

Acceptance of Shaken Baby Syndrome and Abusive Head Trauma as Medical Diagnoses

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Objective To assess the current general acceptance within the medical community of shaken baby syndrome (SBS), abusive head trauma (AHT), and several alternative explanations for findings commonly seen in abused children.

Study design This was a survey of physicians frequently involved in the evaluation of injured children at 10 leading children's hospitals. Physicians were asked to estimate the likelihood that subdural hematoma, severe retinal hemorrhages, and coma or death would result from several proposed mechanisms.

Results Of the 1378 physicians surveyed, 682 (49.5%) responded, and 628 were included in the final sample. A large majority of respondents felt that shaking with or without impact would be likely or highly likely to result in subdural hematoma, severe retinal hemorrhages, and coma or death, and that none of the alternative theories except motor vehicle collision would result in these 3 findings. SBS and AHT were considered valid diagnoses by 88% and 93% of the respondents, respectively.

Conclusions Our empirical data confirm that SBS and AHT are still generally accepted by physicians who frequently encounter suspected child abuse cases, and are considered likely sources of subdural hematoma, severe retinal hemorrhages, and coma or death in young children. Other than a high-velocity motor vehicle collision, no alternative theories of causation for these findings are generally accepted. (*J Pediatr* 2016;■■■:■■-■■).

Although shaking, with or without impact, has been recognized as a dangerous form of child physical abuse since the early 1970s,^{1,2} the validity of shaken baby syndrome (SBS) and abusive head trauma (AHT) has recently been called into question in prominent national newspapers such as the *New York Times* and *Washington Post*,^{3,4} judicial decisions,^{5,6} and some medical literature.^{7,8} In fact, a US Supreme Court Justice recently commented in a dissenting opinion that there is widespread "controversy" within the medical community regarding the concepts of AHT and SBS.^{9,10} Not surprisingly, this has resulted in confusion in the courts and a chilling effect on child protection hearings and criminal prosecutions.¹¹

Legal interventions are an important part of primary safety determinations and secondary prevention for victims of maltreatment. In that process, courts frequently rely on medical expert testimony to opine on the most likely source of a child's injuries. To determine the admissibility of scientific testimony, courts must assess whether concepts are "generally accepted" in the medical community. In approximately one-half of the US jurisdictions, known as Frye jurisdictions, "general acceptance" is the sole criterion for admitting expert testimony on a certain concept.¹¹ In the remainder of US jurisdictions, known as Daubert jurisdictions, "general acceptance" is one of several criteria used to assess reliability, but is still afforded significant weight.¹² In addition, several professional medical society ethical guidelines for expert testimony state that testimony should reflect generally accepted opinions, and/or that an expert who endorses a minority opinion should volunteer that information.¹³⁻¹⁶

In courts, evidence of what is generally accepted in the medical community has typically been adduced by the opinion of a solitary expert or a small cadre of experts. This approach is susceptible to the biases and knowledge base of the testifying physicians, and leaves open the possibility that a small group could create an incorrect impression about whether or not any particular concept is generally accepted. Courts are ill-equipped to measure the broad opinion of the wider medical field or to assess the validity of a single physician's assessment of that broad opinion. Although SBS has historically been considered a valid medical diagnosis,¹⁷ to date no well-conducted study has measured the acceptance of SBS or AHT as diagnoses, or of the likelihood that shaking will result in subdural hematoma (SDH), retinal hemorrhages (RH), or coma or death, the findings commonly associated with SBS and AHT.^{18,19}

Given the importance of this issue to child protection and legal outcomes, we aimed to attain empirical data on the acceptance of SBS and AHT as valid medical

AHT	Abusive head trauma
MVC	Motor vehicle collision
REDCap	Research Electronic Data Capture
RH	Retinal hemorrhages
SBS	Shaken baby syndrome
SDH	Subdural hematoma

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diagnoses by the physicians most commonly involved in those cases. We also sought to determine whether shaking, with or without impact, and other mechanisms of injury are generally accepted as reasonable explanations for SDH, RH, and coma or death.

Methods

This observational survey study was reviewed and approved by the University of Texas-Houston Institutional Review Board, and was conducted between March and October 2015. To identify a feasible sample size and limit enrollment or response bias, we surveyed hospitals identified from the 2014-15 *US News & World Report* Honor Roll of Children's Hospitals.²⁰ From the 10 leading children's hospitals, we identified faculty physicians (MD, DO) within the specialty departments most commonly involved in suspected AHT cases: Emergency Medicine, Critical Care, Child Abuse Pediatrics, Pediatric Ophthalmology, Pediatric Radiology, Pediatric Neurosurgery, and Child Neurology. Because forensic pathologists are not typically located within children's hospitals, we contacted the medical examiners' offices that jurisdictionally comported with the surveyed hospitals and offered participation in the survey. If no medical examiner's office comported with a particular jurisdiction, we contacted the responsible coroner's office and offered participation in the survey.

We obtained contact information (e-mail and mailing addresses) from hospital websites or physician collaborators. In March 2015, physicians were invited to participate by e-mail, and were informed that the survey was voluntary and anonymous. Using a modified Dillman method,²¹ the lead investigator (S.N.) sent an e-mail to eligible physicians, providing a summary of the study's objective and methods, along with a unique, anonymous online link to the survey. After the initial e-mail, nonresponders were sent a reminder e-mail (with survey links) every 2 weeks on 2 separate occasions. If a physician had not completed the survey after 3 e-mail attempts, then a hard copy of the survey (with \$1 attached) was mailed to the physician's office address on 2 separate occasions at 2-week intervals. After this, if the participant still had not responded, he or she was logged as a nonresponder, and his or her contact information was permanently deleted. Data collection efforts were completed in October 2015. As an incentive to improve response rates, participants were entered into up to 5 randomized, biweekly drawings for a \$200 gift card (depending on the time of response, with earlier responders being eligible for and entered into more drawings).

To minimize the potential for bias, we did not approach nonresponders and used no additional methods to encourage recruitment by any respondent. To ensure an appropriate sampling frame, we asked each respondent to report his or her specialty on the survey, and those who reported specialties other than those being sought to be surveyed excluded.

Study data were collected and managed using REDCap (Research Electronic Data Capture) tools hosted at the Univer-

sity of Texas at Houston.²² REDCap is a secure, web-based application designed to support data capture for research studies. No identifying information was recorded in REDCap, and once a physician completed the survey, his or her contact information was permanently deleted, thereby preserving anonymity.

Survey

Each participant reported his or her age (20-30, 31-40, 41-50, 51-60, 61+ years), board certification status, and years in practice (0-5, 6-10, 11-20, 20-30, 31-40, or 41+ years). Each participant was also asked to choose his or her field of specialty from the list of specialties sought (ie, Emergency Medicine, Critical Care, Child Abuse Pediatrics, Pediatric Ophthalmology, Pediatric Radiology, Pediatric Neurosurgery, and Child Neurology), or to report another specialty. Those reporting more than 1 surveyed specialty (n = 8) were included under each specialty for the report of respondent characteristics, but were only counted once in the remainder of the survey. Those reporting a specialty that was included in the sampling frame and a specialty that was not included (eg, Pediatric Emergency Medicine, General Pediatrics) were counted within the included specialty. Those identified within a division of pediatric emergency medicine who listed their specialty as "urgent care" were included with Emergency Medicine. Those listing only exclusion specialties (eg, General Pediatrics, Allergy and Immunology, Anesthesia, Pulmonology) were excluded.

Respondents rated the likelihood of each finding (SDH, RH, coma or death) to result from several proposed mechanisms in a child aged <3 years using a 5-point Likert scale (from "highly unlikely" to "highly likely"). "Severe RH" was defined as too numerous to count, multilayered hemorrhages extending to the periphery. Proposed mechanisms included shaking without impact, shaking with impact against a soft surface (eg, a bed), a very short fall (<3 feet) with impact against a hard surface, a high-velocity motor vehicle collision (MVC), hypoxia, dysphagic choking, vitamin D deficiency rickets, and adverse reaction to vaccines.

Finally, respondents were asked whether they believed SBS to be a valid medical diagnosis (yes, no, don't know/unsure), whether they believed AHT to be a valid medical diagnosis (yes, no, don't know/unsure), and the basis for those opinions (clinical experience, medical literature, both, or neither). Respondents were offered the chance to ask questions or to comment on the survey or the study as a whole by contacting the principal investigator.

For analysis, we defined a "fringe opinion" as one in which <5% of respondents deemed a given mechanism for a finding as likely/highly likely or unlikely/highly unlikely (Table 1). For analysis of shaking with impact versus shaking without impact results, we defined "discordance" as a rating that changed from highly unlikely or unlikely to likely or highly likely (or vice versa), depending on whether or not impact was present. Descriptive statistics were used to determine the prevalence of each response along with associated 95% CIs. Comparisons were conducted using OR with 95% CI.

Table I. Fringe opinions

	Likely/highly likely	%	Unlikely/highly unlikely	%
SDH	Vaccines	0.0	Shake WITH impact	3.2
	Vitamin D	2.3		
	Choking	2.7		
	Hypoxia	4.0		
RH	Vaccines	0.0	Shake WITH impact	1.0
	Vitamin D	0.8	Shake NO impact	1.8
	Short fall	3.2		
Coma/death	Vitamin D	0.6	Shake NO impact	3.7
	Vaccines	1.0	Shake WITH impact	4.8
	Short fall	3.1	MVC	3.5
	SBS invalid		4.8	
	AHT invalid		1.0	

A causative mechanism was considered a fringe opinion if the combined percentage of respondents rating it as likely or highly unlikely or as unlikely or highly unlikely was <5%.

Results

The survey was sent to 1378 clinicians, of whom 682 (49.5%) responded. A department of child neurology (n = 22) at 1 institution declined as a block to participate, and were counted as nonresponders. We excluded 54 (8%) survey respondents because they either did not list their specialty (n = 9) or listed only specialties that were not included in our sampling frame (23 general, primary, or hospitalist pediatricians and 22 other pediatric subspecialists). The remaining 628 respondents composed the main cohort for this analysis. Characteristics of the respondents are summarized in **Table II**. Among the respondents, the most common specialties listed were Emergency Medicine, Critical Care, Neurology, and Radiology. The large

Table II. Respondent characteristics

Characteristics	n (%)
Specialty*	
Emergency Medicine	192 (30.9)
Critical Care	108 (17.4)
Neurology	101 (16.3)
Radiology	96 (15.5)
Ophthalmology	45 (7.2)
Neurosurgery	30 (4.8)
Child Abuse	30 (4.8)
Pathology	27 (4.3)
Board-certified†	548 (88.2)
Age, y‡	
20-30	4 (0.6)
31-40	240 (38.6)
41-50	180 (29.0)
51-60	128 (20.6)
61+	68 (11.0)
Years in practice§	
0-5	148 (23.8)
6-10	135 (21.7)
11-20	164 (26.4)
21-30	106 (17.1)
31-40	48 (7.7)
41+	16 (2.6)

*Sums to 629 because 8 respondents listed 2 specialties.

†Six respondents did not report board certification status.

‡One respondent did not report age.

§Four respondents did not report years in practice.

majority (88.2%) of respondents reported being board-certified in their specialty.

Ninety-nine respondents (15.8%) omitted answers for at least 1 question. The most common scenarios in which more than 3 responses were omitted were nonophthalmologists omitting questions about RH and, conversely, ophthalmologists exclusively answering questions related to RH. No question was omitted by more than 22 respondents.

Respondents' opinions about the most likely source of SDH, severe RH, and coma or death are shown in the **Figure**. More than 80% of respondents felt that shaking with or without impact was likely or highly likely to produce SDH, more than 90% reported that it was likely or highly likely to produce RH, and more than 78% reported that it was likely or highly likely to result in coma or death. The corresponding results for a short fall were 18%, 3%, and 3%, respectively.

Either SBS or AHT was characterized as a valid diagnosis by 607 respondents (96.7%; 95% CI, 94.9%-97.9%). SBS was endorsed as valid by 554 respondents (88.1%; 95% CI, 85.3%-90.5%); AHT, by 584 respondents (93.0%; 95% CI, 90.7%-94.9%). Pathologists were statistically significantly more likely to be divergent with respect to the validity of AHT and SBS, with 8 of 27 stating that SBS is not a valid diagnosis, but that AHT is valid (OR, 13.5; 95% CI, 4.7-38.1, relative to other specialties) (**Table III**). Two pathologists responded that SBS is valid, but AHT is not.

Among the respondents stating that SBS or AHT is a valid diagnosis, 545 (89.7%) reported that they were informed by both the scientific literature and their own clinical experience, 48 (8%) were informed only by their clinical experience, and 11 (1.8%) were informed only by the scientific literature. One respondent did not answer the question, and 2 respondents listed "other" as the reason for considering the diagnosis valid. With respect to specific findings (SDH, RH, coma or death), the respondents showed very little discordance in their responses according to the presence or absence of impact.

Using our definition of "fringe opinion," 165 respondents (26.6%) reported at least 1 fringe opinion. We also included respondents who stated that either SBS (n = 30; 4.8%) or AHT (n = 6, 1.0%) were not valid. Of the 6 respondents who stated that they thought AHT was not a valid diagnosis, 5 agreed that shaking with or without impact was likely or highly likely to result in SDH and RH. All 5 of these respondents agreed that shaking with impact was likely or highly likely to result in coma or death; 2 of the 5 were neutral about the likelihood of shaking without impact resulting in coma or death. One respondent reported that AHT was invalid, and that shaking with or without impact is unlikely or highly unlikely to result in SDH, RH, or coma or death. This respondent reported that only a MVC or a short fall were likely to result in SDH, no option was likely to result in RH, and only a MVC was likely to result in coma or death.

Discussion

Our survey results represent national, multidisciplinary physician opinions on the validity of SBS and AHT, and of the

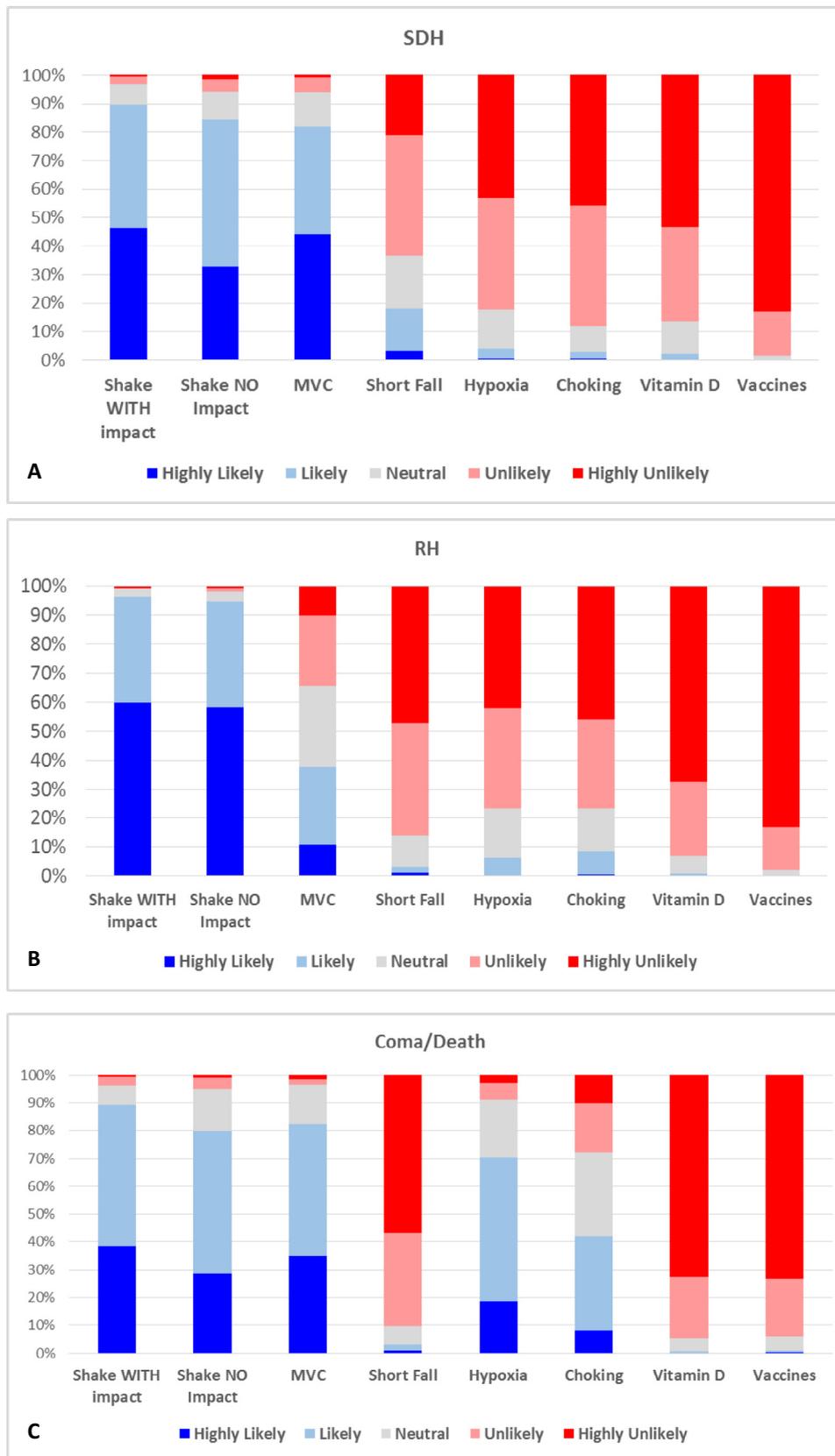


Figure. Percentage of respondents who believe that SDHs, severe RHs, and coma/death would result from the above events.

Table III. Validity of AHT and SBS by specialty

Specialties	n	Yes, n (%)	No	Don't know/ unsure	Blank
AHT valid					
Emergency Medicine	196	184 (93.9)	0	10	2
Critical Care	108	102 (94.4)	2	3	1
Neurology	103	95 (92.2)	1	5	2
Radiology	96	82 (88.5)	2	8	4
Ophthalmology	46	44 (95.7)	0	2	0
Neurosurgery	30	30 (100.0)	0	0	0
Child Abuse Pediatrics	30	30 (100.0)	0	0	0
Pathology	27	25 (92.6)	1	1	0
SBS valid					
Emergency Medicine	196	175 (89.3)	7	11	3
Critical Care	108	99 (91.7)	2	7	0
Neurology	103	96 (93.2)	4	1	2
Radiology	96	84 (87.5)	2	6	4
Ophthalmology	46	45 (97.8)	0	1	0
Neurosurgery	30	23 (76.6)	5	2	0
Child Abuse Pediatrics	30	28 (93.3)	2	0	0
Pathology	27	11 (40.7)	8	8	0

Totals sum to 636 because 8 respondents listed 2 specialties: 4 for Child Abuse Pediatrics and Emergency Medicine, 2 for Critical Care and Emergency Medicine, and 2 for Critical Care and Neurology.

likelihood that findings commonly seen in those cases—SDH, severe RH, and coma or death—result from various causal mechanisms. Although “general acceptance” is not defined by a definitive numerical threshold in legal settings (although acceptance by <50% of field clearly would not meet the criterion for “general acceptance”), our results provide empirical data that clearly support the conclusion that SBS and AHT are still generally accepted as valid medical diagnoses across a broad range of specialties. Furthermore, our data show that shaking with or without impact (in contradistinction to several other alternative theories) is generally accepted to be a dangerous form of child physical abuse and capable of producing SDH, RH, and coma or death. Several alternative explanations that have been proposed to cause SDH, RH, and coma or death are not generally accepted. This high degree of consensus, irrespective of specialty, experience, or age, refutes recent reports in the lay press and legal commentary of a substantial controversy within the medical community regarding SBS and AHT. Other authors have discussed the various motivations for those media sources to proffer such assertions.^{22,23}

As a specialty, forensic pathologists were discordant from other respondents, being more likely to question the validity of SBS as a diagnosis, although not more likely to question the validity of AHT (Table III). In this respect, our results are similar to the results of a survey of forensic pathologists that showed 35% questioning SBS.²³ That survey did not address the topic of AHT separately from SBS, however.

Our survey results demonstrate that physicians, irrespective of specialty, viewed the risks of shaking, with or without impact, to be similar to a high-velocity MVC and dissimilar to a very short fall. Although this finding may seem unremarkable to clinicians, it is important in light of some biomechanical literature arguing that shaking without impact cannot generate sufficient forces to cause SDH,^{24,25} and biomechanical²⁴ and pathology²⁶ literature suggesting very short

falls as a reasonable explanation for those findings. We believe the divergence of our results from this literature represents a recognition of the limitations of biomechanical data, a primacy of clinical literature and experience in relation to that literature, or both.

Our study has several limitations. First, we did not include general pediatricians in our sampling frame, even though some general pediatricians have substantial experience caring for children who have sustained physical abuse. Thus, our results are susceptible to selection bias. However, we chose to include only those specialties with the greatest likelihood of evaluating and treating pediatric traumatic brain injury. Our results could be different if general pediatricians with high rates of exposure to traumatic brain injury had systematically different opinions about the risks and injuries associated with shaking or other suggested mechanisms.

Second, as with all survey studies, ours might have been subject to response bias if respondents held systematically different opinions from nonrespondents. If present, this could have affected our results by increasing or decreasing the true proportion of clinicians who accept SBS or AHT. We do not feel that this limitation significantly affected our results, however, for several reasons. First, our sampling frame was chosen to reflect practicing clinicians from 10 leading hospitals, rather than groups that are most active in legal proceedings involving child abuse and neglect (and thus more motivated to respond). Second, our relatively high response rate (nearly 50% of those surveyed, with more than 600 clinicians) limits the potential that a small cadre of clinicians with divergent opinions would significantly affect results. Finally, our results show remarkable unanimity. Thus, nearly all nonresponders would have to harbor opinions that are diametrically opposed to responders for AHT or SBS to have an acceptance rate of <50% or for fringe opinions to be generally accepted.

The limitations of the *US News & World Report* hospital rankings have been discussed elsewhere.²⁷ Our intention in using these rankings was not to endorse a ranking of any particular children’s hospital; rather, we sought to identify a relatively large and diverse cohort of clinicians likely to care for child victims of trauma, and to decrease the possibility that the survey would be preferentially distributed to clinicians whose opinion regarding AHT or SBS was known to the authors. It is possible that our results would differ if we were to use different hospitals or a different ranking system; however, given the degree of consensus, we believe it unlikely that such different choices would change the conclusion regarding whether SBS, AHT, or the other alternative hypotheses are generally accepted.

Finally, some respondents indicated confusion about the questions. For example, 1 respondent (who contacted the lead investigator) noted that there are important developmental and anatomic differences between infants aged <12 months and young children aged <3 years that could significantly impact the likelihood of the resulting findings. Another respondent noted that it would have been more appropriate to ask about the likely mechanism, given a particular finding, than to ask about the likely findings resulting from a given mechanism.

Although we recognize both points, we believe that any ambiguity in the survey design would bias against a high level of consensus. ■

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