84] After the fall, she cried, drank, and talked, but soon vomited, became dazed, and eventually died.[85] The hospital findings included the SBS triad—all from a short fall.[86]

Since Plunkett's paper "several additional studies have been published that provide further support for the view that subdural hematomas, retinal hemorrhages, and other forms of significant head injury can result from accidental short falls."[87] For example, a 2017 paper reported on eight cases of witnessed accidental short falls onto the back of a child's head (average child age 12.5 months), which all produced subdural and retinal hemorrhage, including one death.[88] In addition, biomechanical analysis confirms that short falls, unlike shaking, can generate conditions that exceed estimated thresholds for subdural hemorrhage and brain injury.[89] As a chapter on biomechanics in a forensic neuropathology treatise summarizes: "Impacts, including those produced by falling

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80. *See, e.g.*, People v. Basuta, 114 Cal. Rptr. 2d 285, 293 (Ct. App. 2001) ("Dr. Alexander stated studies indicated that short falls do not cause serious brain injuries. In a small percentage of short fall cases, a minor skull fracture can occur and cause no internal injury. Short falls do not cause subdural bleeding.").

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

82. *Id.* at 1, 4.

83. The Plunkett paper states that the platform was 28 inches above the ground. *Id.* at 4. Plunkett and a co-author subsequently clarified in a separate paper that the rail over which the child fell was 42 inches above the ground. *See* Goldsmith & Plunkett, *supra* note 70, at 95.

84. Plunkett, *supra* note 81, at 4.

85. *Id.*

86. *Id.*

87. Commonwealth v. Epps, 53 N.E.3d 1247, 1264 (Mass. 2016).

88. *See* Norrell Atkinson et al., *Childhood Falls with Occipital Impacts*, 34 PEDIATRIC EMERGENCY CARE 837 (2018) (reporting on eight children, average age 12.5 months, with subdural and retinal hemorrhage after witnessed short falls onto the back of their heads, including one death); *see also* PAPETTI, *supra* note 2, § 3.1.2 (collecting numerous case reports and papers regarding triad injuries and deaths resulting from short falls).

89. *See, e.g.*, A. K. Ommaya et al., *Biomechanics and Neuropathology of Adult and Paediatric Head Injury*, 16 BRIT. J. NEUROSURGERY 220, 226 (2002) ("Hence, the [3-4 foot] fall generates a load about 10 times greater than can be achieved by SBS and in substance can clearly produce these injuries [concussion, subdural hemorrhage, subarachnoid hemorrhage, and deep brain hemorrhages].").

from heights less than [four] feet, can produce forces at least one order of magnitude larger than shaking."[90] Yet, pediatric physicians regularly rejected short falls as a plausible history, while insisting that shaking was a better biomechanical explanation for the child's findings.[91] Several courts in recent years have reopened past convictions where the caregiver provided a history that the child had fallen, but judges or juries had rejected that history due to inaccurate physician testimony that a short fall could not explain the SBS findings.[92] As one court remarked in 2014, there has been a "sea change" in understanding about the potential lethality of short falls and their ability to produce the triad findings.[93] The former SBS dogma, that children do not die in short falls, "has been proven false."[94]

The Consensus Statement fails to acknowledge that, for decades, major medical organizations and leading figures in child abuse pediatrics gave mistaken guidance and testified inaccurately about the potential dangers of short falls and that a history of a short fall can, in fact, explain the child's triad findings. The Statement purports to advise courts, but fails to address what courts should do to review the convictions of caretakers who relayed a history of a short fall, yet were convicted because physician experts and prosecutors insisted that history was necessarily false. Indeed, the Statement is worrisome in that it signals a continuing resistance to the realities of short falls.[95]

The Statement argues that the models used in the short fall biomechanical studies lack "complete biofidelic integrity."[96] That is true, but the models are well-suited to their primary function—to measure forces and conditions during particular traumatic events, and the studies using the models clearly show that short falls with primary head impact predictably involve biomechanical conditions sufficient to cause intracranial injury, while shaking does not.[97] The Statement also warns that the

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90. David Fowler, *Biomechanics of Injury*, *in* ESSENTIAL FORENSIC NEUROPATHOLOGY 68 (Juan C. Troncoso et al. eds., 2010).

91. *See, e.g.*, *supra* notes 77-79 and accompanying text.

92. *See, e.g.*, Commonwealth v. Epps, 53 N.E.3d 1247 (Mass. 2016); People v. Bailey, 999 N.Y.S.2d 713 (Monroe Cty. Ct. 2014), *aff'd*, 41 N.Y.S.3d 625 (App. Div. 2016).

93. *Bailey*, 999 N.Y.S.2d at 724.

94. *Id.* (finding that the "mainstream belief in 2001-2002, espoused by the Prosecution's expert witnesses at Trial, that children did not die from short falls, has been proven to be false").

95. *See Consensus Statement*, *supra* note 3, at 1052, 1059.

96. *Id.* at 1052.

97. *See supra* notes 65-72 & 88-89 and accompanying text; LEESTMA, *supra* note 8 (discussing and presenting tables from the work of Van Ee, a biomechanical engineer, which show that shaking produces much less acceleration than short falls); *Feigned Consensus*, *supra* note 7, at 12-13 ("To rely on brain and eye injuries to diagnose SBS or AHT, despite a caretaker's report of a short fall (as happens with some regularity), is inherently controversial, given that the biomechanical research so strongly points to the short fall as the much more plausible

predictions from any biomechanical study should not be accepted if they deviate too much from real-life experience.[98] This warning is another instance where the views of the Statement's authors are postured as superior to the results of scientific studies. It is also a curious protest given that the biomechanical literature is consistent with the many confirmed cases of short falls and other household accidents leading to the triad findings.[99] By contrast, there remains no videotaped or even documented witnessed cases of shaking (without impact) resulting in the triad findings or death,[100] a reality consistent with the results of the biomechanical studies on shaking.

The Statement also advises that non-focal subdural hematomas "are rarely consistent with a history of a short fall of less than four feet," because "extensive literature demonstrates that severe intracranial injury from short falls is rare."[101] It is true that only a tiny percentage of falls will result in intracranial hemorrhage, brain injury, or death. But all children fall; some are more vulnerable to intracranial injury than others; and even a small percentage of millions of falls will annually produce numerous cases of intracranial injury and even death. In seeking to downplay the danger of short falls, the Statement cites very controversial literature. In particular, it cites Chadwick's 1991 paper[102] and his follow-up paper in 2008.[103] Chadwick is a questionable source for the Statement to deem authoritative on this issue given the mistaken understandings traceable to his 1991 paper. As the Supreme Court of Massachusetts noted, Chadwick supported his conclusions in his 1991 paper by deeming short-fall cases reported in older literature as missed cases of abuse.[104] Remarkably, Chadwick's 2008 paper does the same thing and thus, again, has been subject to pointed criticism.[105] The 2008 paper

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cause of the injuries."). Other easily understandable illustrations and a video featuring Van Ee comparing the biomechanical conditions in a shaking episode to other traumatic events can be found in Debbie Cenziper et al., *Doctors Who Diagnosed Shaken Baby Syndrome Now Defend the Accused*, WASH. POST, Mar. 23, 2015, https://www.washingtonpost.com/graphics/investigations/shaken-baby-syndrome/Former-medical-examiner-Alleged-cases-of-pure-shaking-are-unusual.html.

98. *See Consensus Statement*, *supra* note 3, at 1053.

99. *See, e.g.*, PAPETTI, *supra* note 2, § 3.1.2.

100. *See id.* at 152.

101. *Consensus Statement*, *supra* note 3, at 1052.

102. *See* Chadwick, *Deaths from Falls*, *supra* note 76.

103. *See* David L. Chadwick et al., *Annual Risk of Death Resulting from Short Falls Among Young Children: Less Than 1 in 1 Million*, 121 PEDIATRICS 1213 (2008). *Consensus Statement*, *supra* note 3, references the Chadwick papers at page 1053.

104. *See* Commonwealth v. Epps, 53 N.E.3d 1247, 1261 n.17 (Mass. 2016) (noting this potential methodological shortcoming of the 1991 Chadwick article).

105. *See, e.g.*, Hall's Letter to the Editor, *supra* note 74 (explaining that the 2008 Chadwick paper erroneously deemed the eighteen fatalities attributed to falls in Hall's 1989 paper, *supra* note 74, as not validated when in fact each case was extensively investigated and two of the fatal short falls occurred in medical facilities). For a fuller critique of the Chadwick

also relies heavily on hospital and epidemiological data from 1999-2003 showing that physicians only very rarely classified fatal head injuries as resulting from short falls.[106] But during that timeframe the AAP, the DOJ, and leading child abuse specialists (largely on the basis of Chadwick's 1991 paper) improperly informed physicians and investigators to reject a history of a short fall because such falls allegedly could not cause the triad findings or death.[107] Thus, virtually all histories of such household accidents akin to a short fall were rejected in favor of SBS/AHT. With such self-fulfilling circularity built into the data, there are no reliable historic statistics to assess the frequency with which short falls will cause the triad or prove fatal. Moreover, it is an ecological fallacy to apply statistics about the general population to any individual case.[108]

As a matter of proven fact, short falls in infants and young children can and do cause subdural hemorrhage, retinal hemorrhages, retinal folds and schisis, and death. Accordingly, as a matter of forensic medicine, absent significant physical or investigatory evidence of abuse beyond the triad findings, there is no medical basis in such cases to rule out a short fall as an explanation for those findings.[109]

3. The Absence of Significant Neck Injury

Despite SBS being premised on a belief that SBS victims are whiplashed so violently that their brains and eyes are damaged and bleed, until recently most literature reported that significant neck and cervical injuries are rare in purported SBS/AHT cases.[110] Nor did the literature

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paper and why it should not be used in judicial proceedings, see Maria Cuellar, *Short Fall Arguments in Court: A Probabilistic Analysis*, 50 U. MICH. J.L. REFORM 763 (2017).

106. Chadwick, *Annual Risk of Death*, *supra* note 103, at 1214.

107. *See supra* notes 46 & 76-79 and accompanying text.

108. For a discussion of how statistics are misused in the SBS/AHT debate, see Keith A. Findley et al., *Shaken Baby Syndrome, Abusive Head Trauma, and Actual Innocence: Getting it Right*, 12 HOUS. J. HEALTH L. & POL'Y 209, 286-90 (2012).

109. *See, e.g.*, Sarathchandra Kodikara & Michael Pollanen, *Shaken Baby Syndrome and the Legal Perspective*, *in* LEGAL AND FORENSIC MEDICINE 1373, 1378 (Roy Beran ed. 2013) ("Overall, it seems that a short fall rarely can cause fatal head injury and SDH, RH and HIE. In most cases, the appearance of an isolated impact injury, at autopsy, cannot exclude a fall."); *id.* at 1381 ("The single most common condition which could mimic SBS is accidents due to short falls."); L.J. Dragovic, *Neuropathology of Brain Trauma in Infants and Children*, *in* ESSENTIAL FORENSIC NEUROPATHOLOGY, *supra* note 90, at 193 ("The forensic neuropathologist should be aware that short-distance falls can cause fatal head injuries in children, and that these injuries may mimic those of presumed shaken baby syndrome.").

110. *See* Reece, *supra* note 77, at 384 ("Injuries to the neck muscles or cervical vertebrae are distinctly uncommon in SBS/SIS."); Wilbur R. Smith, *Radiographic Evaluation of Inflicted Neurotrauma – Response*, *in* INFLICTED CHILDHOOD NEUROTRAUMA, *supra* note 42, at 125 ("While intuitively one would suspect injury of the craniovertebral junction in shaking, the data on prevalence is not convincing."); Kenneth W. Feldman et al., *Cervical Spine MRI in Abused Infants*, 21 CHILD ABUSE & NEGLECT 199, 202 (1997) (finding no evidence by MRI of cervical cord injury or bleeding around the cord in 12 cases studied); *see also* People

report that surviving alleged SBS/AHT victims frequently have symptoms referable to their necks. This represented a new challenge to SBS in that it makes little sense to regard the triad findings as proof of severe whiplash forces when so few alleged SBS victims have significant neck or cervical injury, especially given that biomechanical papers counsel that in most cases whiplash shaking will cause serious neck injury before intracranial injury.[111]

The initial responses of SBS/AHT proponents to this challenge were unpersuasive. They were mostly in the nature of speculation that the neck and spine of infants and young children must be especially resistant to injury.[112] More recently, the child abuse literature began claiming that SBS/AHT victims actually do commonly have neck injury, but that the neck injury either was not looked for until recently (a false claim) or was only recently discovered.[113] The Consensus Statement cites a 2014 study from Arabinda K. Choudhary et al., which reported finding spinal "ligamentous abnormalities" on MRI in a high percentage of AHT victims.[114] The Statement chides that "[p]rior to knowledge of the ligamentous injury, those who denied the existence of the shaken baby mechanism used 'lack of spinal injury' to boost their unfounded theory."[115] It is not clear what "unfounded theory" the Statement is referencing. But if the theory is that very few children diagnosed as SBS victims have neck injury that one would expect from repetitive violent shaking, then nothing in the Choudhary paper disproves that theory.

The Choudhary paper may prove to be an important contribution. But at present it is quite a leap to urge courts or anyone else to make

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v. Basuta, 94 Cal. App. 4th 370, 382 (Ct. App. 2001) (forensic pathologist called by the prosecution "stated that the lack of injury to Oliver's neck did not contraindicate SBS since in the vast majority of cases such injuries are not seen").

111. *See, e.g.*, Fowler, *supra* note 90, at 68 ("One concern is that the forces generated by shaking alone are insufficient to produce significant brain injury. Another concern is that forces capable of producing brain injuries would also have to produce significant cervical spine and cervical cord/brainstem contusions."); Waney Squier & Julie Mack, *The Neuropathology of Infant Subdural Haemorrhage*, 187 FORENSIC SCI. INT'L 6, 12 (2009) ("The forces required to cause bridging vein rupture would exceed the strength of the infant neck; indeed, infants restrained in car seats and subjected to rapid deceleration and neck hyperflexion (whiplash) in road traffic accidents have cervical fractures and nerve root avulsion rather than SDH. Any infant shaken sufficiently violently to produce SDH would be expected also to have injury to the bones and soft tissues of the neck and spinal cord.").

112. *See, e.g.*, Jacy Showers, *Executive Summary of the Second National Conference on Shaken Baby Syndrome* 14 (2000) ("Spinal cord injuries in SBS victims are reportedly uncommon, in part because the spinal column in babies is very soft and flexible.").

113. *See* Laura K. Brennan et al., *Neck Injuries in Young Pediatric Homicide Victims*, 3 J. NEUROSURGERY PEDIATRICS 232 (2009). In reality, emergency rooms have routinely done advanced imaging for cervical injury in potential SBS/AHT victims since the late 1980s, yet such injuries were only rarely found. *See* PAPETTI, *supra* note 2, § 2.7.5.

114. Arabinda K. Choudhary et al., *Imaging of Spinal Injury in Abusive Head Trauma: A Retrospective Study*, 44 PEDIATRIC RADIOLOGY 1130 (2014).

115. *Consensus Statement*, *supra* note 3, at 1054-55.

medical or legal decisions based on that paper. Choudhary reported the same MRI-based ligamentous abnormalities in forty-six percent of children who sustained accidental trauma[116] and a separate 2014 study found that those MRI signs "did not … help discriminate between accidental and abusive head trauma."[117] Furthermore, the Choudhary paper adds no insight into how significant trauma must be to cause these ligamentous abnormalities. One of Choudhary's cases had the findings merely after a prolonged seizure.[118] Even more fundamentally, MRI often cannot even confirm that this kind of MRI abnormality reflects injury from trauma, as opposed to mere edema (swelling of soft tissue), which can develop after brain injury (including brain injury due to lack of oxygen), which was common in the children in the Choudhary paper.[119] Indeed, Choudhary et al. acknowledged that they had "no pathological confirmation that the findings in the study are directly trauma related."[120]

In sum, while SBS/AHT proponents now sometimes claim that neck findings are common instead of rare in purported SBS/AHT cases, the reality remains that neck findings consistent with the extreme force supposedly present in such cases are, indeed, rare.

B. The Mistaken Pathophysiological Premises

The triad findings have served as the primary basis for SBS diagnoses since the early 1980s. But once investigators began evaluating the basis for connecting these findings to shaking and abuse, they discovered that the beliefs were based on assumption, subject to many exceptions, and, in key respects, altogether wrong.

1. Subdural Hemorrhage

Recall that in both its 1993 and 2001 Statements on SBS, the AAP advised that a "presumption of child abuse" is warranted whenever an infant has intracranial injury, such as subdural hemorrhage.[121] Subdural hemorrhage was deemed to be reliable proof of shaking or of severe head trauma because physicians believed the hemorrhage results from brain

116. *See* Choudhary, *supra* note 114.

117. *See* Nadja Kadom et al., *Usefulness of MRI Detection of Cervical Spine and Brain Injuries in the Evaluation of Abusive Head Trauma*, 44 PEDIATRIC RADIOLOGY 839, 839 (2014).

118. Choudhary, *supra* note 114, at 1139.

119. *See* Kadom, *supra* note 117, at 843 (stating that it is "known that MRI has poor ability to differentiate ligamentous rupture from edema or hemorrhage"); Choudhary, *supra* note 114, at 1138 (reporting a high association between the ligamentous findings and hypoxic-ischemic injury).

120. Choudhary, *supra* note 114, at 1139.

121. *See* 2001 AAP Statement, *supra* note 26, at 206; 1993 AAP Statement, *supra* note 26, at 872.

displacement.[122] More specifically, what are referred to as bridging veins extend at certain points from the brain through the arachnoid membrane and into the dura, another membrane encasing the brain.[123] Where the veins are extended, they can rupture or tear when the brain itself is displaced,[124] and the blood that escapes from such traumatized veins may pool in an area between the arachnoid and dural membranes known as the subdural space. Since in healthy children considerable force is usually necessary to displace a brain enough to rupture or tear bridging veins, physicians assumed that children with unexplained subdural hemorrhage had sustained significant trauma.[125] And because the AAP and other pediatric experts promoted that violent shaking is a common and effective means of causing such brain displacement, bridging vein rupture, and resulting subdural hemorrhage, physicians presumed SBS when a child presented with subdural hemorrhage and no given history of major trauma.[126]

This reasoning, however, was grossly oversimplified. In a landmark study published in 2001, Jennian Geddes and colleagues observed that the subdural hemorrhage they saw in the very young children diagnosed as SBS/AHT victims often was very different from that seen in adults who suffer traumatic head injury.[127] The hemorrhage in the children

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122. *See, e.g.*, NAME Position Paper, *supra* note 38, at 115 ("Even a small amount of subdural hemorrhage indicates that brain displacement has been produced.").

123. *See, e.g.*, PAPETTI, *supra* note 2, at 323-28 & fig. 5 (discussing and providing illustrations of the relevant anatomy).

124. *See, e.g.*, 2001 AAP Statement, *supra* note 26, at 208 ("Subdural hemorrhage caused by the disruption of small bridging veins that connect the dura to the pia arachnoid is a common result of shaking."); Blumenthal, *supra* note 29, at 732 ("Movement of the brain within the subdural space causes stretching and tearing of the bridging veins, which extend from the cortex to the dural venous sinus. The loss of blood, typically 2-15 ml, into the subdural space is not of itself harmful. It provides firm evidence of shaking in the absence of a history of severe accidental head trauma."); Mary Case, *Head Injury in Child Abuse*, *in* CHILD MALTREATMENT, *supra* note 31, at 95-96 ("The pathophysiological consequences of shaking primarily consist of diffuse axonal injury produced by the acceleration of the head as it moves rapidly forward and backward.... Another finding in shaking is subdural hemorrhage resulting from tearing of the bridging veins between the cortex and dura[.]"); Glenn A. Tung et al., *Comparison of Accidental and Nonaccidental Traumatic Head Injury in Children on Noncontrast Computed Tomography*, 118 PEDIATRICS 626, 630 (2006) ("With rapid to-and-fro motion, the brain and bridging superficial cortical veins move at a different rate than the calvarium and attached dural venous sinuses. As a result, the rupture of cortical veins may create a hematoma in the subdural space.").

125. *See, e.g.*, Thomas Pittman, *Significance of A Subdural Hematoma in a Child with External Hydrocephalus*, 39 PEDIATRIC NEUROSURGERY 57, 57 (2003) ("Most physicians take the presence of a subdural hematoma in a child without a history of trauma as presumptive evidence of abuse. This assumption rests on our understanding of the pathophysiology of subdural hemorrhage; subdural hematomas are caused by tearing intracranial bridging veins and it requires substantial force to rupture the veins and cause bleeding.").

126. *See, e.g.*, *supra* notes 25-29 and accompanying text.

127. *See* J. F. Geddes et al., *Neuropathology of Inflicted Head Injury in Children: I. Patterns of Brain Damage*, 124 BRAIN 1290, 1297 (2001) [hereinafter Geddes I].

often was trivial in amount and in the nature of "thin film," which contrasted with the more voluminous, space-occupying subdural hematomas found in older children and adults attributed to bridging vein rupture.[128] Geddes et al. posed the question whether, "given the differences between 'adult'-type subdurals and those seen in infants in [non-accidental injury], are the conditions or forces that produce the two necessarily the same?"[129]

Several papers have since confirmed Geddes et al.'s observation that the subdural hemorrhage in many SBS/AHT cases is in the nature of thin film rather than hematoma.[130] Whether one can reliably infer bridging vein rupture from scant or thin film hemorrhage is questionable. Bridging veins carry considerable blood.[131] A traumatic rupture of even a single vein should result in more intracranial hemorrhage than present in many SBS cases.[132] Nor are ruptured bridging veins typically identified at autopsy in such cases.[133]

So what, then, is the source of the thin film hemorrhage? In 2009, Julie Mack, a radiologist, and Waney Squier, a pediatric neuropathologist, co-authored papers urging that thin film subdural hemorrhage in infancy can result from vascular leakage within the dura itself, as opposed to from torn bridging veins.[134] Such "intradural" hemorrhage can

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128. *See id.* at 1292, 1295, 1297.

129. *Id.* at 1297.

130. *See, e.g.*, Jeanne E. Bell, *The Neuropathology of Non-Accidental Head Injury*, *in* SHAKING AND OTHER NON-ACCIDENTAL HEAD INJURIES 345, 359 (Robert A. Minns et al., eds., 2006) ("It is clear from the above discussion that considerable uncertainties still remain regarding the pathogenesis of NAHI and this leads to dilemmas of interpretation. The debate hinges around the following facts. In infants, the SDH is often 'trivial' and certainly not space occupying …."); Janice J. Ophoven & Judy A. Olein, *Childhood Head Trauma—Forensic Approach*, *in* FORENSIC SCIENCES § 25G.04[f][1] (Cyril H. Wecht ed. 2008) ("Subdural hemorrhage in young infants is more typically a thin layer of blood over the hemispheres or within the interhemispheric fissure."); Marvin S. Platt et al., *The Abused Child and Adolescent*, *in* SPITZ AND FISHER'S MEDICOLEGAL INVESTIGATION OF DEATH 379 (Werner U. Spitz et al. eds., 4th ed. 2006) ("The subdural hemorrhage associated with abusive head trauma in children often consists of a widely distributed thin film of blood.").

131. *See, e.g.*, Steven C. Gabaeff, *Challenging the Pathophysiologic Connection Between Subdural Hematoma, Retinal Hemorrhage and Shaken Baby Syndrome*, 12 W. J. EMERGENCY MED. 144, 147-49 (2011).

132. *Id.*; Matshes et al., *supra* note 2, at 88 ("One would expect that rupture of a bridging vein would result in larger, more often unilateral, space occupying SDH, rather than the classically described thin, bilateral, non-space occupying hemorrhages identified in shaking and impact head trauma cases."); Waney Squier, *The "Shaken Baby" Syndrome: Pathology and Mechanisms*, 122 ACTA NEUROPATHOLOGICA 519, 525 (2011) ("It is clear that rupture of even a single BV will cause a massive space occupying clot, not a thin film, and the bleeding will be at least partially subarachnoid.").

133. *See, e.g.*, Julie Mack et al., *Anatomy and Development of the Meninges: Implications for Subdural Collections and CSF Circulation*, 39 PEDIATRIC RADIOLOGY 200, 206 (2009) ("Although bridging vein rupture has long been considered the source of SDH, rarely are torn bridging veins identified at autopsy.").

134. *See id.* Squier & Mack, *supra* note 111.

occur from trauma that would not be sufficient to tear bridging veins and sometimes without any trauma at all, as it can occur in natural conditions.[135] The full list of potential traumatic and nontraumatic causes of small-quantity subdural hemorrhage is still being investigated, but would include comparatively minor trauma, infectious processes, several diseases, coagulation abnormalities, and combinations of circumstances, such as, by way of example, those that can be present during child birth, during a prolonged period of cardiac arrest or low oxygen, or, perhaps, while an infant is sustained on life support.[136]

Notably, the Consensus Statement appears to acknowledge that hemorrhage in the subdural area in some purported SBS/AHT cases may indeed originate from intradural leakage rather than torn bridging veins.[137] The Statement, however, citing only a sentence of opinion from a half-page 2009 commentary by one of the Statement's authors,[138] says that the intradural hemorrhage is still "likely caused by trauma."[139] There is no evidence to support that assertion, let alone consensus about it. It is merely unproven speculation from a decade ago that has not since been validated and, even if correct, begs the questions of how "likely" such hemorrhage is attributable to trauma generally and abusive trauma more specifically. Moreover, even if shaking can cause thin film subdural hemorrhage, there is no reliable basis for inferring shaking or abuse from such hemorrhage. The prior forensic belief that subdural hemorrhage in infancy is firm proof of torn bridging veins and significant trauma, was false and unwarranted. Consequently, so was the guidance that the discovery of such hemorrhage justifies a presumption of child abuse.

Even in purported SBS/AHT cases involving larger subdural blood and fluid collections, several developments have undermined the past

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135. *See* Marta C. Cohen & David Ramsey, Commentary on *"Shaken Baby Syndrome" and Forensic Pathology*, 10 FORENSIC SCI. MED. PATHOLOGY 244, 245 (2014) ("These observations indicate that the SDH in the triad is the result of bleeding from the dural plexuses rather than from torn bridging veins, a pattern of bleeding that may be associated with trauma or be of natural etiology. Such bleeding alone is therefore unreliable evidence of an 'inflicted' head injury or SBS."); Philip R. Croft & R. Ross Reichard, *Microscopic Examination of Grossly Unremarkable Pediatric Dura Matter*, 30 AM. J. FORENSIC MED. PATHOLOGY 10 (2009) ("In conclusion, intradural blood is a common microscopic finding in the dura matter of infants .... Such findings should not be over-interpreted as evidence of recent or craniocerebral trauma."); Gabaeff, *Challenging the Pathophysiologic*, *supra* note 131, at 149 ("It is now clear that SDH begins as IDH [intradural hemorrhage] and is caused by physical or physiologic damage to the dural capillary plexus. IDH can occur in response to a variety of primary insults.").

136. *See generally* PAPETTI, *supra* note 2, at 116-17 (citing numerous references).

137. *See Consensus Statement*, *supra* note 3, at 1054.

138. *Id.* (citing Marvin D. Nelson Jr., Commentary, *Unraveling the Puzzle*, 39 PEDIATRIC RADIOLOGY 199 (2009)).

139. *See Consensus Statement*, *supra* note 3, at 1054.

beliefs about what can be gleaned from such collections. It is common in SBS/AHT cases for subdural collections to contain a mix of blood and fluid of different ages.[140] These collections are sometimes referred to as a chronic subdural hematoma or, less frequently, as a subdural hygroma or hematoma-hygroma. The origin of these collections is often unknown and may have been perinatal, during birth, from various natural conditions, or past head trauma.[141] Well into the 1990s, even most child abuse specialists cautioned that these chronic collections were not necessarily associated with abuse and should be interpreted cautiously.[142] But, over time, given the extreme forensic significance that came to be attributed to subdural blood, child abuse specialists began advising that these mixed-age chronic subdurals usually should be interpreted as representing multiple episodes of abuse, with acute hemorrhage within the collections reflecting recent abuse.[143] These forensic beliefs about chronic

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140. *See* Heather T. Keenan, *Epidemiology of Abusive Head Trauma*, *in* CHILD ABUSE AND NEGLECT: DIAGNOSIS, TREATMENT AND EVIDENCE 35 (Carole Jenny ed. 2011) (stating that evidence of older brain injury is found in as many as 30-45% of children diagnosed with AHT); Squier, *The "Shaken Baby" Syndrome*, *supra* note 132, at 535 ("The majority of babies with the triad, perhaps 70-80% have chronic SDH.").

141. *See* Patrick D. Barnes, *Imaging of Nonaccidental Injury and the Mimics: Issues and Controversies in the Era of Evidence-Based Medicine*, 49 RADIOLOGIC CLINICS N. AM. 205, 217 (2011) ("By definition, a newly discovered chronic SDH started as an acute SDH that, for whatever reason, may have been subclinical."); Kenneth W. Feldman et al., *The Cause of Infant and Toddler Subdural Hemorrhage: A Prospective Study*, 108 PEDIATRICS 636, 644 (2001) ("It is possible that some of these children with chronic SDH represent unrecognized perinatal SDHs. They may present later as a result of enlarging head size or because of rebleeding into chronic SDH.... Likewise, it is not known how these perinatal SDHs progress to chronic effusions.").

142. *See, e.g.*, Derek A. Bruce, *Neurosurgical Aspects of Child Abuse*, *in* CHILD ABUSE: A MEDICAL REFERENCE 117, 119 (Stephen Ludwig & Allan E. Kornberg eds., 2d ed. 1992) ("Chronic subdural hematomas and hygromas have not been clearly linked to child abuse"); ANGELO P. GIARDINO ET AL., A PRACTICAL GUIDE TO THE EVALUATION OF CHILD PHYSICAL ABUSE AND NEGLECT 153 (1997) ("No specific etiology is found in most instances of chronic subdural collections. Although it is reasonable to assume that some degree of trauma preceded the development of the collections, it is not possible to presume child abuse in the absence of other supporting evidence. Until more is understood about the biomechanical mechanisms of chronic extracerebral collections, the diagnosis of child abuse as the etiology of chronic collections must rest on other findings indicative of child abuse. Such findings include unexplained long-bone fractures or characteristic soft-tissue injuries, because the presence of collections alone is insufficient to presume a deliberate violent traumatic event.").

143. *See* Brian Lundeen, *Radiographic Evaluation*, *in* THE SHAKEN BABY SYNDROME: A MULTIDISCIPLINARY APPROACH, *supra* note 33, at 123 (advising that new hemorrhage within a chronic collection should be viewed as a "consequence of another episode of abuse"); Robert W. Block, *Child Abuse—Controversies and Imposters*, 29 CURRENT PROBLEMS PEDIATRICS 253, 260 (1999) ("These older SDHs may be found when a child has a *new episode of inflicted brain injury* or has a CT or MRI for an unrelated reason.") (emphasis added); Blumenthal, *supra* note 29, at 734 ("Other than in children with glutaric aciduria type 1 and ventricular shunts, chronic subdural hematomas should be regarded as inflicted."); Kent P. Hymel et al., *Comparison of Intracranial Computed Tomographic (CT) Findings in Pediatric Abusive and Accidental Head Trauma*, 27 PEDIATRIC RADIOLOGY 743, 746 (1997) ("Chronic subdural hematomas have been reported as late sequelae of child abuse....In our study, all eight large,

subdurals, however, are unraveling.

In adults, it is unanimously accepted that membranes rich with blood vessels may form around collections of subdural blood (of whatever origin) as part of a healing process and these membranes (aka neomembranes) can themselves repeatedly bleed or "rebleed," a process that can become chronic and occasionally trigger dangerous consequences.[144] A premise for the belief that chronic subdural hematomas evidence abuse was that this rebleeding process does not occur in infancy.[145] But this guidance was speculative[146] and, it now seems clear, mistaken. The weight of authority now is that the course of bleeding and rebleeding of chronic subdural collections in infants and young children is similar or identical to that in adults.[147] This provides a non-SBS/AHT explanation for the common finding in a child reporting with seizures (which can be triggered by the collections), an enlarging head, and small-quantity acute hemorrhage within a larger chronic collection of blood

non-acute extra-axial fluid collections...were diagnosed in the NAT [non-accidental trauma] patient group[.]").

144. *See* Leestma, *supra* note 8, at 614 (stating that "it has been known for more than 100 years that some subdural hematomas become chronic and enlarge, with varying consequences, and that chronic subdural hematomas regularly are shown to contain recent bleeding, or rebleeding, as some prefer"); Juan C. Troncoso & Olga Pletnikova, *Traumatic Brain Injuries and Dural Hemorrhages*, *in* ESSENTIAL FORENSIC NEUROPATHOLOGY, *supra* note 90, at 79 ("These organized SDHs, however, may expand and/or rebleed, posing a significant risk to the patient."); Ronald H. Uscinski, *Shaken Baby Syndrome: Fundamental Questions*, 16 BRIT. J. NEUROSURGERY 217, 218 (2002) ("Rebleeding in subdural haematomas may occur, with minimal or no trauma, owing to the nature of the membranes and the process of resorption, explaining the slowing enlarging subdural which suddenly becomes symptomatic.").

145. *See, e.g.*, Patrick D. Barnes et al., *CT Findings in Hyperacute Nonaccidental Brain Injury*, 30 PEDIATRIC RADIOLOGY 74, 79 (2000) ("Spontaneous rebleeding has not been reported to occur in infants[.]"); Parrish, *supra* note 46, at 33 ("[Dr. Case] explained that when children suffer a fresh injury, the blood in the head goes away quickly, it doesn't stay and form a membrane as is the case with chronic subdural blood collections in older adolescents or adults.").

146. *See* Kent P. Hymel et al., *Intracranial Hemorrhage and Rebleeding in Suspected Victims of Abusive Head Trauma: Addressing the Forensic Controversies*, 7 CHILD MALTREATMENT 329, 344 (2002) ("To date, no prospective, comparative studies have measured the frequency of subdural rebleeding—or its clinical consequences, specifically in young children with known chronic subdural collections.").

147. *See, e.g.*, Marguerite M. Carè, *Neuroradiology*, *in* ABUSIVE HEAD TRAUMA IN INFANTS AND CHILDREN 81 (Lori D. Frasier et al. eds., 2006) ("Septations or membranes that develop within chronic subdural hematomas may predispose infants to repeated episodes of bleeding within these collections. Rebleeding may occur with little or no trauma."); J. F. Geddes, *Pediatric Head Injury*, *in* DEVELOPMENTAL NEUROPATHOLOGY 185, 186 (Jeffrey A. Golden et al. eds., 2006) ("It is also important to remember that on occasion subdural hematomas rebleed, the mechanism being exactly the same as in adults."); Barnes, *Imaging of Non-accidental Injury and the Mimics*, *supra* note 141, at 217 ("The pathology and pathophysiology of neomembrane formation in chronic SDH, including rebleeding, is well established in adults and seem similar, if not identical, to that in infants.").

and fluid—a return to the understanding that existed before being displaced by SBS.[148] And since such chronic subdurals are known to present potentially serious neurological risks in adults,[149] there is no basis to rule out such outcomes in infancy.

2. Retinal Hemorrhages

Starting in the late 1970s, papers within the child abuse literature, as well as statements from major medical organizations, advised that retinal hemorrhages in a child effectively mean abuse until proven otherwise.[150] And proving otherwise was no easy task, as most physicians accepted very few explanations for retinal hemorrhages other than abuse.

For decades, pediatric ophthalmologist and child abuse specialist Alex V. Levin has been the most influential expert in promoting the forensic value of retinal hemorrhages. In 1990, Levin wrote: "It is difficult to answer the question whether trauma other than that resulting from deliberate abuse can cause retinal hemorrhage in infants."[151] In 2000, he similarly advised: "Most authors find a zero incidence of retinal haemorrhage in accidentally head injured children less than [three] years of age even in the presence of severe brain injury, subdural and/or epidural hemorrhage."[152]

The belief that retinal hemorrhages are strong evidence of child abuse is based on the shaking hypothesis[153]—i.e., that the hemorrhages reflect traumatic damage to the eye that occurs when the vitreous and retina shear and tug against each other during violent shaking (or other repetitive or severe acceleration-deceleration trauma).[154] This hypothesis is known as the vitreo-retinal traction theory. In 2010, Levin authored an AAP Statement on examining children's eyes for proof of

148. *See supra* note 142 and accompanying text.

149. *See supra* note 144 and accompanying text.

150. *See supra* notes 30-36 and accompanying text.

151. Alex V. Levin, *Ocular Manifestations of Child Abuse*, 3 OPHTHALMOLOGY CLINICS N. AM. 249, 256 (1990).

152. Alex V. Levin, *Retinal Haemorrhages and Child Abuse*, *in* RECENT ADVANCES IN PAEDIATRICS 151, 179 (2000).

153. *See supra* note 32 and accompanying text.

154. *See, e.g.*, *supra* note 32 and accompanying text; ALEX V. LEVIN ET AL., AM. ACAD. OF OPHTHALMOLOGY, INFORMATION STATEMENT: ABUSIVE HEAD TRAUMA/SHAKEN BABY SYNDROME (Mar. 2015) (advising that "the primary cause of retinal hemorrhage in victims of Shaken Baby Syndrome is vitreo-retinal traction"), https://www.aao.org/clinical-statement/abusive-head-traumashaken-baby-syndrome; Alex V. Levin, *Ophthalmic Manifestations of Inflicted Childhood Neurotrauma*, *in* INFLICTED CHILDHOOD NEUROTRAUMA, *supra* note 42, at 129 ("The body of literature suggests that it is shaking itself, with resulting shear injury, that is the primary factor in the generation of RHs seen in SBS.").

abuse,[155] which the AAP affirmed in 2015.[156] According to the AAP Statement, "the critical factor in causing retinal hemorrhage" is "vitreoretinal traction and orbital injury sustained during the unique repetitive acceleration-deceleration mechanism" of shaking, which, the Statement claims, "distinguishes this form of abuse from single-impact trauma."[157] The forensic corollary of the hypothesis is that, when retinal hemorrhages are found, one may presume (subject to certain limited exceptions) that the child was shaken or endured other repetitive acceleration-deceleration trauma and did not sustain these hemorrhages from a single impact such as in an accidental fall.[158]

The belief that retinal hemorrhages are strong proof of shaking and abuse remains fixed in pediatric medicine. But the foundational premises for treating retinal hemorrhages as proof of abuse have collapsed.[159] The retinal hemorrhage hypothesis is not merely subject to new qualifications, but appears to be totally mistaken.

On one side of the dispute surrounding retinal hemorrhages is the belief that retinal hemorrhages in these cases reflect vitreo-retinal traction—i.e., mechanical damage to the retina caused by shaking or other severe, usually repetitive acceleration-deceleration trauma. On the other side is the belief that retinal hemorrhages do not reflect mechanical damage to the eye, but are, instead, a secondary consequence of other pathology or combinations of pathologies, such as suddenly raised intracranial pressure, intracranial hemorrhage, fluctuations in venous pressure, bleeding or clotting dysfunction, lack of oxygen (hypoxia), metabolic collapse, and/or time on life support. The forensic difference between the two approaches is critical: if retinal hemorrhages are a secondary

155. Alex V. Levin et al., *The Eye Examination in the Evaluation of Child Abuse*, 126 PEDIATRICS 376 (2010) [hereinafter 2010 AAP Eye Statement].

156. *See AAP Publications Reaffirmed or Retired*, 137 PEDIATRICS (Feb. 2016), http://pediatrics.aappublications.org/content/pediatrics/137/2/e20154272.full.pdf.

157. *See* 2010 AAP Eye Statement, *supra* note 155, at 378; *see also* Cindy W. Christian & Alex V. Levin, *The Eye Examination in the Evaluation of Child Abuse*, 142 PEDIATRICS (Aug. 2018) ("This research, along with clinical experience, support the role of vitreoretinal traction sustained during the repetitive acceleration or deceleration mechanism that characterizes shaking as an important contributory factor in causing RH and macular retinoschisis."), http://pediatrics.aappublications.org/content/142/2/e20181411.

158. *See, e.g.*, Caban v. State, 892 So. 2d 1204, 1207 (Fla. Dist. Ct. App. 2005) (reciting that frequent prosecution expert Dr. Randell Alexander testified that "retinal hemorrhaging requires shaking or monster impact"); Middleton v. State, 980 So. 2d 351, 356 (Miss. Ct. App. 2008) ("Dr. Stidham additionally explained that the retinal hemorrhages, which are blood vessels in the back of the eye that rupture and bleed, could only be caused by either a massive crush injury to the brain, likened to having a person's head run over by a car, or by Shaken Baby Syndrome."); Rios v. State, No. 08-06-211-CR, 2008 WL 4351133, at *2 (Tex. Ct. App. Sept. 24, 2008) ("[Dr. Stern] added that the abusive head injuries occurred with shaking. She based the latter conclusion on her examination of the eyes. She found bleeding in both optic nerve sheaths which is caused exclusively by a shaking-type motion of the head.").

159. *See, e.g.*, PAPETTI, *supra* note 2, § 3.2.

consequence, then they presumably can be found in a range of circumstances not involving shaking or abuse or even any trauma; by contrast, if the hemorrhages reflect mechanical damage to the eye caused by severe acceleration-deceleration, then the argument that one may infer abuse from them (in the absence of major accidental trauma) is more plausible.

For years, this debate has played out in the medical and scientific literature. But the evidence for retinal hemorrhages being a secondary consequence is now overwhelming.

Pediatric medicine and prosecutors embraced the vitreo-retinal traction theory without the theory first being validated with any methodology or experiment. And it has not been confirmed in the more than forty years since. Several rounds of animal testing have failed to validate the theory.[160] For example, a 2017 study shook fifty piglets at levels similar to abusive shaking, yet reported "no ocular injury" in any piglet.[161] Outside the child abuse context, medical understanding for the last 100 years has been that retinal hemorrhages can result from spikes in intracranial pressure, especially in the presence of intracranial hemorrhage.[162] This theory has been tested via inducing retinal hemorrhages in a rhesus monkey by raising its intracranial pressure.[163] Moreover, if retinal hemorrhages in children are a distinct traumatic injury, as opposed to a cascade consequence secondary to other pathology, then one would expect to see with some regularity cases where an abused child has retinal hemorrhages, but no intracranial, venous, or systemic pathology. But studies have revealed that such a picture is almost never seen.[164]

Perhaps most devastating to the shaking hypothesis is that literature is now filled with cases of retinal hemorrhages of all shapes, sizes, and locations in a wide variety of traumatic and non-traumatic circumstances ranging from severe infection, several natural diseases, short falls and

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160. *See id.* at 135-38.

161. *See* Brittany Coats et al., *Cyclic Head Rotations Produce Modest Brain Injury in Infant Piglets*, 34 J. NEUROTRAUMA 235 (2017).

162. *See* Leestma, *supra* note 8, at 383 ("Intraocular (retinal) and optic nerve sheath hemorrhages have been known to be complications of sudden increases in intracranial pressure for many years, perhaps dating back to nearly the turn of the twentieth century.").

163. *See* Dale C. Smith et al., *Preretinal and Optic Nerve-Sheath Hemorrhage: Pathologic and Experimental Aspects in Subarachnoid Hemorrhage*, 61 TRANSACTIONS - AM. ACAD. OPHTHALMOLOGY & OTOLARYNGOLOGY 201 (1957).

164. *See* Mary V. Greiner et al., *Dedicated Retinal Examination in Children Evaluated for Physical Abuse Without Radiologically Identified Traumatic Brain Injury*, 163 J. PEDIATRICS 527, 529 (2013); J. Thackeray et al., *Yield of Retinal Examination in Suspected Physical Abuse with Normal Neuroimaging*, 125 PEDIATRICS 5 (2010) (extensive retinal hemorrhage found in only 2 of 282 children evaluated for potential abuse without neuroimaging evidence of brain injury; both showed evidence of head or face injury and/or altered mental status).

other single-impact household accidents (where intracranial injury occurs), crush injury, coagulopathies and bleeding disorders, high altitude, aneurysms, and commonly after normal child birth.[165] One cannot reliably infer any particular traumatic mechanism or "abuse" from retinal hemorrhage when they appear in such a diverse variety of conditions and when the pathophysiological basis for such an inference has never been validated.

Unfortunately, faced with these developments, child abuse specialists have not abandoned the retinal hemorrhage construct. Instead, they have tried to rescue it with an endless series of qualifications and refinements. Without warning that past statements about retinal hemorrhages were wrong, and without disclaiming the longstanding guidance that any retinal hemorrhages in infancy or young children are suspicious for abuse, the Statement advises that "complex" retinal hemorrhages, further described as too numerous to count, multilayered, or extending out to the periphery of the retina, remain "specific for AHT."[166] The Statement also says that "retinal folds and retinoschisis are [even] more specific for AHT."[167]

This purported refinement—that severe retinal hemorrhages or retinal hemorrhage with particular characteristics are specific for SBS/AHT—is a refinement of a false construct.[168] The range of experimental studies have failed to produce even a single instance of a violently shaken or accelerated animal having the type of severe retinal hemorrhages that the Statement claims is specific for such trauma.[169] Several caregivers have been caught on video violently shaking infants (e.g., via so-called nanny cams) and none of the infants had retinal hemorrhages, let alone complex or severe retinal hemorrhages.[170] Retinal hemorrhages of all shapes, sizes, locations, and severity have been found

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165. *See, e.g.*, PAPETTI, *supra* note 2, at 130-32, 242-43; M. Mattheij et al., *Retinal Haemorrhages in a University Hospital: Not Always Abusive Head Injury*, 117 ACTA NEUROLOGICA BELGICA 515, 521 (2017); Mark J. Shuman, *Severe Retinal Hemorrhages with Retinoschisis in Infants are Not Pathognomonic for Abusive Head Trauma*, 62 J. FORENSIC SCI. 807 (2016).

166. *Consensus Statement*, *supra* note 3, at 1053.

167. *Id.*

168. *See* PAPETTI, *supra* note 2, § 4.3.2.

169. *See id.* at 135-38.

170. *See, e.g.*, Findley, *supra* note 108, at 237 n.97 (noting the lack of a videotaped or witnessed shaking incident that resulted in the triad or any injury at all); Gabaeff, *Challenging the Pathophysiologic Connection*, *supra* note 131, at 146 ("Case reports of witnessed or videotaped shaking of a previously healthy child with demonstrated RH or SDH upon immediate evaluation are conspicuously lacking from a thorough search of the forensic and medical literature. Conversely, shaking episodes have been recorded, but have not been associated with SBS injury markers…."); Lawrence E. Thibault et al., Letter to the Editor, *Commentary* on *Cerebral Traumatism With A Playground Rocking Toy Mimicking Shaken Baby Syndrome*, 53 J. FORENSIC SCI. 1249, 1249 (2008) (stating that "to our knowledge, not a single witnessed case of SBS resulting in 'classic triad' injuries has been published").

in children who suffered accidental trauma and in non-traumatic contexts, which is consistent with the severity of retinal pathology reflecting the severity of underlying internal pathologies and, in some instances, the time they persist rather than anything specific to shaking, abuse, or even trauma.[171] As a 2017 study concluded: "Clinicians should also know that there is no pathognomonic size, distribution, or location of [retinal hemorrhages] seen only in AHT."[172]

Table 2 in the Consensus Statement, which is derived from Levin's work, intends to convey that ophthalmologists can reliably distinguish retinal hemorrhages caused by AHT from retinal hemorrhages caused by most other etiologies.[173] Not so. Although certain natural pathologies produce distinct ocular findings, there is no scientific basis to claim that shaking or "abuse" do, or that ophthalmologists can distinguish retinal hemorrhages caused by shaking or abuse from other potential pathologies. In fact, a 2011 study reported on an experiment in which ophthalmologists reviewed RetCam images of retinal hemorrhages in pediatric patients who had different histories (e.g., suspected abuse, various diseases, accidental trauma).[174] When blinded to these histories, the ophthalmologists often interpreted and described the same hemorrhages very differently and overall interobserver agreement among the physicians was low. The study reported: "We have demonstrated that a clinical classification of RetCam images of retinal haemorrhages in children, based on the generally held defining features of haemorrhages in different retinal layers, lacks consistency between examiners and even on re-examination by the same examiner."[175]

Moreover, many, perhaps most, cases involving severe retinal hemorrhaging involve neurologically compromised or collapsed children. Many of these infants are unstable, or even near death, when their eyes are examined. Retinal examinations usually are not a clinical priority in treating unstable children, except to evaluate for abuse. Such examinations, therefore, rarely occur until well after a child arrives at the hospital. By the time of the retinal examination, the child often has already developed several pathological conditions that are known, individually or in combination, to trigger or exacerbate retinal hemorrhaging.[176]

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171. *See* PAPETTI, *supra* note 2, §§ 3.2.3, 4.3.2.

172. Mattheij, *supra* note 165, at 521.

173. *Consensus Statement*, *supra* note 3, at 1054 tbl.2.

174. *See* AO Mulvihill et al., *An Inter-Observer and Intra-Observer Study of a Classification of RetCam Images of Retinal Haemorrhages in Children*, 95 BRIT. J. OPHTHALMOLOGY 99 (2011).

175. *Id.* at 101.

176. *See* PAPETTI, *supra* note 2, at 244 n.698; *see also* 2010 AAP Eye Statement, *supra* note 155 (acknowledging that "[f]actors such as hypoxia, anemia, and intracranial pressure may play important secondary roles in modulating the appearance of retinal hemorrhages").

There is no scientific evidentiary foundation to enable anyone to distinguish or account for the extent to which factors such as age, genetics, past history of retinopathy of prematurity, hypoxia, ischemia, resuscitation efforts, seizures, cardiac arrest, clotting derangement, thrombocytopenia, venous stasis, raised intracranial pressure, intracranial hemorrhage, metabolic collapse, cerebral edema, and time on life support have played in contributing to a child's retinal appearance. The implicit assertion in the Statement that ophthalmologists can draw reliable forensic conclusions from miniscule petechial bleeding in the back of the eye, without an adequate evidentiary foundation for doing so, is the type of ipse dixit expert claim ultimately rejected in other discredited areas of forensic science, such as bite mark matching and aspects of arson science.

As for the claim in the Statement that retinal folds or retinoschisis are highly specific for SBS/AHT, that, too, appears to be false or, at least, very questionable and has never been reliably validated. A 2007 study found that the belief that retinal folds in infancy are pathognomonic of SBS was based on a total of seven cases spread throughout decades and involved a mix of children with and without evidence of impact injuries.[177] It appears that retinal folds and schisis usually are merely advanced stages of the same pathologies that can lead to retinal hemorrhaging.[178] Indeed, retinal folds and schisis have been shown to develop over time in hospitalized patients and have been observed in cases involving no trauma whatsoever.[179] A 2017 paper reported severe retinal hemorrhages, folds, and schisis in cases of a ruptured vascular malformation and a fatal fall off a children's train ride inside a shopping mall.[180] The paper concluded: "The finding of severe retinal hemorrhages with retinoschisis cannot be used to determine how, or even if, a traumatic event

177. *See* M. Vaughn Emerson et al., *Ocular Autopsy and Histopathologic Features of Child Abuse*, 114 OPHTHALMOLOGY 1384, 1389 (2007).

178. *See id.* at 1388-93; Steven C. Gabaeff, *Investigating the Possibility and Probability of Perinatal Subdural Hematoma Progressing to Chronic Subdural Hematoma, With and Without Complications, in Neonates, and Its Potential Relationship to the Misdiagnosis of Abusive Head Trauma*, 15 LEGAL MED. 177, 188 (2013) ("If [increased intracranial pressure] is sufficient, it can result in widespread RH in all layers and covering the entire retina, and if very high, schisis cavities and vitreous hemorrhage can develop as the pressure further damages the retina by denying it oxygen.").

179. *See, e.g.*, Patrick E. Lantz et al., *Extensive Retinal Hemorrhagic Retinopathy, Perimacular Retinal Fold, Retinoschisis and Retinal Hemorrhage Progression Associated with a Fatal Spontaneous, Non-Traumatic, Intracranial Hemorrhage in an Infant*, 19 PROCEEDINGS - AM. ACAD. FORENSIC SCI. 340 (2013) (reporting on a case in which retinal hemorrhages, a retinal fold, and retinoschisis developed over time during the course of a hospitalization for an eventually fatal vascular malformation); *see also* Mulvihill, *supra* note 174, at 101 ("Retinal haemorrhages after some days may assume a different appearance and not be like a typical textbook description.").

180. Shuman, *supra* note 165.

occurred."[181] Nevertheless, in 2018 Levin and co-authors, writing for the AAP's Committee on Child Abuse and Neglect, issued a new statement continuing to urge that schisis and folds are highly specific for inflicted traumatic injury,[182] though this new statement is filled with qualifications and less certainty than prior statements written by the same authors.

The beliefs regarding retinal hemorrhages have been wrongly influencing legal cases for decades. They lack even minimum levels of scientific reliability.[183]

3. Cerebral Edema or Encephalopathy

For years, physicians claimed that the cerebral edema (brain swelling) and dysfunction in purported SBS/AHT cases is the result of traumatic brain injury.[184] For example, a 2001 Position Paper on Fatal Abusive Head Injuries in Infants and Young Children published by the Ad Hoc Committee on Shaken Baby Syndrome of the National Association of Medical Examiners explained that the brain swelling and encephalopathy (brain dysfunction) seen in many serious SBS/AHT cases reflects "shearing injury or traumatic diffuse axonal injury [DAI]."[185] Traumatic DAI, the Position Paper advised, generally requires extreme rotational force, such as that present in motor vehicle accidents, and so the common finding of brain swelling and dysfunction in suspected SBS cases further supported that SBS victims had endured extreme shearing trauma.[186]

As it turns out, the assumption that the brain swelling in these children reflected traumatic DAI or other traumatic brain injury caused by shearing was, at least in most cases, wrong. The belief was based on almost no evidence and was promoted as forensically reliable without first being validated.[187]

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181. *Id.* at 810.

182. *See* Cindy W. Christian et al., *The Eye Examination in the Evaluation of Child Abuse*, 142 PEDIATRICS 1 (2018).

183. *See* State v. Jacoby, No. 15-11-0917-I, 2018 WL 5098763, at *12 (Super. Ct. N.J. Aug. 17, 2018) ("[T]he Court finds that presently there is no sufficiently reliable evidence and no general consensus in the scientific and medical community as to both the age and causation of retinal hemorrhages to satisfy the *Frye* standard. As such, retinal hemorrhage evidence in this case is not admissible."); Evan Matshes & Randy Papetti, *Law, Child Abuse, and the Retina*, THE CHAMPION 18, 22 (Dec. 2018) ("Although the beliefs regarding retinal hemorrhages were widely accepted for decades, and still clung to by many pediatric physicians, they lack sufficient reliability for legal purposes.").

184. *See, e.g.*, Jentzen, *supra* note 40, at 204 ("The pathological changes noted during the autopsy examination are best understood as resulting from the primary effect of shearing injuries and secondary associated injuries. Injuries that are primarily due to the effects of shearing forces include subarachnoid and subdural hemorrhage, retinal hemorrhage, diffuse axonal injury, brain swelling ... and brain contusions.").

185. NAME Position Paper, *supra* note 38, at 114.

186. *Id.* at 120.

187. *See* PEKKA SAUKKO ET AL., KNIGHT'S FORENSIC PATHOLOGY 470 (3d ed. 2004)

It is technically accurate that many purported SBS/AHT victims have DAI. But neuropathologic and neuroimaging studies have confirmed that the axonal brain injury is generally not traumatic DAI.[188] Instead, the brain "injury" previously thought to reflect traumatic DAI is actually the result of hypoxia (lack of oxygen), which can, if prolonged, lead to diffuse brain swelling, brain dysfunction, DAI, and death. Hypoxia, of course, can occur for many reasons having nothing to do with shaking, shearing, or child abuse, especially in infancy.[189]

The understanding that the brain injury in these cases reflected traumatic DAI contributed to the false beliefs (and courtroom talking points) that these children had endured forces akin to those in auto accidents and multi-story falls and that the nature of the brain injury in these cases is incompatible with the child having a lucid interval between the time of injury and collapse.[190] But the understanding was wrong.[191]

("[T]he idea of the presence of DAI in these cases was widely accepted before the advent of the modern diagnostic methods and before the diagnostic criteria for DAI had been established."); J. F. Geddes et al., *Neuropathology of Inflicted Head Injury in Children*: *II. Microscopic Brain Injury in Infants*, 124 BRAIN 1299, 1299 (2001) [hereinafter Geddes II] ("However, review of the literature suggests that the scientific evidence for this being traumatic damage is scanty.").

188. *See* Carė, *supra* note 147, at 74 ("However, widespread traumatic axonal injury is found infrequently in cases of abusive head injury, except those of significant impact injuries."); Mark S. Dias, *The Case for Shaking*, *in* CHILD ABUSE AND NEGLECT: DIAGNOSIS, TREATMENT AND EVIDENCE, *supra* note 140, at 368 ("It is becoming increasingly clear from both neuroimaging and post-mortem analyses of fatal cases that the widespread cerebral and axonal damage in cases of AHT are, in fact, ischemic rather than directly traumatic in nature."); Geddes I, *supra* note 127, at 1294, 1297; Geddes II, *supra* note 187, at 1304; Neil Stoodley, Commentary, *Non-Accidental Head Injury in Children: Gathering the Evidence*, 360 THE LANCET 271, 271-72 (2002) ("In a meticulous neuropathological study of infants and children who had fatally inflicted head trauma, Geddes' work showed that many cases had hypoxic neuronal damage but very few had pathological evidence of traumatic axonal injury....The low incidence of traumatic axonal injury reported by Geddes also agrees with our neuroradiological experience."); Manfred Oehmichen et al., *Shaken Baby Syndrome: Reexamination of Diffuse Axonal Injury as Cause of Death*, 116 ACTA NEUROPATHOLOGICA. 317, 326-27 (2008) ("Geddes could establish DAI in only two cases, while we did in none .... But what exactly is the cause of death in SBS victims? .... Hypoxic-ischemic brain injury as a cause of death is supported by our present findings, and the findings of Geddes et al.").

189. *See, e.g.*, Kodikara, *supra* note 109, at 1381 ("Wide ranges of traumatic and non-traumatic brain insults can cause HIE [hypoxic-ischemic encephalopathy].").

190. *See, e.g.*, John H. Menke & Richard G. Ellenbogen, *Postnatal Trauma and Injuries by Physical Agents*, *in* CHILD NEUROLOGY 659, 661 (John H. Menkes et al. 7th ed., 2006) (DAI "refers to a clinical-pathologic-radiologic entity that clinically manifests itself by loss or impairment. The lesion usually is not the result of a fall, except when the fall occurs from a considerable height. Instead, it results from severe angular acceleration-deceleration forces and is believed to induce coma …. It is responsible for severe, irreversible, and potentially fatal brain damage occurring at the moment of injury."); Platt, *supra* note 130, at 389 ("Head injuries in young children that result from shear forces to the brain causing DAI are generally not associated with a lucid interval, especially if severe neurologic injury or death results.").

191. *See, e.g.*, Meghan J. Acres & James A. Morris, *The Pathogenesis of Retinal and Subdural Haemorrhage in Non-Accidental Head Injury in Infancy: Assessment Using Bradford Hill Criteria*, 82 MED. HYPOTHESES 1, 3 (2014) ("In the [twenty-first] century, however, we

C. The Flawed SBS/AHT Evidence Base

With the biomechanical and pathophysiological rationales for key SBS/AHT beliefs in shambles, the Consensus Statement attempts to reassure courts with statistics showing that subdural and retinal hemorrhaging are much more associated with abuse than with accidental trauma or other causes.[192] A basic scientific principle is that association is not causation, and it is disturbing to see the Statement conflate the concepts. Moreover, such heavy reliance on these probabilistic statistics is particularly inappropriate given the very serious questions about whether the statistics are reliable.

1. The Circularity in the SBS/AHT Literature

It is true that several papers report a strong association between subdural and retinal hemorrhaging and SBS/AHT.[193] But these studies, cited throughout the Statement, are known to be plagued with fundamental methodological flaws and biases. The most pervasive flaw is circularity, and it undermines virtually all the SBS/AHT literature.

Here is an overview of the problem.[194] The studies supposedly validating the SBS/AHT beliefs, and giving rise to the extraordinary statistics associating subdural and retinal hemorrhages with abuse, first sought to identify a cohort of SBS/AHT victims to then catalog their injuries and other clinical findings. But there has never been a test to reveal or confirm SBS/AHT; there is no cohort of videotaped or independently witnessed cases to study; and thus in cases without significant external injury, identifying which babies had been shaken or abused can be very difficult. In most other clinical settings, physicians would rely on caretaker histories or the patient's own verbal history, but in this context those sources are not trusted or are unavailable. Accordingly, the physicians often had to rely on clinical judgment or criteria to classify which

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have discovered, thanks to the pioneering work of Geddes et al., that the brain injury in cases classified as NAHI [non-accidental head injury] is due to hypoxic ischaemic damage not traumatic damage. This is the paradigm change which renders the conventional hypothesis (post-Geddes) outmoded and incoherent."); Barnes, *Imaging of Nonaccidental Injury and the Mimics*, *supra* note 141, at 214-15 (reasoning that "because the observed edema does not represent [traumatic DAI] (which results in immediate neurologic dysfunction) a lucid interval is possible, particularly in infants whose sutured skull and dural vascular plexus have the distensibility to tolerate early increases in intracranial pressure"); Vivian S. Snyder & Lawrence A. Hansen, *A Conceptual Overview of Axonopathy in Infants and Children with Allegedly Inflicted Head Trauma*, 6 ACAD. FORENSIC PATHOLOGY 608, 609 (2016) ("Whether or not axonal injury in an infant is due to physical trauma or is secondary to anoxia may have critical implications ... particularly in infants with the above-described 'pure triad.' ").

192. *See Consensus Statement*, *supra* note 3, *passim*.

193. *See, e.g.*, Sandeep K. Narang, *A* Daubert *Analysis of Abusive Head Trauma/Shaken Baby Syndrome*, 11 HOUS. J. HEALTH L. & POL'Y 505 (2011) [hereinafter Narang I].

194. For a fuller discussion of the methodological problems in the SBS/AHT literature, see PAPETTI, *supra* note 2, § 3.4.4, and Findley et al., *supra* note 108, at 273-90.

children were SBS/AHT victims and which were not. Because these studies post-date SBS' acceptance, the researchers (or the clinical physicians they relied on) routinely diagnosed and classified the children using SBS dogma. Thus, if an infant had subdural and retinal hemorrhage, but no history of major trauma akin to an automobile accident or multi-story fall, the children were presumptively classified as abused. Conversely, if the infant did not have subdural or retinal hemorrhage or had a history of major trauma, that child likely would be classified as an accident victim (or another pathology might be accepted). Entirely predictably, the studies would then report that subdural and retinal hemorrhages are very common in abused children, but very rare in accidental trauma, except accidental trauma akin to automobile accidents or multi-story falls. Because physicians used SBS dogma to determine whether an infant was abused, it was self-fulfilling that the studies would find a high association between abuse and subdural and retinal hemorrhages, and a low association between accidental trauma and such hemorrhages.[195]

That the evidentiary foundation for SBS/AHT is based on studies that suffer from circularity and selection bias (as well as other methodological problems) is not a new observation. In 2002, Eva Lai Wei Fung et al. raised this exact concern.[196] She and her co-authors reasoned that the diagnosis of non-accidental head injury in young children had become a self-fulfilling prophecy—physicians are taught that subdural and retinal hemorrhage mean abuse; they diagnose and classify cases accordingly; and the classification statistics are then used to prove the validity of the original belief.[197] At a 2002 conference, which required participants to evaluate the evidence supporting SBS/AHT, leading child abuse specialists acknowledged the "circularity of reasoning" in the SBS/AHT literature.[198] In a 2003 paper, Mark Donohoe evaluated the SBS literature through 1998 and found it plagued with circular reasoning, selection bias, a lack of matched controls, and conclusions that overstepped the

195. *See, e.g.*, Niels Lynøe et al., *Authors' Overarching Reply to All the Responses Received to the Systematic Literature Review on Shaken Baby Syndrome*, 106 ACTA PAEDIATRICA 1031 (2017) ("As the triad is a very important criterion used by child protection teams, the extremely high diagnostic accuracy of the triad is obviously not based on scientific criteria but rather on circular reasoning. In other words, it is a self-fulfilling prophecy.").

196. Eva Lai Wah Fung et al., *Unexplained Subdural Hematoma in Young Children: Is It Always Child Abuse?*, 44 PEDIATRICS INT'L 37, 40 (2002) ("It is therefore not clear to what extent these conclusions are a self-fulfilling prophecy, that is, defining child abuse on the basis of subdural hemorrhage and retinal hemorrhage when there is '*no history accounting for patient's serious head injury*,' and then concluding that there is a high incidence of retinal hemorrhage in child abuse.").

197. *Id.*

198. *See* Carole Jenny, *Modes of Presentation of Inflicted Childhood Neurotrauma*, *in* INFLICTED CHILDHOOD NEUROTRAUMA, *supra* note 42, at 49.

data.[199] Patrick Lantz in 2004 raised similar concerns about circularity and bias within the literature claiming that macular folds and retinoschisis are pathognomonic of SBS/AHT.[200] In 2005, Matthieu Vinchon, whose work the Statement cites approvingly, wrote: "The importance of RH [retinal hemorrhage] for the diagnosis of child abuse is well established; however, the evaluation of its incidence in child abuse is almost impossible because the diagnosis of child abuse is in great part based on the presence of RH, providing a circularity bias."[201]

SBS/AHT proponents eventually began attempting to address the circularity problem. In a series of papers, proponents took the data in the existing studies (or a subset of them) and performed meta-analyses or generated various algorithms and reported that these more sophisticated analyses affirmed that most traditional SBS/AHT beliefs are well supported.[202] The statistics in these newer papers are now cited to courts and in legal and medical journals as proof that the core SBS/AHT beliefs have been validated and are supported by reliable evidence.[203]

These recent reviews and meta-analyses, however, did not solve the circularity problem. They merely buried the circularity of individual studies within sophisticated analyses of aggregated, but flawed data. In 2012, Pediatrics published a systematic review to "help front-line clinicians in the difficult task of distinguishing between AHT and nAHT."[204]

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199. *See* Mark Donohoe, *Evidence-Based Medicine and Shaken Baby Syndrome*: *Part I: Literature Review*, 1966-1998, 24 AM. J. FORENSIC MED. PATHOLOGY 239, 241 (2003) ("Many studies lacking these critical data make the obvious logical error of selecting cases by the presence of the very clinical findings and test results they seek to validate as diagnostic. Not surprisingly, such studies tend to find their own case selection criteria pathognomonic of SBS.").

200. P. E. Lantz et al., *Perimacular Retinal Folds from Childhood Head Trauma*, 328 BRIT. MED. J. 754, 755-56 (2004); Patrick Lantz, Letter to the Editor, *Junk Science and Glass Houses*, 114 PEDIATRICS 330, 330 (2004).

201. Matthieu Vinchon et al., *Accidental and Nonaccidental Head Injuries in Infants: a Prospective Study* 102 J. NEUROSURGERY 380, 383 (2005).

202. *See, e.g.*, Gaurav Bhardwaj et al., *A Systematic Review of the Diagnostic Accuracy of Ocular Signs in Pediatric Abusive Head Trauma*, 117 OPHTHALMOLOGY 983 (2010); Alison M. Kemp et al., *What are the Clinical and Radiological Characteristics of Spinal Injuries from Physical Abuse: A Systematic Review*, 95 ARCHIVES OF DISEASES IN CHILDHOOD 355, 357 (2010); Sabine Ann Maguire et al., *Retinal Haemorrhages and Related Findings in Abusive and Non-Abusive Head Trauma: A Systematic Review*, 27 EYE 28 (2013); Sabine Ann Maguire et al., *Estimating the Probability of Abusive Head Trauma: A Pooled Analysis*, 128 PEDIATRICS 550 (2011).

203. *See, e.g.*, Narang I, *supra* note 193 at 602, 612; Sandeep K. Narang et al., *A* Daubert *Analysis of Abusive Head Trauma/Shaken Baby Syndrome—Part II: An Examination of the Differential Diagnosis*, 13 HOUS. J. HEALTH L. & POL'Y 203, 319 (2013); Joëlle A. Moreno & Brian Holmgren, *Dissent Into Confusion: The Supreme Court, Denialism, and the False "Scientific" Controversy Over Shaken Baby Syndrome*, 2013 UTAH L. REV. 153, 160; Joëlle A. Moreno & Brian Holmgren, *The Supreme Court Screws Up the Science: There Is No Abusive Head Trauma/Shaken Baby Syndrome "Scientific" Controversy*, 2013 UTAH L. REV. 1357, 1387.

204. Shalea J. Piteau et al., *Clinical and Radiographic Characteristics Associated with*

The review found that even the best AHT studies used criteria "fraught with circular reasoning."[205] The review created a scale to rank the quality of the existing literature, but acknowledged that, "for features that have been traditionally associated with abuse (such as subdural hemorrhage and retinal hemorrhage), this ranking scale does not compensate well for circularity."[206]

In 2016, Göran Högberg et al. examined the SBS/AHT literature and confirmed the pervasive continuing circularity in that literature, including in the recent reviews and meta-analyses.[207] Also in 2016, the Swedish Report similarly concluded that, because they rely on methodologically flawed underlying studies, the reviews and meta-analyses are, from an evidence-based perspective, of "low quality"[208] and the "[s]ensitivity, specificity and predictive values" they calculate result in "incorrect conclusions" and "incorrect calculations of incidence."[209] Yet, leading child abuse specialists continue to invoke such statistics in their writings (e.g., the Consensus Statement) and when testifying in court cases. Unfortunately, judges and juries, seemingly unaware of the serious reliability issues concerning those statistics, frequently rely on such writings and testimony.

2. The Only Independent Scientific Body to Assess the SBS Evidence Base Found It to Be Very Low Quality.

Notably, the Statement avoids acknowledging the methodological flaws rampant in the SBS/AHT evidence base. Instead, the Statement lashes out at the most high-profile messenger, attacking the objectivity of the Swedish Report and urging that it should be disregarded because it allegedly reflects an unspecified "alternative agenda."[210] Putting aside the irony in the bias charge, the guidance in the Consensus Statement—

Abusive and Nonabusive Head Trauma, 130 PEDIATRICS 315, 316 (2012).

205. *Id.* at 321.

206. *Id.*

207. Göran Högberg et al., *Circularity Bias in Abusive Head Trauma Studies Could Be Diminished with a New Ranking Scale*, 6 EGYPTIAN J. FORENSIC SCI. 6, 8 (2016) (concluding that "circular reasoning is a serious problem in AHT studies"); *see also* Waney Squier, *Shaken Baby Syndrome and Abusive Head Trauma*, *in* FORENSIC SCIENCE REFORM: PROTECTING THE INNOCENT 107, 129 (Wendy J. Koen & C. Michael Bowers eds., 2017) ("Maguire claimed that her predictive test 'confirms the association of AHT with specific combinations of clinical features,' but detailed examination of the study indicates that her claims are not justified; cases were categorized as abusive or nonabusive entirely on the basis of assumptions; in the metaanalyses these categorizations are then used to prove the assumptions. Given this circularity, the metaanalyses do not provide an evidence base for diagnosing abuse; instead, they simply predict the likelihood that specific findings will be categorized as abusive or nonabusive ….").

208. Swedish Report, *supra* note 9, at 31.

209. *Id.* at 30.

210. *Consensus Statement*, *supra* note 3, at 1059.

that the Swedish Report should be dismissed because it is biased—is wholly unfounded.

The background of the Report—which was a watershed development in the SBS/AHT debate—is as follows. In 2014, after hearing divergent expert opinions, the Supreme Court of Sweden acquitted a man convicted of child abuse based on an SBS diagnosis. The Court explained that, to provide adequate proof of guilt, the scientific basis for a medical diagnosis must be shown to be very reliable, yet such proof had not been provided and, accordingly, the Court was unable to determine SBS's reliability.[211] This was of particular concern given that Sweden had seen a tenfold increase in SBS/AHT diagnoses since the 1990s.[212]

In response to the controversy in Sweden about SBS, the Swedish Agency for Health Technology Assessment and Assessment of Social Services appointed a panel of experts to review the quality of the SBS evidence base in order to advise whether SBS is a reliable diagnosis.[213] This Swedish Agency is one of the oldest medical assessment organizations in the world, and the experts it appointed included two pediatricians, and experts in forensic medicine, radiology, medical epidemiology, and medical and research ethics.[214] Four of the experts came from the Karolinska Institute in Stockholm,[215] which selects the winners of the Nobel Prize in Physiology or Medicine. Over more than two years, the expert group formulated their study and reviewed the literature; the group's findings were then reviewed by three scientific boards within the Swedish Agency as well as external reviewers before the Report was published.[216] One of the external reviewers apparently leaked the draft to certain child abuse specialists,[217] which prompted demands from them and pediatric organizations to be allowed to participate in the review process before the Report was released.[218] The demands failed.[219] The

211. *See* Högsta Domstolen [HD] [Supreme Court] 2014-10-16 B 3438-12 (Swed.), http://www.hogstadomstolen.se/Domstolar/hogstadomstolen/Avgoranden/2014/2014-10-16%20B%203438-12%20Dom.pdf (translation available at http://rffr.se/wp-content/uploads/2014/12/Swedish_supreme_court_20141016.pdf) (translated expert opinion that the Court appeared to accept: "In view of what has emerged recently, there is currently no clarity about the extent to which the components of the triad are specific to violent shaking....Instead, it must be concluded that we do not know; we are in a quagmire.").

212. *See* Ulf Högberg et al., *Infant Abuse Diagnosis Associated with Abusive Head Trauma Criteria: Incidence Increase Due to Overdiagnosis?*, 28 EUR. J. PUB. HEALTH 641, 643 (2018).

213. *See* Måns Rosén et al., *Shaken Baby Syndrome and the Risk of Losing Scientific Scrutiny*, 106 ACTA PAEDIATRICA 1905, 1905 (2017).

214. *Id.* at 1906

215. Swedish Report, *supra* note 9, at 37.

216. Rosén, *supra* note 213, at 1906.

217. *Id.* at 1906-07.

218. *Id*. at 1907

219. *Id*.

Swedish Report concluded: "There is insufficient scientific evidence on which to assess the diagnostic accuracy of the triad in identifying traumatic shaking (very low quality evidence)."[220] The Report advised that, given the lack of reliable evidence to support the SBS diagnosis, it would be "incompatible with both doctors' professional duties and the regulations concerning legal certification" for a physician to give a definite opinion based on the triad findings that a child was shaken.[221] In sum, the Swedish Report confirms that there is not (and thus never has been) a valid scientific basis for diagnosing SBS based on its classic diagnostic criteria.

The Statement says the Swedish Report's authors chose to review only thirty publications. Actually, the Report makes clear that 1065 papers were identified as relevant, but only thirty met the inclusion criteria of potentially providing actual evidence on the issue being evaluated.[222] Of those thirty papers, the Report found that twenty-eight had a high risk of bias, two had a moderate risk of bias, and no study had a low risk of bias.[223] Although the Statement implies that the Swedish Report overlooked papers providing additional higher-quality evidence for SBS, the Statement conspicuously fails to identify any such papers.[224]

The Statement points to commentaries from child abuse specialists or pediatric organizations criticizing the Swedish Report, but fails to acknowledge that the authors of the Report responded to each of those papers explaining why the criticisms were misguided or erroneous.[225]

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220. Swedish Report, *supra* note 9, at 5.

221. *Id.* at 66.

222. *Id.* at 21-22.

223. *See id.* at 21.

224. *See* Nicholas R. Binney et al., Letter to the Editor, *Don't Blame the Messenger: A Response to Debelle et al and the Royal College of Paediatrics and Child Health*, 103 ARCHIVES OF DISEASE IN CHILDHOOD 714 (2018) ("They criticise the [Swedish Report's] literature search, but fail to put forward the body of unbiased literature that the SBU has supposedly overlooked, which suggests that the SBU has been thorough.").

225. *See* Niels Lynøe & Anders Eriksson, *Consensus Should Be Adapted to the Evidence and Not Vice-Versa*, 107 ACTA PAEDIATRICA 1476, 1476 (2018); Niels Lynøe et al., Letter to the Editor, *Pouring Out the Dirty Bathwater Without Throwing Away Either the Baby or Its Parents: Commentary to Saunders et al*., 48 PEDIATRIC RADIOLOGY 284, 284 (2018) [hereinafter *Pouring Out the Dirty Bathwater Without Throwing Away Either the Baby or Its Parents*]; Niels Lynøe & Anders Eriksson, *In Order to Ensure that Evidence Is Unbiased It Is Sometimes Necessary to Retreat to the Scientific Ivory Tower*, 15 FORENSIC SCI. MED. PATHOLOGY 164, 164 (2018); Niels Lynøe et al., *Is Accepting Circular Reasoning in Shaken Baby Studies Bad Science or Misconduct?*, 106 ACTA PAEDIATRICA 1445, 1446 (2017); Niels Lynøe et al., *The Scientific Evidence Regarding Retinal Haemorrhages. Response to Hellgren et al. and Levin*, 106 ACTA PAEDIATRICA 1041, 1041 (2017); Niels Lynøe et al., *The Shaken Baby Syndrome Report was Not the Result of a Conspiracy. Response to Dr. Narang et al*., 106 ACTA PAEDIATRICA 1050, 1050 (2017); Niels Lynøe et al., *Conflicts of Interest Issues. Response to Lucas et al.*, 106 ACTA PAEDIATRICA 1036, 1036 (2017) [hereinafter *Conflicts of Interest Issues. Response to Lucas et al.*]; Lynøe et al., *Authors' Overarching Reply*, *supra* note 195, at 1031; Rosén et al., *supra* note 213, at 1907.

The Statement strangely says that the Report has "no role in true science,"[226] and urges courts instead to defer to the clinical experience of child abuse specialists and pediatric physicians who care for abused children.[227] But as the authors of the Swedish Report point out, "it is important to distinguish between clinical experts who perform clinical examinations … and scientific experts who assess the scientific literature. In a systematic review of the scientific literature, the skills of the latter are obviously far more important than clinical skills."[228]

In 2012, Guthkelch, the first to offer the shaking hypothesis, warned: "Since the issue is not what the majority of doctors (or lawyers) think but what is supported by reliable scientific evidence, the evidence should be reviewed by individuals who have no personal stake in the matter, and who have a firm grounding in scientific principles, including the difference between hypothesis and evidence."[229] The Swedish Report is the first review by an independent scientific body with expertise in systematically reviewing evidence bases. Its findings are devastating to SBS and to the Statement's key tenets.

3. The Heavy Reliance on Purported Perpetrator Confessions

Both the Statement and an Editorial in Pediatric Radiology accompanying the Statement[230] reference confessions as supporting SBS/AHT beliefs. The Statement cites a 2011 textbook chapter by Dias,[231] which, while conceding there is no other "coherent" evidentiary argument to support SBS, urged that perpetrator confessions validate the SBS beliefs.[232] That pediatric physicians advocating for SBS/AHT now rely so heavily on purported perpetrator confessions to support their positions reveals the weakness, not the strength, of the SBS/AHT evidence base.

In evaluating cases of confessed shaking, it is important to keep in mind that the primary forensic controversy is not whether shaking is capable of inflicting the triad findings in a healthy child (which even the Statement concedes is an open question).[233] Rather, the central dispute

226. *Consensus Statement*, *supra* note 3, at 1059.

227. *See, e.g.*, *id.* at 1052, 1057.

228. *Conflicts of Interest Issues. Response to Lucas et al.*, *supra* note 225, at 1036.

229. A. N. Guthkelch, *Problems of Infant Retino-Dural Hemorrhage with Minimal External Injury*, 12 HOUS. J. HEALTH L. & POL'Y 201, 207-08 (2012).

230. *See* Peter J. Strouse, *Shaken Baby Syndrome Is Real*, 48 PEDIATRIC RADIOLOGY 1043 (2018).

231. *Consensus Statement*, *supra* note 3, at 1051 (citing Dias, *supra* note 188, at 364-72).

232. *See* Dias, *supra* note 188, at 368 ("To those who argue that a contribution of shaking to the pathophysiology of AHT is a hypothesis lacking a sufficient evidentiary base, the consistent and repeated observation that confessed shaking results in stereotypical injuries that are so frequently encountered in AHT—and which are so extraordinarily rare following accidental/impact injuries—*is* the evidentiary basis for shaking.").

233. *See Consensus Statement*, *supra* note 3, at 1051 ("There remains discussion over whether shaking alone or shaking with blunt trauma is necessary for the injuries of these

is whether and under what circumstances can a physician reliably infer or diagnose shaking, abuse, or severe trauma from those findings.[234] Although confessions may provide anecdotal evidence that shaking is a form of abuse and, perhaps, that shaking can cause intracranial injury and death, confessions, especially those obtained during criminal investigations, are of little scientific value in answering whether one may reliably diagnose shaking or abuse from the triad (or any other physical findings). Confessions are not scientific evidence, and the literature does not contain enough reliable confessions to draw meaningful statistical conclusions. As one forensic pathology reference concludes: "Reported confessions, uncommonly cited in the literature, do not permit a valid statistical analysis or support for currently existing hypotheses in SBS."[235]

Moreover, as highlighted by the many DNA exonerations in cases where the individual confessed or even pled guilty to a crime he or she had not committed, it is unsettling that physicians would rely so heavily on purported perpetrator confessions as somehow validating questionable SBS/AHT beliefs. Approximately twenty-five percent of the DNA exonerations in this country were in cases where the innocent defendant had allegedly confessed, and most of these involved serious crimes such as sexual assault and murder.[236] SBS/AHT cases are not uniquely situated to avoid problems of false confessions. In fact, just the opposite is true.

Several courts and commentators have recognized the extraordinary reliability problems with police-obtained confessions and plea agreements in SBS/AHT cases.[237] Many purported SBS "confessions"

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abused children, but confessional evidence is quite striking that shaking alone can cause AHT.").

234. *See* Kodikara, *supra* note 109, at 1377.

235. *Id.* at 1376.

236. *See* Steven Wall, *Waiving Goodbye: In Memory of the Reasonable-Doubt Standard*, 44 HASTINGS CONST. L.Q 61, 68 (2016) ("Evidence suggests that innocent defendants plead guilty with startling frequency. In fact the Innocence Project estimates that one in four wrongful convictions, which are later overturned by DNA evidence, involve false confessions."); *see also* John H. Blume & Rebecca K. Helm, *The Unexonerated: Factually Innocent Defendants Who Plead Guilty*, 100 CORNELL L. REV. 157, 172-73 (2014) (noting, in 2014, that the National Registry of Exonerations listed 151 defendants who pled guilty who were subsequently exonerated).

237. *See, e.g.*, People v. Thomas, 8 N.E.3d 308, 316-17 (N.Y. 2014) ("Every scenario of trauma induced head injury equal to explaining the infant's symptoms was suggested to defendant by his interrogators. Indeed, there is not a single inculpatory fact in defendant's confession that was not suggested to him."); State v. Hogeland, 395 P.3d 960, 961-62 (Or. Ct. App. 2017) (finding confession in alleged SBS case to be involuntary where father was told that fact of shaking was established and only questions were whether it was accidental or deliberate and which parent did it); Swedish Report, *supra* note 9, at 29 ("Because of the risk of false confessions, all confessions in these studies must be considered with caution."); Findley et al., *supra* note 108, at 256-61 (discussing problems with using confessions and pleas in

are obtained pursuant to plea agreements; or as a requirement to retain or regain parental rights in dependency proceedings; or the confession was merely to shaking the child in an effort to resuscitate after the child had already collapsed; or the confession was induced by law enforcement through suggestion that confessing to shaking would allow the child to receive important medical treatment or was the "only" possible explanation for the child's condition. One study's observation in this context is illustrative.[238] The study reported on homicides of infants and young children in Bexar County (San Antonio), Texas between 1998-2009. Confessions were obtained in many cases, but in no case did the accused caretaker confess solely to shaking,[239] which differs from other studies in the child abuse literature that identify shaking as a commonly obtained confession. The study explained this discrepancy as follows: the local medical examiner's office during the relevant period did not believe the SBS findings could be caused by shaking alone, a fact known by local law enforcement and prosecutors, and so those interrogating caregivers did not suggest shaking as a likely mechanism and, perhaps consequently, caregivers did not confess to shaking.[240]

D. The Improper Rejection or Minimization of Alternative Diagnoses

A growing aspect of the SBS/AHT controversy concerns what other events and conditions may lead to the intracranial and retinal findings historically attributed to SBS/AHT. The Statement exhibits a marked bias against acknowledging such other conditions. The Statement minimizes, rejects, and even ridicules several alternative explanations for the

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child abuse cases as reliable scientific evidence); Deborah Tuerkheimer, *Science-Dependent Prosecution and the Problem of Epistemic Contingency: A Study of Shaken Baby Syndrome*, 62 ALA. L. REV. 513, 534-35 (2011) ("While this problem is hardly unique in the SBS context, the pressures on an innocent defendant to plead guilty are exacerbated by factors that tend to be present in triad-based prosecutions: first, regardless of guilt, a significant probability of conviction; and, second, a substantial disparity between the sentence being offered and the sentence likely to be imposed upon conviction after trial."); Cassandra A. Jenecke, Comment and Note, *Shaken Baby Syndrome, Wrongful Convictions, and the Dangers of Aversion to Changing Science in Criminal Law*, 48 U.S.F. L. REV. 147, 170 (2013) ("It is now well recognized that in cases where perpetrators have confessed to shaking the child, confessions cannot be used as a scientific correlation between the injuries suffered because confessions are not scientific and are subject to a variety of contamination issues."); Jon M. Sands et al., *Flawed Convictions: 'Shaken Baby Syndrome' and the Inertia of Injustice*, 55 JURIMETRICS 407, 411 (2015) (book review) ("False convictions present a unique problem within the confines of SBS cases, primarily because the caregiver being accused of the crime has already experienced an incredible loss. This trauma leaves them particularly vulnerable to coercive police interrogation techniques…. Given the certainty of a doctor's diagnosis, police officers routinely approach investigations with misplaced confidence about what transpired.").

238. *See* D. Kimberley Molina et al., *A Review of Blunt Force Injury Homicides of Children Aged 0 to 5 Years in Bexar County, Texas, from 1998 to 2009*, 33 AM. J. FORENSIC MED. PATHOLOGY 344 (2012).

239. *Id.* at 346.

240. *Id.* at 347.

triad findings that have considerable support in the literature and, increasingly, in the courts. Meanwhile, the Statement embraces SBS/AHT beliefs that, as discussed supra, have already been shown to be questionable or false.

To be sure, much is still unknown in this area. Some of the diagnoses are rare, require more validation, or can be difficult to confirm in individual cases. A full discussion of the relevant differential is beyond the scope of this response. But as challenges to the SBS/AHT diagnosis mounted over the last decade, so too have efforts to investigate other potential explanations. This process is ongoing, but the trend is unmistakable: SBS/AHT has been and continues to be diagnosed frequently in cases where the given history and the child's physical findings are consistent with other etiologies having nothing to do with abuse.

The Statement refers to the following diagnoses as "unsubstantiated" and as "speculative causation theories" and suggests that experts who testify about them in purported SBS/AHT cases "run afoul of professional norms and standards."[241] However, each of the following diagnoses is supported by substantial and growing evidence and in many cases fits the clinical findings as well as or better than SBS/AHT.

1. Cerebral Venous Thrombosis ("CVST")[242]

CVST is a form of stroke that occurs when clots form in the venous system that drains the brain. It can occur throughout life, but is more prevalent in early infancy.[243] CVST is rare, but is increasingly diagnosed due to improvements in neuroimaging and greater awareness of the condition.[244]

As of 2001, CVST was almost never identified as a potential cause of the triad findings. Today, many references identify CVST as an important consideration when evaluating an infant for SBS/AHT.[245]

The Statement, however, insists that CVST will not cause subdural

241. *Consensus Statement*, *supra* note 3, at 1055, 1057-58, 1059.

242. CVST is shorthand for two variants of intracranial venous thrombosis: cortical vein and sinus thrombosis.

243. *See* Nomazulu Dlamini et al., *Cerebral Venous Sinus (Sinovenous) Thrombosis in Children*, 21 NEUROSURGERY CLINICS N. AM. 511, 523 (2010) ("Cerebral sinovenous thrombosis is an underdiagnosed but important cause of stroke in childhood occurring most often in the neonatal period.").

244. *See* Gabrielle deVeber et al., *Cerebral Sinovenous Thrombosis in Children*, 345 NEW ENG. J. MED. 417, 417 (2001) (noting that CVST "is a rare disorder but one that is increasingly diagnosed because of greater clinical awareness, sensitive neuroimaging techniques, and the survival of children with previously lethal diseases that confer a predisposition to sinovenous thrombosis").

245. *See* Kodikara, *supra* note 109, at 1382 tbl.79.1; Kent P. Hymel & Katherine P. Deye, *Abusive Head Trauma*, *in* CHILD ABUSE AND NEGLECT, *supra* note 140, at 351; Janice J. Ophoven, *Pediatric Forensic Pathology*, *in* POTTER'S PATHOLOGY OF THE FETUS, INFANT AND CHILD 741, 814 box 17.16 (Enid Gilbert-Barness et al. eds., 2d ed. 2007).

hemorrhage and so it is not a condition likely to be confused with SBS/AHT.[246] The Statement advises concern that CVST cases are being misdiagnosed as SBS/AHT is a false controversy cooked up by defense lawyers and their supposedly denialist experts.[247] Yet, outside the child abuse literature, the connection between CVST and subdural hemorrhage and/or subdural effusion is not controversial. For example, the Statement overlooks a well-known, highly objective resource titled: *The American Heart Association Scientific Statement, Management of Stroke in Infants and Children*.[248] This resource advises physicians that some children with CVST "develop hydrocephalus, subdural effusion or hematoma."[249] Other references recognize that CVST may present with subdural hemorrhage, and the connection between CVST and subdural hemorrhage is increasingly noted in both the adult and pediatric literature. For example, a 2013 paper regarding CVST in adults states that "[t]here is growing evidence that [CVST] can cause SDH [subdural hematoma]…. Our case series provides additional support for the association of CVST and SDH."[250] Moreover, there is consensus that CVST may present with subarachnoid hemorrhage, subdural effusion, or hemorrhagic infarction, all of which may be difficult to distinguish on a CT scan from subdural hemorrhage or traumatic brain contusion; and which, even when properly identified, are still frequently considered as evidence of SBS/AHT.[251] This is especially true if the radiologist has a high index of suspicion for SBS/AHT (as they have been taught to have) and lacks experience with CVST. Finally, papers discussing the rarity of subdural hematoma in cerebrovascular disorders such as CVST may not reliably account for clinically insignificant scant or thin film subdural hemorrhage that may appear with such disorders, yet is commonly

246. *Consensus Statement*, *supra* note 3, at 1056.

247. *See Consensus Statement*, *supra* note 3, at 1055.

248. E. Steve Roach et al., AHA Scientific Statement, *Management of Stroke in Infants and Children*, 39 STROKE 2644 (2008).

249. *Id.* at 2668.

250. *See, e.g.*, Paul T Akins et al., *Cerebral Venous Sinus Thrombosis Complicated by Subdural Hematomas*, 4 SURGICAL NEUROLOGY INT'L 85 (2013); *see also* PAPETTI, *supra* note 2, § 3.6.2; Dlamini, *supra* note 243, at 515 ("Less well appreciated is CVST-related primary subarachnoid and subdural hemorrhage."); Florian Eichler et al., *Magnetic Resonance Imaging Evaluation of Possible Neonatal Sinovenous Thrombosis*, 37 PEDIATRIC NEUROLOGY 317, 319 (2007) (reporting small subdural hematomas in 9/15 newborns with CVST); R. N. Ichord et al., *Paediatric Cerebral Sinovenous Thrombosis: Findings of the International Paediatric Stroke Survey*, 100 ARCHIVES OF DISEASE IN CHILDHOOD 174 (2015) (intracranial hemorrhage in 31% of patients in study).

251. Michael V. Krasnokutsky, *Cerebral Venous Thrombosis: A Potential Mimic of Primary Traumatic Brain Injury in Infants*, 197 AM. J. ROENTGENOLOGY W503, W503 (2011); Barnes, *Imaging of Nonaccidental Injury and the Mimics*, *supra* note 141, at 219 (noting that cerebral venous thrombosis may be "difficult to distinguish [through radiology] from hemorrhage (SDH or SAH), hemorrhagic infarction, contusion, or hemorrhagic shear injury").

treated as evidence of abuse in SBS/AHT cases.[252]

Similarly, although few papers have studied ocular findings in patients with CVST, several sources now confirm that a range of retinal hemorrhages may occur in CVST patients.[253]

In addition, the Statement claims that clotted or abnormal cortical veins, which would appear to support a diagnosis of CVST, actually may reflect venous injury caused by shaking or other inflicted head trauma.[254] This is a relatively new argument, seemingly not present, even in the child abuse literature, until 2012.[255] It is true that head trauma may cause or contribute to development of CVST. But the weight of the literature is that head trauma is not a frequent cause or trigger of CVST, let alone a dominant cause.[256] In Binenbaum's cases, only one of twenty-nine pediatric patients with CVST had a history of head trauma.[257] DeVeber listed major risk factors for CVST as perinatal complications, dehydration, and infection; trauma was not even listed.[258] Wasay, too, did not list trauma, other than birth trauma, as a predisposing factor.[259] Sebire's series identified recent head trauma in only four percent of cases;[260] Ichord's report of the findings of the International Paediatric Stroke Study identified a history of trauma in eleven percent of cases.[261] Recent infection, dehydration, and hematologic disorders all are more associated with CVST than trauma.[262]

By contrast, the Statement relies heavily on a controversial 2015

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252. *See* Squier, *The "Shaken Baby" Syndrome*, *supra* note 132, at 534 (opining that CVST is "one of the most frequently overlooked pathologies, clinically and pathologically, in babies with the triad").

253. *See, e.g.*, Leestma, *supra* note 8, at 317 ("It is apparently not uncommon that various patterns of retinal hemorrhages can occur with cerebral venous thrombosis ...."); Gil Binenbaum et al., *Patterns of Retinal Hemorrhage Associated with Pediatric Cerebral Sinovenous Thrombosis*, 21 J. AAPOS 23 (2017) (Five of twenty-nine pediatric CVST patients had retinal hemorrhages; the authors distinguished the "pattern" of the hemorrhages from the patterns allegedly indicative of AHT).

254. *Consensus Statement*, *supra* note 3, at 1054, 1056, 1060.

255. *See* Catherine Adamsbaum et al., *Abusive Head Trauma: Don't Overlook Bridging Vein Thrombosis*, 42 PEDIATRIC RADIOLOGY 1298 (2012).

256. *See* PAPETTI, *supra* note 2, at 182-83.

257. *See* Binenbaum, *supra* note 253, at tbl.1.

258. *See* deVeber, *supra* note 244, at 418-19 & tbl.2.

259. *See* Mohammad Wasay et al., *Cerebral Venous Sinus Thrombosis in Children: A Multicenter Cohort from the United States*, 23 J. CHILD NEUROLOGY 26, 28 & tbl.4 (2008).

260. *See* G. Sébire et al., *Cerebral venous thrombosis in children: risk factors, presentation, diagnosis and outcome*, 128 BRAIN 477, 479 (2005).

261. Ichord et al., *supra* note 250, at tbl.1.

262. *Id.* (46% had head or neck infection; 17% dehydration; 19% hematological disorder); Krasnokutsky, *supra* note 251, at W504 ("The underlying causes of CVT are numerous, with infection and dehydration identified as the most common causes."); Sébire et al., *supra* note 260, at 479 (73% of children had recent infection; 47% ear infection; 33% recent diarrhea or other dehydration); *see also* Roach et al., *supra* note 248, at 2645 ("Head trauma appears to be a trigger for arterial stroke and dehydration for venous stroke, whereas infections, ... anemia, [and other disorders] are probably risk factors for both.").

retrospective review from Choudary et al.,[263] in urging that findings attributed to CVST often reflect traumatic venous damage. This paper examined a series of past AHT diagnoses and found a high incidence of evidence of damaged or thrombosed cerebral veins.[264] But the conclusions to be drawn from this paper are subject to interpretation. The study appears to suffer from circularity and thus may simply have succeeded in identifying a number of CVST cases misdiagnosed as SBS/AHT because the child had subdural and/or retinal hemorrhage. The Statement fails to acknowledge that there is no scientific evidence that shaking causes venous thrombosis and, if there is no external evidence of trauma to the head, there is no reason to infer from thrombosed cortical veins that the child sustained significant head trauma when the thrombosis can and usually does occur naturally.

In sum, there appears to be much to learn about the causes and clinical courses of CVST in infancy. But, contrary to the Consensus Statement, there is no consensus that CVST may be excluded in the differential merely due to the presence of subdural or retinal hemorrhage. Indeed, several courts in recent years have rejected charges of SBS/AHT because CVST could explain the child's condition.[265]

2. BESS

Benign enlargement (or expansion) of the subarachnoid spaces ("BESS") is a diagnosis known by several other names, including external hydrocephalus, benign subdural effusions, benign extra-cerebral fluid collections, benign subdural hygromas of infancy, as well as other names. This condition, which may include multiple variants, is associated with macrocephaly (an extraordinarily large head) or rapid growth in head circumference.[266] Children with the condition often accumulate excess fluid in the frontal region outside their brain or in the subdural

263. *See* Arabinda K. Choudhary et al., *Venous Injury in Abusive Head Trauma*, 45 PEDIATRIC RADIOLOGY 1803 (2015).

264. *Id.*

265. *See, e.g.*, *In re* Natalie AA, 10 N.Y.S.3d 720, 726-27 (App. Div. 2015) (reversing family court finding of abuse based on evidence of CVST); State v. Pheils, No. WD-14-072, 2015 WL 5306548, at *4, *9 (Ohio Ct. App. Sept. 9, 2015) (granting a new trial in part due to testimony that CVST would explain the child's death).

266. *See, e.g.*, Barnes, *Imaging of Nonaccidental Injury and the Mimics*, *supra* note 141, at 216-17, 221-22; Leslie C. Hellbusch, *Benign Extracerebral Fluid Collections in Infancy: Clinical Presentation and Long-Term Follow-Up*, 107 J. NEUROSURGERY 119, 119-23 (2007); Hee Chang Lee et al., *Benign Extracerebral Fluid Collection Complicated by Subdural Hematoma and Fluid Collection*, 34 CHILD'S NERVOUS SYS. 235, 235-36 (2018); David Miller et al., *The Significance of Macrocephaly or Enlarging Head Circumference in Infants with the Triad*, 36 AM. J. FORENSIC MED. PATHOLOGY 111, 115 (2015); Sverre M. Zahl et al., *Benign External Hydrocephalus: A Review, with Emphasis on Management*, 34 NEUROSURGERY REV. 417, 420 (2011).

space.[267] The condition arises in the first year of life, is relatively common, and typically resolves over time without neurological damage to the baby, although irritability, vomiting, seizures, and raised intracranial pressure are not uncommon.[268] Like SBS/AHT, the condition has a two to one male predominance.[269] Understanding the way the condition has been described in the child abuse literature provides insight into the biases that, we submit, pervade the Consensus Statement.

Before the SBS/AHT beliefs became more categorical in the late 1980s, several papers reported on a condition then referred to as benign subdural collections of infancy (though, again, other names also were used).[270] These papers included cases in which babies had fluid in the subdural compartment, which sometimes were mixed or tinged with blood.[271] The subdural collections did not appear to stem from significant head trauma and in some instances seemed to appear spontaneously.[272] In time, however, child abuse specialists came to advise that any unexplained subdural collections in an infant gave rise to a presumption of child abuse.[273] Consequently, in its 1993 and 2001 Statements on SBS, the AAP discredited the diagnosis of benign subdural collections, advising that that past literature about the condition should be "viewed with caution" because "multidisciplinary evaluations [for abuse] in previously described cases were lacking."[274] A 1994 review by influential child abuse specialists[275] similarly stated: "A literature review of the past decade reveals several articles and commentaries regarding 'benign subdurals of infancy' as an explanation for rapidly progressing head circumference in neurologically normal patients. This

267. For a fuller discussion of the condition and its role in the SBS/AHT debate, see PAPETTI, *supra* note 2, § 3.6.1.

268. Zahl, *supra* note 266, at 420, 423-25.

269. *See, e.g.*, Rubin Miller & Marvin Miller, *Overrepresentation of Males in Traumatic Brain Injury of Infancy and in Infants with Macrocephaly: Further Evidence that Questions the Existence of Shaken Baby Syndrome*, 31 AM. J. FORENSIC MED. PATHOLOGY 165, 166 (2010).

270. *See generally* Susan Briner & John Bodensteiner, *Benign Subdural Collections of Infancy*, 67 PEDIATRICS 802 (1981); William C. Robertson et al., *Benign Subdural Collections of Infancy*, 94 J. PEDIATRICS 382 (1979).

271. *See* Robertson et al., *supra* note 270, at 384; Mohsen Hamza et al., *Benign Extracerebral Fluid Collections: A Cause of Macrocrania in Infancy*, 3 PEDIATRIC NEUROLOGY 218, 219 (1987); *see also* Akira Ikeda et al., *Infantile Acute Subdural Hematoma*, 3 CHILD'S NERVOUS SYS. 19, 21 (1987) ("We suggest that most of the infants with so-called acute subdural hematoma had a preexisting fluid accumulation, such as subdural effusion or hematoma with or without membrane formation over the cerebral convexity, and that they were extremely vulnerable to even minor injury. . . .").

272. *See, e.g.*, K. Mori et al., *Subarachnoid Fluid Collections in Infants Complicated by Subdural Hematoma*, 9 CHILDS NERVOUS SYS. 282 (1993).

273. *See supra* notes 25-29 and accompanying text.

274. 2001 AAP Statement, *supra* note 26, at 208; *see also* 1993 AAP Statement, *supra* note 26, at 873.

275. Sirotnak & Krugman, *supra* note 29, at 397.

diagnosis remains controversial and in our view should not be made. The finding of extracerebral fluid collections in an infant should trigger an immediate investigation . . . ."[276]

This guidance from the AAP and leading child abuse specialists—that the condition may not even exist or at least should be viewed skeptically and that children with findings and histories consistent with the condition should presumptively be regarded as abused—lacked any scientific basis. It was biased in favor of SBS/AHT and against the diagnosis, now more frequently known as BESS. Since 2001, numerous papers have documented that the condition indeed exists, is not uncommon, and is usually benign in its clinical course (though, to reiterate, seizures and raised intracranial pressure may occur).[277] The papers further report that children with the condition indeed may develop subdural hemorrhage or blood-tinged fluid collections with only minor trauma or even spontaneously.[278] As summarized in a 2011 review: "Several studies have shown an increased risk of subdural hematomas in children with external hydrocephalus after minimal or no known head trauma."[279] Retinal hemorrhages, too, have been reported in the condition.[280]

The Statement overlooks these many papers and studies as well as the AAP's role in urging skepticism about a condition that even the Statement now acknowledges is common. But repeating past error, the Statement selectively cites to certain recent studies reporting that children with the condition rarely develop subdural hemorrhage.[281] The Statement then asserts that the studies reporting a higher prevalence of subdural hemorrhage did not adequately investigate for child abuse.[282] In reality, the papers reporting a lower prevalence can be explained by

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276. *Id.*

277. *See, e.g.*, PAPETTI, *supra* note 2, § 3.6.1.

278. *See, e.g.*, John Amodio et al., *Spontaneous Development of Bilateral Subdural Hematomas in an Infant with Benign Infantile Hydrocephalus: Color Doppler Assessment of Vessels Traversing Extra-Axial Spaces*, 35 PEDIATRIC RADIOLOGY 1113, 1116 (2005); Barnes, *Imaging of Nonaccidental Injury and the Mimics*, *supra* note 141, at 216-17, 221-22; Partha S. Ghosh & Debabrata Ghosh, *Subdural Hematoma in Infants Without Accidental or Nonaccidental Injury: Benign External Hydrocephalus, a Risk Factor*, 50 CLINICAL PEDIATRICS 897, 897, 902 (2011); Lee et al., *supra* note 266, at 243; Joseph H. Piatt, Jr., *A Pitfall in the Diagnosis of Child Abuse: External Hydrocephalus, Subdural Hematoma, and Retinal Hemorrhages*, 7 NEUROSURGERY FOCUS 1, 1-2 (1999); Mathieu Vinchon et al., *Subdural Hematoma in Infants: Can it Occur Spontaneously?*, 26 CHILD'S NERVOUS SYS. 1195, 1201 (2010) ("We concur with . . . Hellbusch: 'infants with benign extracerebral fluid collections can have subdural hematoma/hygroma complication with slight trauma or none.' ").

279. Zahl, *supra* note 266, at 420.

280. *See* Horace B. Gardner, *A Witnessed Short Fall Mimicking Presumed Shaken Baby Syndrome*, 43 PEDIATRIC NEUROSURGERY 433 (2007) (reporting case of infant with likely external hydrocephalus who developed retinal hemorrhages after short fall); Piatt, *supra* note 278, at 5.

281. *See Consensus Statement*, *supra* note 3, at 1056 & tbl.4.

282. *Id.*

methodological choices utilized in those papers.

For example, some BESS studies excluded cases where the child's history and findings were consistent with BESS, but the child had retinal hemorrhages.[283] As explained, the use of retinal hemorrhages as proof of shaking and abuse is not scientifically reliable, plus it is known that children with BESS can develop retinal hemorrhages,[284] so this would appear to be a misguided exclusion criterion. The Statement relies on a paper by Heather McKeag et al.,[285] but that McKeag et al. would report a lower prevalence of subdural hemorrhage was predictable from the study's methodology. The stated goal of the McKeag paper was rather narrow: to determine how often children with the condition develop subdural hemorrhage spontaneously.[286] The paper thus excluded cases where the baby had a history of recent minor trauma, which is known to cause subdural hemorrhage in children with the condition.[287] The paper also excluded children with findings consistent with BESS who reported with seizures.[288] Given that subdural hemorrhage may trigger seizures,[289] this exclusion criteria, too, would likely exclude children with the condition who had developed such hemorrhage spontaneously or after minor trauma.

Evidence continues to grow to support the majority understanding that infants, more frequently boys, often with a history of a rapidly growing head circumference or macrocephaly, may develop subdural and retinal hemorrhage and seizures after only minor accidental trauma or even spontaneously.[290] Many of these children fit the diagnostic criteria for BESS. The frequency with which children with BESS will develop subdural hemorrhage is unknown, and the reliability of statistics in this area is undermined by the excessive diagnosis of SBS/AHT when the findings would fit BESS. But there is no basis for claiming there is consensus that children with the condition will develop subdural hemorrhage only very rarely. Furthermore, where its diagnostic criteria are otherwise met, a condition's rarity should not, by itself, justify rejecting it in favor

283. *See* M.V. Greiner et al., *Prevalence of Subdural Collections in Children with Macrocrania*, 34 AM. J. NEURORADIOLOGY 2373, 2375 (2013) (case excluded because patient had retinal hemorrhages); Lee et al., *supra* note 266, at 243 (implying that cases may have been excluded from study and deemed as suspicious for abuse if ocular findings were present).

284. *See supra* note 278 and accompanying text.

285. Heather McKeag et al., *Subdural Hemorrhage in Pediatric Patients with Enlargement of the Subarachnoid Spaces*, 11 J. NEUROSURGERY: PEDIATRICS 438 (2013).

286. *Id.*

287. *Id.* at 439.

288. *Id.*

289. *See, e.g.*, Kenneth Till, *Subdural Haematoma and Effusion in Infancy*, 3 BRIT. MED. J. 400, 400 (1968).

290. *See, e.g.*, Ulf Högberg et al., *Epidemiology of Subdural Haemorrhage During Infancy: A Population-Based Register Study*, https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0206340&type=printable.

of diagnosing SBS/AHT, let alone preclude the condition from being presented in legal proceedings as a plausible alternative to abuse.[291]

3. Hypoxic-Ischemic Injury (HII)

A 1995 paper noted the "stereotyp[ical] regularity" in SBS/AHT cases in which caretakers reported finding a baby not breathing normally or not breathing at all.[292] In addition, many SBS/AHT cases involve a history that a child choked, or had an accident (such as a fall) and suddenly thereafter went into cardiac arrest, stopped breathing or began to breathe abnormally.[293] The common strain in these histories is that the child endured hypoxia—insufficient oxygen—for an extended period, yet did not die right away and, in many cases, endured time on life support. Given how commonly SBS/AHT cases involved a history of hypoxia,[294] some researchers began investigating the role that hypoxia can play in producing the triad.

Hypoxia can lead to hypoxic-ischemic injury (HII) (a lack of a sufficiently oxygenated blood supply to the brain). As noted, in most fatal SBS/AHT cases, HII is what causes the brain to swell and leads to death.[295] Hypoxic-ischemic brain damage can occur as a consequence of both abusive and accidental trauma.[296] It may also occur in a variety of natural conditions and events (such as choking).[297] It is thus not unique to or specific for trauma, shaking, or abuse.

That HII has a destructive impact on the brain is undisputed, but what consequences it triggers throughout the central nervous system in infants and young children is incompletely understood. After Geddes et al. reported in 2001 that the brain damage in purported SBS/AHT cases reflects HII rather than traumatic DAI,[298] and that the subdural hemorrhage in these cases frequently is not a hematoma but rather a thin

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291. *See, e.g.*, *Feigned Consensus*, *supra* note 7, at 52-53.

292. Dennis L. Johnson et al., *Role of Apnea in Nonaccidental Head Injury*, 23 PEDIATRIC NEUROSURGERY 305, 308 (1995); *see also* DOJ BATTERED CHILD SYNDROME GUIDE, *supra* note 34, at 9 ("The typical explanation given by the caretakers is that the baby was 'fine' and then suddenly went into respiratory arrest or began having seizures.").

293. *See, e.g.*, DOJ BATTERED CHILD SYNDROME GUIDE, *supra* note 34, at 7, 9; *see also* Craig C. DeWolfe, *Apparently Life-Threatening Event: A Review*, 52 PEDIATRIC CLINICS N. AM. 1127 (2005) (reviewing several conditions and events that may lead to hypoxia in infancy).

294. The Consensus Statement cites a study finding that 97% of SBS/AHT cases involve some form of hypoxia-related brain insult or injury. *See Consensus Statement*, *supra* note 3, at 1052 (citing P. Kelly et al., *Abusive Head Trauma and Accidental Head Injury: A 20-Year Comparative Study of Referrals to a Hospital Child Protection Team*, 100 ARCHIVES OF DISEASE IN CHILDHOOD 1123 (2015)).

295. *See supra* notes 187-89 and accompanying text.

296. *See supra* notes 187-89 and accompanying text.

297. *See supra* notes 187-89 and accompanying text.

298. *See supra* notes 187-91 and accompanying text.

film,[299] she and colleagues proposed a hypothesis to explain the triad in cases involving hypoxia and thin-film hemorrhage.[300] The hypothesis was that prolonged hypoxia, if accompanied by a change in venous and arterial pressure (which can happen after brain insult, including from non-traumatic insults such as hypoxia), may trigger a physiological cascade resulting in brain swelling, thin film subdural hemorrhage, and, if prolonged and coupled with raised intracranial pressure, retinal hemorrhages.[301] The hypoxia could have begun as part of a natural pathology or from head or neck trauma that caused cardiac or respiratory failure.[302] According to Geddes et al., the hypothesis would explain the brain injury in purported SBS/AHT patients (which she had already shown to be hypoxic-ischemic), the thin film hemorrhage (which she argued could be from oozing from blood vessels within the dura caused by hypoxia and a change in venous pressure), and retinal hemorrhages (which the paper argued should be regarded as a cascade consequence and not an independent "injury").[303]

As the Statement notes, Geddes' hypothesis was very controversial and several subsequent papers reported findings that undercut the hypothesis—i.e., they did not find subdural hemorrhage to develop in cases involving purely hypoxic events.[304] The Statement, however, overlooks that more recent developments have provided additional support for the hypothesis.

The conclusion in Geddes et al.'s 2001 papers that the brain damage in purported SBS/AHT cases reflects hypoxia rather than traumatic DAI has since been repeatedly affirmed.[305] Her hypothesis that thin film subdural hemorrhage may originate from oozing within the dura, rather than from ruptured cortical bridging veins, also has since been shown by radiologic and pathologic studies.[306] And multiple studies have now found dural or subdural hemorrhage, albeit typically in small quantity, in fatal cases of nontraumatic hypoxic brain damage.[307]

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299. *See supra* notes 127-30 and accompanying text.

300. J. F. Geddes et al., *Dural Haemorrhage in Non-Traumatic Infant Deaths: Does it Explain the Bleeding in 'Shaken Baby Syndrome'?*, 29 NEUROPATHOLOGY & APPLIED NEUROBIOLOGY 14, 18-19 (2003) [hereinafter Geddes III].

301. *Id.* at 19-20.

302. *See id.* at 18-20.

303. *Id.* at 20.

304. *See Consensus Statement*, *supra* note 3, at 1055.

305. *See supra* notes 188-89 and accompanying text.

306. *See supra* note 127 and accompanying text.

307. *See* Marta C. Cohen et al., *Subdural Hemorrhage, Intradural Hemorrhage and Hypoxia in the Pediatric and Perinatal Post Mortem: Are They Related?*, 200 FORENSIC SCI. INT'L 100, 106 (2010) ("We have demonstrated a strong association between hypoxia and MRI evident SDH and between hypoxia and histological IDH in this group....Thus there appears to be an association between IDH, SDH and hypoxia in children dying of natural causes."); Irene Scheimberg et al., *Nontraumatic Intradural and Subdural Haemorrhage and*

Geddes' theory is not inconsistent with trauma, including shaking, being an event that can precipitate hypoxia. For example, some papers have embraced Geddes' hypothesis in arguing that traumatic injury to an infant's spinal cord or spinal nerve roots, which may occur during whiplash shaking or in a fall involving flexion of the neck, may damage a child's ability to breathe and thus initiate hypoxia.[308] They reason that, unless promptly fatal, such hypoxia can trigger the cascade of pathologies that Geddes surmised may lead to the triad without any tearing of bridging veins, vitreo-retinal traction damage to the eyes, or shearing injury to brain tissue. Even some child abuse specialists now argue that violent shaking may cause minute spinal or brainstem damage that may induce death via HII rather than traumatic DAI,[309] though they are not clear about what they believe causes the subdural and retinal hemorrhage.

The circumstances under which hypoxia can trigger or combine with other pathologies and result in the triad findings remain unresolved. But it is now generally accepted that caregivers accused of SBS/AHT frequently provide histories that the baby became hypoxic without any abuse occurring; that, consistent with these histories, HII is indeed common in purported SBS/AHT victims; and that HII is what actually causes the brain swelling that leads to death in most fatalities diagnosed as SBS/AHT cases. The hypothesis that hypoxia in certain circumstances may play a role in producing brain swelling, thin film subdural hemorrhage, and retinal hemorrhages has growing support.[310] If the hypothesis is correct, it might actually validate that infant shaking can lead to the

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Hypoxic Ischaemic Encephalopathy in Fetuses, Infants and Children Up to 3 Years of Age, 16 PEDIATRIC & DEVELOPMENTAL PATHOLOGY 149 (2013) (reporting 636 cases of nontraumatic subdural and intradural hemorrhage).

308. *See* Matshes et al., *supra* note 2, at 88 ("A combination of increased intravascular pressure and hypoxic damage … may lead to extravasation of blood into the subdural space. Our work is a refinement of the Geddes hypothesis...."); Mary Ann Sens, et al., *Cervical Ganglia and Nerve Root Injury: Evidence for Respiratory Arrest as Initiating Injury in Pediatric Head Trauma*, 4 ACAD. FORENSIC PATHOLOGY 514, 518 (2014) ("Geddes hypothesized that hypoxic events, in some instances, initiate the cascade of findings culminating in the triad of encephalopathy, bilateral subdural hemorrhage, and retinal hemorrhage. This case would support this proposed evolution of findings.").

309. *See, e.g.*, Jakob Matschke et al., *Encephalopathy and Death in Infants with Abusive Head Trauma Is Due to Hypoxic-Ischemic Injury Following Local Brain Trauma to Vital Brainstem Centers*, 129 INT'L J. LEGAL MED. 105, 112 (2015) ("In summary, our investigations on the nature of encephalopathy in AHT identify hypoxic-ischemic injury as the cause of brain damage and consequently as the cause of death in infants with AHT.").

310. *See, e.g.*, Acres & Morris, *supra* note 191, at 4 ("The Geddes hypothesis makes sense of the data."); Barnes, *Imaging of Nonaccidental Injury and the Mimics*, *supra* note 141, at 213-14 ("Although the unified hypothesis of Geddes and colleagues has received criticism, their findings and conclusions have been validated by the research of Cohen and Scheimberg, Croft and Reichard, and others.").

triad, while confirming that hypoxia traceable to a wide range of accidental and non-traumatic circumstances can produce identical findings.

4. Subdural Hemorrhage Since Birth

In the last decade, several studies have revealed a strikingly high percentage of neonates who have asymptomatic subdural hemorrhage. The range of studies report the prevalence as between nine and fifty percent.[311] The hemorrhage is found after both natural and cesarean birth, but far more commonly after natural birth and after unplanned cesareans.[312] This is consistent with past observations that infants often have subdural hemorrhage and effusions without any clarity as to the source.[313]

Most subdural collections from birth resolve within a short time, usually within a month or so. But millions of children are born with subdural hemorrhage. Today, it is known that subdural hemorrhages from birth may become chronic or develop into mixed-density fluid collections that linger after the first month of life,[314] though very little research has been done to understand how often this occurs. These collections can lead to increased intracranial pressure, vomiting, seizures, and,

311. *See* C.B. Looney et al., *Intracranial Hemorrhage in Asymptomatic Neonates: Prevalence on MR Images and Relationship to Obstetric and Neonatal Risk Factors*, 242 RADIOLOGY 535 (2007) (finding twenty-six percent of newborns with asymptomatic intracranial hemorrhages); Veronica J. Rooks et al., *Prevalence and Evolution of Intracranial Hemorrhage in Asymptomatic Term Infants*, 29 AM. J. NEURORADIOLOGY 1082, 1083 (2008) (forty-six percent).

312. *See* Squier & Mack, *supra* note 111, at 9-10; *see also* Niels Lynøe & Anders Eriksson, *May the Fear of Being Falsely Accused of Having Shaken A Baby Increase Parents' Demands for Scheduled Caesareans?*, 106 ACTA PAEDIATRICA 1052 (2017).

313. *See, e.g.*, A. N. Guthkelch, *Subdural Effusions in Infancy*, 1 BRIT. MED. J. 233, 233 (1953) (stating that infantile subdural effusion "is not a rare condition" and that the "frequency with which these effusions are found is proportional to the intensity with which they are sought"); Ingraham, *supra* note 25, at 3 (observing that the frequency with which subdural hematoma is found in infancy is "largely proportional to the intensity with which it is sought").

314. *See* Terry E. Inder et al., *Intracranial Hemorrhage*, *in* NEUROLOGY OF THE NEWBORN 602 (Joseph J. Volpe et al. eds, 6th ed. 2018) ("A third clinical presentation may be the occurrence of subdural hemorrhage in the neonatal period with few clinical signs and then the development over the next several months of a *chronic subdural effusion*. It is certainly well known that many infants presenting in the first 6 months of life with an enlarging head, increased trans-illumination, and chronic subdural effusions have no known cause for the lesion and that subdural hemorrhage can evolve into subdural effusion."); Squier & Mack, *supra* note 111, at 10 ("Due to the very small numbers used in these studies compared with the overall frequency of birth-related bleeding, meaningful interpretation is difficult and we have no good data on the natural history of birth-related SDH. It is obvious that most heal without any significant morbidity, although birth-related bleeding has been shown to be the cause of between 14% and 17% of infant chronic subdural haemorrhage."); *see also* P. Kelly et al., *Subdural Hemorrhage and Hypoxia in Infants with Congenital Heart Disease*, 134 PEDIATRICS 773 (2014) (43% of infants in study had subdural hemorrhage, including in locations some associate with abusive head trauma, and hemorrhage persisted in eight infants beyond twenty-eight days of life).

of course, can be mistaken for traumatic injuries. As the Swedish Report explains:

> Although most bleedings related to delivery are symptomless and disappear (are resorbed) within a few months, occasionally a hemorrhage can degenerate into a hygroma. This circumscribed collection of fluid is contained by a membrane in which small vessels form and it is considered that this in turn can lead to renewed bleeding (rebleeding) and a chronic subdural pool of fluid. The possibility cannot be discounted that in certain cases, rebleeding can cause symptoms.[315]

By contrast, without acknowledging the Swedish Report or other literature on this topic, the Statement advises that subdural hematomas that trace to birth "do not appear to rebleed."[316] The Statement cites no evidence for that speculation, there is no reliable evidence to support it, and it appears to be wrong.[317]

E. Recognition of the Controversy

It took several years for the courts to address the questions raised in the medical and scientific literature about SBS/AHT. It was not until 2008 that the first published American judicial opinion granted post-conviction relief based on the evolution in the science surrounding SBS.[318] That same year a 674-page governmental report on The Inquiry into Pediatric Forensic Pathology in Ontario observed that "one of the deepest controversies surrounding pediatric forensic pathology concerns shaken baby syndrome."[319] The Report noted the "evolution in forensic pathology in this area" and described the area as "fraught with controversy."[320] The Report went on to conclude that "our systemic examination has identified this particular area of forensic pathology as one where change has raised the real possibility of past error."[321]

In 2009, Professor Deborah Tuerkheimer, a former prosecutor, juxtaposed the collapse of the SBS premises against the thousands of SBS-based criminal convictions. She urged that "[w]hen placed against the

315. Swedish Report, *supra* note 9, at 34.
316. *Consensus Statement*, *supra* note 3, at 1057.
317. *See* PAPETTI, *supra* note 2, at 119 (collecting authorities for the proposition that subdural hemorrhages in infancy may form a membrane that can rebleed in the same manner as occurs in older children and adults); Gabaeff, *Investigating the Possibility and Probability of Perinatal Subdural Hematoma*, *supra* note 178 (comprehensively discussing the potential for perinatal subdural hematomas to become chronic and rebleed).
318. *See* State v. Edmunds, 746 N.W.2d 590, 599 (Wis. Ct. App. 2008).
319. Goudge Report, *supra* note 2, at 527.
320. *Id.* at 528.
321. *Id.* at 531.

backdrop of recent scientific developments, these numbers reflect a crisis in the criminal justice system."[322] In 2011, an SBS post-conviction case made it to the United States Supreme Court.[323] The majority found it unnecessary to reach the SBS-related merits of the case, but Justice Ginsburg and two other justices wrote separately about their concern with the conviction given the SBS controversy.[324] In 2012, Guthkelch, who had been feted for decades as the founder of the SBS hypothesis, published an article expressing his concern that SBS was being overdiagnosed and was merely an unproven hypothesis.[325] He further observed that "there has arisen a level of emotion and divisiveness on shaken baby syndrome/abusive head trauma that has interfered with our commitment to pursue the truth."[326] In 2014, a federal district court heard from leading experts on both sides of the controversy and, near the end of its long order, expressed concern that SBS may be "more an article of faith than a proposition of science."[327] In 2016, a report on forensic science in criminal courts from the President's Council of Advisors on Science and Technology recommended that SBS/AHT is a subject meriting "urgent attention."[328] A 2018 medicolegal text exhaustively explores the SBS/AHT controversy and concludes that cornerstone SBS/AHT beliefs fail to satisfy the Daubert reliability standard.[329] Although they differ about what to do about it, courts routinely acknowledge the significant and growing controversy surrounding SBS.[330] The Swedish Report exposed the myth that SBS rests on validated science.[331]

F. The AAP Renames the Diagnosis

As developments revealed the AAP's past SBS guidance as misguided, the AAP issued a new statement in 2009 that conceded no past error, but recommended that physicians cease using the term SBS in "their medical diagnosis and communications" and instead use the term Abusive Head Trauma.[332] According to the 2009 statement: "Legal

322. Tuerkheimer, *supra* note 24, at 10.
323. *See* Cavazos v. Smith, 565 U.S. 1 (2011).
324. *Id.* at 8-11 (Ginsburg, J., dissenting).
325. *See* Guthkelch, *supra* note 229, at 206-07.
326. *Id.* at 201.
327. *See* Del Prete v. Thompson, 10 F. Supp. 3d 907, 956-58 n.10 (N.D. Ill. 2014).
328. *See* PRESIDENT'S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY, REPORT TO THE PRESIDENT: FORENSIC SCIENCE IN CRIMINAL COURTS: ENSURING SCIENTIFIC VALIDITY OF FEATURE-COMPARISON METHODS 23 n.15 (Sept. 2016) [hereinafter REPORT TO THE PRESIDENT].
329. *See* PAPETTI, *supra* note 2, § 4.4 & ch. 5.
330. *See, e.g.*, cases cited in *supra* note 2.
331. *See supra* notes 210-28 and accompanying text.
332. 2009 AAP Statement, *supra* note 2, at 1411.

challenges to the term 'shaken baby syndrome' can distract from the more important questions of accountability of the perpetrator and/or safety of the victim."[333] The focus of the controversy by that point, of course, was not about the name. It was (and is) about the fact that the diagnosis—by whatever name—is made in too many cases where there is no reliable medical proof that there is a "perpetrator" or a "victim."

The name change did not fix SBS' shortcomings; it merely changed the diagnosis' name, principally for legal purposes. The co-author of the 2009 AAP statement, a pediatrician, explained that the name change would "provide more clarity in the courtroom."[334] It did not. If physicians cannot reliably diagnose shaking from the triad findings, and if there is no external evidence of head impact, then it is fallacious to insist they can diagnose "abuse" from those findings.[335] There is no different, more reliable AHT evidence base than the evidence base developed with SBS dogma. If that dogma was based on false or otherwise uncertain premises, then changing the name of the syndrome is hardly a responsible solution.

Moreover, whether called SBS or AHT, the name of this diagnosis reflects legal and child advocacy considerations, not any medical description. As Guthkelch noted, while almost all medical syndromes are named after their discoverer or for a prominent clinical feature, SBS, by contrast, "asserts a unique etiology (shaking)," and AHT goes even further in implying "both mechanism (trauma) and intent (abusive)."[336] As authors of the Swedish Report explained, "a medical expert can have a hypothesis of the mechanism behind a medical finding, but to decide whether a trauma was inflicted intentionally or unintentionally is not a medical issue; this is the task of the judicial system."[337]

Unless defined by specific diagnostic criteria (e.g., the triad), or connected to some unique mechanism of injury (e.g., shaking), the term "abusive head trauma" is medically and scientifically meaningless. It is merely a label given when physicians believe a child's intracranial and retinal findings were inflicted. The Consensus Statement and other related efforts to persuade courts that a high percentage of physicians regard AHT as a "valid" diagnosis[338] mischaracterize the controversy, as

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333. *Id.* at 1410.

334. *'Shaken Baby Syndrome' Given New Name*, NBC NEWS, (Apr. 27, 2009), http://www.nbcnews.com/id/30425052/ns/health-childrens_health/t/shaken-baby-syndrome-given-new-name/#.XIftpC2ZPPA.

335. *See* PAPETTI, *supra* note 2, § 4.3.3.

336. Guthkelch, *supra* note 229, at 202.

337. *Pouring Out the Dirty Bathwater Without Throwing Away Either the Baby or Its Parents*, *supra* note 225, at 285.

338. *See Consensus Statement*, *supra* note 3, at 1049 (urging that there is no controversy concerning the "validity" of the AHT diagnosis); Sandeep K. Narang et al., *Acceptance of Shaken Baby Syndrome and Abusive Head Trauma as Medical Diagnoses*, 177 J. PEDIATRICS

no one denies that abusive head trauma occurs and that such abuse may validly be diagnosed in some cases. But a consensus that AHT may validly be determined in some cases is useless to courts or anyone else assessing whether the controversial SBS/AHT beliefs are reliable.

IV. THE DIAGNOSIS CONTINUES AND REMAINS UNRELIABLE.

There appears to have been little real change in how many pediatric physicians diagnose SBS/AHT. Physicians may express their beliefs about SBS/AHT less categorically than in the past, but the Statement confirms the traditional beliefs persist. However, given the collapse of the triad as a reliable basis for diagnosing SBS/AHT, there has been a devoted effort within child abuse pediatrics to argue that the diagnosis is not based on the triad.[339] Consistent with this new approach, the Statement describes the SBS/AHT diagnosis in a manner that implies nuance and complexity and no real reliance on the triad. The description, however, is misleading.

The Statement claims that AHT is a "scientifically non-controversial medical diagnosis,"[340] that it is made "like any other medical diagnosis,"[341] and that it is reached only after a "complex and multifaceted diagnostic process."[342] Using language that is now almost a mantra within the child abuse literature,[343] the Statement strongly denies that the diagnosis is based on the triad. According to the Statement, the claim that the diagnosis is based on the triad is a "straw man."[344]

Medical diagnoses, especially those that purport to be grounded in

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273, 277 (2016) (reporting that eighty-eight percent of pediatric physicians at children's hospitals view SBS as a valid medical diagnosis and ninety-three percent view AHT as a valid medical diagnosis and arguing that such "acceptance" proves that those who challenge the diagnosis' reliability hold fringe opinions). The survey, however, revealed that only about forty percent of pathologists view SBS as a valid diagnosis.

339. *See* PAPETTI, *supra* note 2, § 4.3.1.

340. *Consensus Statement*, *supra* note 3, at 1049.

341. *Id.* at 1052.

342. *Id.* at 1050.

343. *See, e.g.*, Steven Lucas et al., Editorial, *The Way Forward in Addressing Abusive Head Trauma in Infants—Current Perspectives from Sweden*, 106 ACTA PAEDIATRICA 1033 (2017) ("The construct of the 'triad' represents a rhetorical fallacy known as a straw man, which gives the impression of refuting an opponent's argument [that] the 'triad' is pathognomonic for AHT—when, in fact, that argument was never advanced by that opponent. We maintain that the term 'triad' carries no value for clinicians experienced in evaluating suspected AHT."); Sandeep K. Narang & Christopher S. Greeley, *#the RestoftheStory*, 106 ACTA PAEDIATRICA 1047, 1047 (2017) ("Physicians experienced in the clinical evaluation of paediatric traumatic brain injury and AHT *do not* diagnose SBS by a 'triad.' That is a 'strawman' created for legal purposes and legal recourse."); Cindy W. Christian et al., AM. ACAD. PEDIATRICS, *Understanding Abusive Head Trauma in Infants and Children* 7 (2015) ("This controversy regarding a triad is a 'straw man' created for legal arguments."), https://www.aap.org/en-us/Documents/cocan_understanding_aht_in_infants_children.pdf.

344. *Consensus Statement*, *supra* note 3, at 1050.

science, have objective diagnostic criteria. Notwithstanding the protest in the Consensus Statement, it is a matter of easily confirmed historic fact that, for at least three decades, the triad findings served as the primary diagnostic criteria for SBS/AHT.[345] The triad findings were thought to be so forensically reliable that the AAP advised that SBS/AHT need not be made as a "diagnosis of exclusion," but rather could be presumed merely from the internal findings.[346] SBS proponents argued and testified that the notion that almost anything else could explain the triad findings in a young child was "foolish."[347]

Even while trying to convey the opposite impression, the Statement and the accompanying Pediatric Radiology Editorial actually confirm the continuing centrality of the triad findings to the diagnosis. The Editorial states that *"[t]he findings of subdural hematoma, retinal hemorrhage and hypoxic-ischemic encephalopathy remain highly suggestive of shaken baby syndrome*, particularly in the absence of evidence of an impact injury. Although this 'triad' is not absolutely diagnostic of child abuse, it is highly suggestive of the diagnosis."[348] Within a longer discussion in a section titled "How the diagnosis is made," the Statement says essentially the same thing.[349]

The Statement emphasizes that physicians diagnosing SBS/AHT consider the patient's history. No one doubts that they do. But unlike other medical diagnoses, where physicians rely on the patient's given history, pediatric physicians in SBS/AHT cases view themselves as the arbiters of the veracity of the given history and generally reject that history as "insufficient" or "inconsistent with the child's injuries" if the triad is present.[350] Caregivers seeking medical attention for infants and young children rarely relay a history that the child was violently shaken or abused. The two most common histories in SBS/AHT cases are either that the child had not endured any specific trauma[351] or that the baby had

345. *See* PAPETTI, *supra* note 2, § 4.3.1.

346. *See supra* notes 24-29 and accompanying text.

347. *See* Holmgren, *supra* note 40, at 307.

348. Strouse, *supra* note 230, at 1043.

349. *See Consensus Statement*, *supra* note 3, at 1052-55.

350. *See, e.g.*, Gedeit, *supra* note 42, at 157 ("The Shaken Baby Syndrome is diagnosed by obtaining a history that does not fit the clinical findings in an infant who presents with significant neurological abnormalities."); Monte Mills, *Fundoscopic Lesions Associated with Mortality in Shaken Baby Syndrome*, 2 J. AAPOS 67, 68 (1998) ("The history in each case was inconsistent with an etiology of accidental trauma....Ophthalmic, radiologic, and neurologic evaluations were consistent with shaking as a mechanism of injury."); Matthieu Vinchon et al., *Confessed Abuse Versus Witnessed Accidents in Infants: Comparison of Clinical, Radiological, and Ophthalmological Data in Corroborated Cases*, 26 CHILD'S NERVOUS SYS. 637, 642 (2009) ("[T]he criterion for IHI is generally that the lesions are considered not explained by the mechanism of the alleged trauma.").

351. *See Consensus Statement*, *supra* note 3, at 1052; Högberg, *supra* note 207, at 9 (caregivers in 44% of cases reviewed offered no trauma mechanism).

suffered a fall of less than four to six feet.[352] But data and the child abuse literature prove that, in the triad's presence, these histories are viewed as presumptively false. The false history, in turn, is then used as further proof of abuse. And the inferred lying by the caretakers only demonizes them further in any continuing medical, investigative, or legal inquiries. In 2016 Högberg et al. reported that in nearly seventy percent of reviewed cases one of the criteria used to make the SBS/AHT diagnosis was that the physicians did not believe the history given by the caregiver.[353] Thus, the diagnostic process used in SBS/AHT cases reflects faith in the triad and the subjective judgment of child abuse teams, not reliance on the given history.

The Statement also says that the diagnosis is made based on a careful physical examination, and suggests physicians look for bruising or other patterns of injury, such as grip marks. An SBS/AHT diagnosis is a diagnosis of violent trauma, and so a careful physical examination is, of course, important. Such examination may reveal evidence of battering or other forensically significant trauma. But in many cases diagnosed as SBS/AHT there is no bruising or other external evidence of mistreatment.[354] In fact, the absence of evidence of head impact has traditionally been used to diagnose SBS,[355] as the absence of impact injury supposedly helps confirm shaking as the cause of the presumptively traumatic internal findings. The Statement confirms as much by approvingly citing Kelly et al. for the proposition that "no external evidence of

352. *See Consensus Statement*, *supra* note 3, at 1052; Högberg, *supra* note 207, at 9 (noting that "a minor trauma such as a short fall" was given in 56% of cases reviewed).

353. Högberg, *supra* note 207, at 9 ("In 329 (69%) of 476 alleged abuse cases one of the diagnostic criteria was the rejection of the caregiver statement."); *see also* J. Hettler & D.S. Greenes, *Can the Initial History Predict Whether a Child with a Head Injury Has Been Abused?*, 111 PEDIATRICS 602 (2003) (finding that "the most highly predictive historical feature for abuse is having no history of trauma").

354. *See* 2001 AAP Statement, *supra* note 26, at 206 ("Externally visible injuries are often absent."); NAME Position Paper, *supra* note 38, at 113 ("Many babies with fatal abusive head injuries do not demonstrate any external injury, although in about 25% to 50% of cases, such injuries are evident on external examination."); DOJ BATTERED CHILD SYNDROME GUIDE, *supra* note 34, at 9 ("In most cases of shaken baby syndrome, there are no skull fractures and no external signs of trauma."). The Statement similarly notes that the "absence of external trauma to the head and neck is common." *Consensus Statement*, *supra* note 3, at 1052.

355. *Consensus Statement*, *supra* note 3, at 1052 (citing Kelly, *supra* note 294, for the proposition that in 90% of cases there is no external evidence of impact to the head)); *see also* William Brooks & Laura Weathers, *Overview of Shaken Baby Syndrome*, *in* THE SHAKEN BABY SYNDROME: A MULTIDISCIPLINARY APPROACH, *supra* note 33, at 5 ("While external signs may be minimal, that is one of the hallmarks of SBS."); Strouse, *supra* note 230, at 1043 ("*The findings of subdural hematoma, retinal hemorrhage and hypoxic-ischemic encephalopathy remain highly suggestive of shaken baby syndrome*, particularly in the absence of evidence of an impact injury." (underlined emphasis added)); Vinchon, *supra* note 350, at 643 (concluding that subdural hemorrhage in association with "severe RH and absence of signs of impact is virtual certainty of abuse").

impact to the head" is strongly associated with AHT.[356] The Editorial does the same, deeming the triad particularly suggestive of SBS "in the absence of an impact injury."[357] Only continuing faith in the internal triad can explain guidance that the absence of external evidence of abuse is evidence of abuse.[358]

Imaging findings, too, are routinely considered in SBS/AHT cases. In some cases, the imaging will illuminate that the child obviously has been mistreated. But in many SBS/AHT cases there is no fracture, or there is only a skull fracture or soft tissue swelling consistent with a given history of accidental head trauma. In such cases, the only other material imaging findings almost always are just subdural (and perhaps subarachnoid) blood or fluid collections—i.e., one of the triad findings. The Statement also says that imaging may expose neck or spinal injury.[359] Significant neck or spinal injury would indeed be an important finding, but, as the Statement recognizes, is rarely present.[360] The papers cited in the Statement that extrapolate from recent findings of ligamentous abnormalities or other subtle and ambiguous neck and spinal findings require far more validation and understanding before being used as reliable forensic evidence of abuse.[361] In sum, the imaging in most cases will do little more than tee up the controversies surrounding how to interpret the intracranial blood and/or fluid collections in these cases.

Standard laboratory tests also are done in hospitalized patients who might be assessed for SBS/AHT cases. They rarely produce evidence of abuse. They occasionally may reveal abnormalities suggestive of an ongoing natural pathology. But basic laboratory tests will not reveal many rare hematological or metabolic conditions and the opportunity to test for them may be lost if they are not done before the child dies.[362] The literature is full of debate about whether certain hematological findings

356. *Consensus Statement*, *supra* note 3, at 1052.

357. Strouse, *supra* note 230, at 1043.

358. *See* State v. Consaul, 332 P.3d 850, 864 n.3 (N.M. 2014) ("We leave for another day an examination of how the *lack* of any physical evidence of child abuse can somehow become probative of the crime of child abuse.").

359. *See Consensus Statement*, *supra* note 3, at 1053.

360. *Id.* at 1054.

361. *See, e.g.*, PAPETTI, *supra* note 2, § 3.1.3; Jennifer C. Love, *The Value of Anthropology in Medicolegal Death Investigation of Pediatric Nonaccidental Injury*, 6 ACAD. FORENSIC PATHOLOGY 478, 480 (2016) ("In order to determine the predictive value of nerve root and dorsal root ganglion hemorrhage in a statistically appropriate manner, a large number of spinal cords from traumatic and nontraumatic deaths must be examined. Further, the study population must include traumatic and nontraumatic deaths and must be free of selective bias.").

362. *See* Kodikara, *supra* note 109, at 1383 ("Although some of the non-traumatic differential diagnoses could be excluded by investigations post-mortem, others are impossible or can only be excluded by tests conducted when the child is alive.").

can, in whole or in part, explain subdural and retinal hemorrhage.[363] But, again, the evidence upon which SBS/AHT is suspected and diagnosed is the triad, not laboratory results.

Other than guidance to look for suspicious bruises, fractures and neck injury, which often are not found and the absence of which does not preclude a finding of SBS/AHT, all that is left in the Statement's discussion about how the diagnosis is made are several references to the supposed predictive power of subdural hematoma and retinal hemorrhages, and the common presence of hypoxia-related brain injury—the triad. The Statement discusses various types of subdural collections, yet eventually proceeds to deem them all as having special prevalence in SBS/AHT.[364] The Statement in this respect is consistent with the literature in that every imaginable subdural collection—whether in the nature of hematoma, thin film hemorrhage, hygroma, effusion, chronic hematoma, or hematoma-hygroma—has for decades in this context been imprecisely lumped under the term "subdural hematoma"[365] and treated as presumptively traumatic and associated with abuse.[366] The Statement deems retinal hemorrhages "an important finding in AHT."[367] For the reasons explained supra, several developments have exposed the beliefs about the forensic power of subdural and retinal hemorrhages as overstated, uncertain, and, in key respects, false.

In sum, notwithstanding its protest against claims that the diagnosis often is based on the triad, the Statement confirms that, in many cases, the diagnostic process is based on little more than taking a history that is deemed suspicious once subdural hemorrhage is discovered—very suspicious if the caretaker denies any significant trauma; an ophthalmologic exam to look for retinal hemorrhages, which if present virtually confirm SBS/AHT, especially if extensive; review of laboratory and imaging

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363. *See, e.g.*, Martha E. Laposata & Michael Laposata, *Children with Signs of Abuse: When Is It Not Child Abuse?*, 123 AM. J. CLINICAL PATHOLOGY S119 (2005); Arne Stray-Pedersen et al., *An Infant With Subdural Hematoma and Retinal Hemorrhages: Does von Willebrand Disease Explain the Findings?*, 7 FORENSIC SCI. MED. PATHOLOGY 37 (2011).

364. *See Consensus Statement*, *supra* note 3, at 1053.

365. *See, e.g.*, Andrew P. Sirotnak, *Medical Disorders that Mimic Abusive Head Trauma*, *in* ABUSIVE HEAD TRAUMA IN INFANTS AND CHILDREN, *supra* note 147, at 191-92 ("Language and medical terms are often used interchangeably and inappropriately, particularly in older literature. Subdural effusion, hematoma, hemorrhage, and hygroma are terms that do not have the same meaning."); Greiner, *supra* note 283, at 2376 (" ' Subdural hematoma' has been used very loosely in the literature in this population and probably has described a wide range of [subdural collections] with different etiologies, including 'subdural hygroma,' 'chronic subdural hematoma,' 'chronic subdural hematoma with rebleeding,' and 'hemato-hygroma.' ").

366. *See Consensus Statement*, *supra* note 3, at 1055 (stating that "trauma has come to be uniformly recognized as the primary etiology of pediatric and adult SDHs"); *id.* at 1053 (stating that studies demonstrate that "subdural hematomas are far more common following AHT").

367. *Id.* at 1053.

studies to confirm they do not indicate one of the few rare conditions that child abuse specialists will accept as "sufficient" to explain the triad findings;[368] and, ultimately, confirmation of SBS/AHT via rejection of the caregiver's history as "inconsistent with" the triad findings. It cannot be emphasized enough: this diagnostic process is dominated at each stage by scientifically unreliable beliefs. It incorporates a now-unspoken, but nevertheless continuing presumption of abuse from the finding of subdural hemorrhage; unwarranted reliance on retinal hemorrhages; and the improper elevation of SBS/AHT to a default diagnosis.

As for the effort to reassure courts that SBS/AHT diagnoses reflect an assessment performed with great care, the problem is that the diagnosis is based on false beliefs, not poor intentions. Courts should reject the invitation[369] to regard the conclusions of child abuse specialists or teams as some sort of "gold standard" in diagnosing abusive head trauma.[370] Again, with respect to the SBS/AHT issues, these specialists are no more reliable than the evidence base and assumptions underlying their beliefs.[371] Consequently, as the authors of the Swedish Report warn, treating classifications by child protection teams as a diagnostic gold standard "entails a high risk of bias."[372] The request for deference also conflicts with the core precept of evidence-based medicine—that medical understandings should be based on the best available evidence that has been gathered and analyzed reliably rather than on historic practice or perceived or claimed expertise. Finally, as demonstrated in this response and elsewhere, the track record of child abuse pediatrics regarding SBS/AHT is poor, has consistently reflected bias in one direction, and the continuing insistence within that field that no legitimate controversy exists reflects a disconcerting lack of objectivity.[373]

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368. Notably, from the face of the Statement, one would not know what these alternative conditions would be, as the Statement focuses almost exclusively on (a) findings that supposedly evidence abuse and (b) diagnoses sometimes offered as alternatives to abuse that the Statement deems speculative, rarely applicable, or altogether fabricated by defense counsel and their experts.

369. *See Consensus Statement*, *supra* note 3, at 1057 ("Whenever members of these teams present testimony in a legal setting, there has usually been much in-depth consideration of the diagnosis, and the probability of the correct diagnosis is high.").

370. *See* PAPETTI, *supra* note 2, at 284-86.

371. *See* Niels Lynøe & Anders Eriksson, *A Diagnostic Test Can Prove Anything If You Use Incorrect Assumptions*, 107 ACTA PAEDIATRICA 2051, 2052-53 (2018).

372. Niels Lynøe et al., *Is Accepting Circular Reasoning in Shaken Baby Studies Bad Science or Misconduct?*, 106 ACTA PAEDIATRICA 1445, 1446 (2017) ("This obviously shows that using the classification used by child protection teams as the gold standard for classifying study cases and controls entails a high risk of bias and carries a risk that false-positive cases are presented as true-positive cases.").

373. *See, e.g.*, Niels Lynøe et al., *From Child Protection to Paradigm Protection—The Genesis, Development, and Defense of a Scientific Paradigm*, J. MED. PHIL. 11 (2018) ("We suggest that the genesis and maintenance of biased criteria in determining whether a baby has been violently shaken is based on groupthink among Child Protection Teams and paradigm

V. THE CAMPAIGN TO INFLUENCE THE COURTS

The developments surrounding SBS/AHT justify an intensive nationwide effort to reassess past convictions and other legal decisions that resulted from medical diagnoses and testimony based on beliefs that, it now appears, were mistaken or, at a minimum, questionable. A meaningful and growing number of courts have already agreed that certain past SBS/AHT convictions need to be reopened. But the Statement exemplifies a totally opposite approach: to ignore or minimize the past error; to almost incoherently insist that the diagnostic criteria proven unreliable to diagnose shaking nevertheless remain valid for diagnosing "abuse;" to reject or minimize plausible alternative explanations for the triad findings; and to urge that continued acceptance of the controversial beliefs among those individuals and medical organizations who created and promoted the very paradigm now under attack should be given nearly controlling deference in determining whether the paradigm is reliable.

As challenges to SBS/AHT beliefs have accumulated, they have raised the question whether courts should continue admitting physician testimony and diagnoses based on those beliefs. The core SBS/AHT beliefs fare poorly under many of the reliability (aka Daubert) criteria that courts use in evaluating the admissibility of expert medical and scientific testimony about the cause or etiology of a patient's condition—such as diagnostic error rate; whether testing has validated the expert's viewpoints; whether the pathophysiology leading to the condition is properly understood; whether other alternatives for the condition can be reliably ruled out; whether the expert's theory was developed and offered primarily for legal purposes; and the amount of subjectivity underlying the opinion.[374] But one important indicia that courts consider is whether the beliefs underlying the expert's opinion are "generally accepted" in the relevant field. Indeed, in some jurisdictions, general acceptance is the dominant or even exclusive admissibility criterion. Those defending SBS/AHT rely heavily on this criterion and, to build a case for it, generate papers such as the Consensus Statement specifically to convey to courts that SBS/AHT remains "generally accepted" in pediatric medicine notwithstanding the challenges and ongoing controversy.[375] These papers are then cited in legal cases as proof of such continuing general acceptance.

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protection strategies in the scientific community, which have enabled the publication of biased studies for a period of more than 40 years."), https://academic.oup.com/jmp/advance-article/doi/10.1093/jmp/jhy015/5090117.

374. *See* PAPETTI, *supra* note 2, ch. 5 (analyzing the reliability of the SBS/AHT diagnostic methodology against the *Daubert* criteria).

375. *See Consensus Statement*, *supra* note 3, at 1058, 1060; Narang et al., *supra* note 338.

As evidence of scientific reliability, such strategically generated evidence of acceptance adds little or nothing. As leading commentators have emphasized, courts must be careful in their gatekeeping role to not give too much weight to expressions of acceptance within a particular community when that community is deeply vested in defending a belief's validity.[376] Over and over, the SBS/AHT construct does not hold up when evaluated by those not already deeply vested in the construct. But the motivation behind the Consensus Statement and similar efforts is that courts and juries, faced with the complexities and controversies surrounding the diagnosis, can be persuaded by a show of hands. For example, in a paper published in connection with the Statement, one of the Statement's authors openly touted the Statement's legal functions:

> The legal implications of this, and other, professional society consensus statements are significant. Albeit low on the hierarchy of evidence-based medicine ratings, professional society consensus statements represent the highest level of medico-legal evidence…. More importantly, they can constitute prima facie evidence of "general acceptance" of a medical community's position on a particular topic, and thus aid the court in admissibility determinations of expert testimony on that topic. At the very minimum, professional society consensus statements can serve as strong cross-examination tools for hypotheses that lie outside mainstream medical opinion.[377]

Courts should reject the invitation to treat low-quality medical evidence as "highest level … medico-legal evidence" in making critical reliability determinations that profoundly affect people's lives.

Finally, the Statement repeatedly holds itself out as impartially crafted. In reality, the Statement is patently slanted. But even on the narrower issue of whether the Statement reliably reflects the "consensus" among pediatric physicians, courts should proceed cautiously. Physicians who openly question SBS/AHT and other forensic child abuse beliefs risk professional harassment and intimidation. For example, the Statement appears in Pediatric Radiology, the official journal of the So-

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376. *See* David L. Faigman et al., *Group to Individual (G2I) Inference in Scientific Expert Testimony*, 81 U. CHI. L. REV. 417, 461 (2014) ("[Courts] must consult a broad enough spectrum of scientists to reach those who are not entirely invested in the expertise. 'Investment' in this context could refer to financial interests, but is intended to be considerably broader, and include professional and ideological."); *id.* at 439-40 ("Daubert, in contrast, does not place deference to professional fields at the center of the evidentiary analysis, but instead calls upon judges to independently assess the methods and principles underlying the proffered opinion in order to determine its reliability. Under Daubert, therefore, simply because a field claims the ability to apply general research to particular cases does not make it so."); *see also* REPORT TO THE PRESIDENT, *supra* note 328, at 42 n.90 ("Importantly, the community is not limited to forensic scientists who practice the specific method.").

377. Sandeep K. Narang, *Combating Misinformation About Abusive Head Trauma: AAP Endorses New Report*, http://www.aappublications.org/news/2018/06/01/headtrauma060118.

ciety for Pediatric Radiology. In 2016 that journal published the following editorial (written by its Editor, who also wrote the Editorial that accompanied the Statement):

> Participation by the denialists in the legal adjudication of child abuse is a growing threat to the health care of children and the well-being of children and families. The court system seems ill-equipped to properly censure the denialists in spite of their deceitful and unethical behavior…Institutions that harbor denialists, whether they be private practices or esteemed academic institutions, should carefully consider their employment. Denialism is tarnishing the name of several prominent academic institutions. Licensing bureaus could have a role by limiting practice…. Finally professional societies must carefully consider whether the unethical activity of the denialists challenges the missions and by-laws of the organization. If the organization's mission is to improve the health care and well-being of children and families, it should question condoning the activities of denialists by allowing them to continue membership and to continue to use society membership as evidence of expertise.[378]

Several physicians willing to publish in this area or testify for defendants have indeed endured efforts to have them ostracized, censured, or fired.[379] The Statement itself implicitly seeks to justify these attacks in arguing that physicians who testify for the defense in cases of SBS/AHT cases often "run afoul of professional norms and standards" and that consensus statements should help medical societies "in curbing and sanctioning members whose testimony impedes the goals of scientific, adjudicative and public health accuracy."[380] In such an environment, professional consensus may be less complete than it appears.[381]

The historic "presumption of child abuse" in this context is, today, rarely uttered, but it pervades the Consensus Statement. The presumption reflects child protection advocacy. It is inconsistent with evidence-based medicine and reflects a mindset and diagnostic process at odds with the burdens of proof that apply to criminal and most family court determinations.[382]

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378. Peter J. Strouse, Editorial, *Child Abuse: We Have Problems*, 46 PEDIATRIC RADIOLOGY 587, 588 (2016).

379. *See* PAPETTI, *supra* note 2, § 4.2.

380. *Consensus Statement*, *supra* note 3, at 1059.

381. Furthermore, the background of the Consensus Statement makes clear that it was not the product of an effort to identify and then memorialize consensus understandings among pediatric radiologists or other pediatric physicians, but rather was written by devout child abuse specialists with little or no meaningful effort to ascertain any consensus or accommodate dissenting viewpoints. *See Feigned Consensus*, *supra* note 7, at 18-21.

382. It is important to keep in mind that the State and the defendant carry different burdens in SBS/AHT cases. The State must prove each element of the offense with evidence that is very strong—to beyond a reasonable doubt in criminal cases and, at a minimum, by clear and convincing evidence when seeking to terminate parental rights. The defendant, by contrast,

VI. CONCLUSION

The Statement is not a reliable resource except to understand one side's viewpoints in an area that is not merely controversial, but is perhaps the most controversial area in forensic medicine.[383] The Statement was openly written for legal advocacy purposes, and its frequent resort to deeming those who raise questions about SBS/AHT as child abuse denialists is alone sufficient to expose its lack of objectivity. The denialist epithet is particularly striking given the track record of pediatric organizations and child abuse specialists in prematurely promoting false, misleading, or never validated beliefs and assumptions about SBS/AHT and in light of the important role the "denialists" have played in exposing the flaws. The SBS/AHT diagnosis is indeed highly controversial, notwithstanding any claimed consensus to the contrary.[384] It is past time for child abuse specialists to adjust their "consensus" about SBS/AHT to reflect the scientific evidence. But, in any event, the interests at stake in these cases require that courts play a greater role in understanding and assessing such testimony and not defer to the views of those overly vested in maintaining an unreliable paradigm.

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has a much lower burden, which he or she can meet by simply pointing out potential deficiencies in the State's evidence or by introducing additional evidence that raises doubt. In many SBS/AHT cases, the State seeks to meet its burden on one or more elements nearly entirely with expert medical testimony. In such cases, the State's expert testimony must be supported by science capable of meeting the governing burden of proof—i.e., beyond a reasonable doubt or clearly and convincingly. The defendant's evidence need only show that other potential explanations for the child's condition are plausible.

383. *See Feigned Consensus*, *supra* note 7, at 57 ("There are very serious questions about the reliability of SBS/AHT diagnoses, and those questions cannot be papered over by bringing together a guild of true believers to publish a 'consensus statement.'").

384. *See* PAPETTI, *supra* note 2, at 314-15 ("Most SBS-related testimony does not belong in the courtroom, regardless of position papers, surveys, or consensus statements from otherwise credible sources offered to reassure the court and the public that SBS remains well accepted in certain medical sub-communities.").