



Overtaken abusive head trauma and shaken baby syndrome convictions in the United States: Prevalence, legal basis, and medical evidence[☆]

S.K. Narang^{a,*}, K.K. Sachdev^{b,1}, K. Bertocci^{c,1}, M.J. Pierre-Wright^d, K. Kaczor^e,
G. Bertocci^c, M.C. Pierce^{f,g}

^a Child Advocacy and Protection Services, Children's Wisconsin, Wauwatosa, WI 53214, United States of America

^b University of Illinois College of Medicine at Chicago, Chicago, IL 60612, United States of America

^c University of Louisville, J.B. Speed School of Engineering, Department of Bioengineering, Louisville, KY 40292, United States of America

^d Northwestern University Feinberg School of Medicine, Chicago, IL 60201, United States of America

^e Mary Ann and J. Milburn Smith Child Health Outreach, Research, and Evaluation Center, Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, IL 60611, United States of America

^f Division of Emergency Medicine, Ann & Robert H. Lurie Children's Hospital of Chicago, United States of America

^g Department of Pediatrics, Northwestern University Feinberg School of Medicine, Chicago, IL 60611, United States of America

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ABSTRACT

Background: Media reports and the Innocence Network assert that wrongful Abusive Head Trauma (AHT)/Shaken Baby Syndrome (SBS) convictions pervade the United States (U.S.) criminal justice system. Yet, no empirical evaluation of overtaken AHT/SBS convictions has been conducted.

Objective: To evaluate the prevalence, legal basis, and characteristics of appellate rulings of AHT/SBS convictions.

Participants and setting: U.S. appellate cases in a legal database, Westlaw.

Methods: Retrospective review of AHT/SBS convictions that had appellate rulings from January 2008 through December 2018. Multiple search terms ensured all potential AHT/SBS cases were included. A mixed-methods analysis was conducted on overtaken AHT/SBS convictions.

Results: We identified a total of 1431 unique AHT/SBS criminal convictions that had appellate rulings since 2008. Of those, 49 convictions (3%) were overtaken, and 1382 (97%) were affirmed/upheld. Of those overtaken, 20 cases (1% overall) were overtaken on medical evidence-related grounds. The most common themes from the medical evidence-related reversals were controversy over the AHT/SBS diagnosis ($n = 12$) and accidental injury mechanism ($n = 11$). After being overtaken on appeal, upon retrial, 42% of defendants either re-plead guilty to or were convicted again of the same offense.

Conclusion(s): AHT/SBS convictions are rarely overtaken on medical evidence-related grounds. When overtaken, medical evidence-related themes seldom reflect new scientific or clinical discoveries, but rather are alternative or differing medical opinions from those offered at the original

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* Corresponding author at: Child Advocacy and Protection Services, Children's Wisconsin, Medical College of Wisconsin, C615, PO Box 1997, Milwaukee, WI 53201, United States of America.

E-mail address: snarang@mcw.edu (S.K. Narang).

¹ These authors contributed equally to this publication.

trial. Our data tends to support the concerns of other authors regarding irresponsible communication of medical information in AHT/SBS cases.

1. Introduction

Abusive Head Trauma (AHT), which includes Shaken Baby Syndrome (SBS), is the third leading cause of head injury in children, surpassed only by motor vehicle collisions and falls (Parks et al., 2020). The mortality rate of AHT ranges from 10 to 20% in children less than 4 years old (Nuno et al., 2020; Rebbe et al., 2020). Despite its significant impact on the health and welfare of infants and children, and because of its translation to the courtroom, AHT/SBS engenders controversy in legal circles and public media.

The Innocence Network and the National Registry of Exonerations proffer AHT/SBS as an “unreliable” diagnosis that has caused children to have been wrongfully removed from parents, and parents and caretakers to have been sent to prison or even sentenced to death (Innocence Network [innocencenetwork.org], 2019a, b). Bolstering this mantle, media articles in prominent journalistic sources have asserted that wrongful AHT/SBS convictions pervade the U.S. criminal justice system (Bazelon, 2011; Cenziper, 2015; Conan, 2011; Szalavitz, 2012; Tuerkheimer, 2010). Specifically, these media reports contend that the magnitude of this problem involves “hundreds” of wrongfully convicted individuals languishing in U.S. prisons (Szalavitz, 2012). These claims have chilled some criminal prosecutions and child protection proceedings of AHT/SBS cases and have increased federal funding for vigorous appeals of current AHT/SBS convictions (Innocence Network, 2019). However, equally as concerning as the social injustice of wrongful convictions is the contention that scientific experts and “faulty science” are key spokes in this wheel of injustice (Szalavitz, 2012).

Despite the media attention, to date, no empirical evaluation of overturned AHT/SBS convictions has been conducted. Instead, media reports have been anchored to physician courtroom opinion testimony, data from The National Registry of Exonerations (The National Registry of Exonerations, 2020), or information from the Innocence Network website (Innocence Network, 2019). Unfortunately, these sources are not bound by rigorous empirical standards of data collection, verification, or reporting.

Empirical data is lacking on several key features of AHT/SBS overturned convictions. Our objectives were to evaluate: 1) the prevalence and characteristics of overturned AHT/SBS convictions in the U.S. appeals system, 2) the legal basis for those overturned convictions, and 3) characteristics of medical evidence-related arguments in those cases. We sought to determine whether AHT/SBS convictions were overturned based on medical evidence and if so, whether this evidence included new scientific discovery or data versus an alternative medical hypothesis.

2. Methods

A mixed methods approach was taken to achieve study objectives. First, we conducted a quantitative analysis to determine the prevalence of overturned AHT/SBS convictions in the U.S. appeals system. Second, we conducted a qualitative analysis to examine themes among AHT/SBS cases that were successfully appealed based on medical evidence. This study was exempt from review by the Ann & Robert H. Lurie Children's Hospital of Chicago Institutional Review Board as all data are in the public record.

Legal cases were included if the following three criteria were met: i) the initial trial resulted in a criminal conviction for which the case had an appellate ruling between January 2008 and December 2018, and, ii) the child's injuries were described as AHT/SBS or met the criteria for AHT as defined by the Centers for Disease Control, and, iii) the case was entered in the Westlaw legal database. Cases were excluded if they involved civil or administrative proceedings.

AHT/SBS legal cases were identified by searching a large, proprietary legal database (Thompson Reuters® Westlaw, St. Paul MN). Westlaw is an online legal research service and proprietary database available in over 60 countries. Information resources on Westlaw include over 40,000 databases of case law, public records, state and federal statutes, legal journals and additional sources. Westlaw publishes all cases reported to the National Reporter System, and case law and public records are uploaded by lawyers and legal professionals on a voluntary basis. Westlaw has been used as a database for medical malpractice studies (Palaniappan & Sellke, 2020; Rynecki et al., 2018; Kessler et al., 2019) making it a suitable choice for medico-legal research. Access is available by paid subscription. Multiple search terms related to AHT/SBS were included to reflect a shift in recommended terminology by the American Academy of

Table 1
Search terms used to identify legal cases using Thompson Reuters® Westlaw.

Database search terms
Abusive head injury
Abusive head trauma
Infant traumatic brain injury
Inflicted neuro-trauma
Non-accidental trauma
Pediatric traumatic brain injury
Shaken baby
Shaken impact syndrome
Whiplash shaken impact
Whiplash shaken infant
Child abuse

Pediatrics (Table 1). Resulting cases were manually reviewed to ensure all inclusion criteria were met and that cases involving multiple appeals were counted only once (i.e., unique cases).

Atlas.ti (Scientific Software Development GmbH; Berlin, Germany), qualitative analysis software, was used to categorize cases as either affirmed or overturned (with variable legal terms, such as affirmed, remanded for new trial, vacated, or reversed, used to indicate overturned convictions). Following the initial sort by Atlas.ti, one author (KS) manually checked cases to insure proper categorization. The full appellate rulings of all overturned AHT/SBS cases were then manually reviewed to identify the legal basis for the overturned conviction.

Manual review included dichotomizing the legal basis of the overturned convictions into two categories, 1) medical evidence-related, or 2) other legal reason. Medical evidence-related cases were operationalized as rulings that directly or indirectly referred to new medical or scientific information. For broadest inclusion of cases involving medical evidence, we included cases overturned for any legal rationale pertaining to new medical or scientific information. For example, cases which were overturned for ineffective assistance of counsel, but where ineffective assistance involved either the failure to present medical evidence related to the case or procure a medical/scientific expert, were counted as medical evidence-related cases. Medical evidence-related cases were set aside for further qualitative analysis. Cases that were solely overturned for a legal reason unrelated to medical or scientific information, i.e., official misconduct, improper jury instruction, or other procedural reasons, were classified as other legal reason cases.

Quantitative analysis included examining the state-wide geographical distribution of all overturned AHT/SBS convictions, the number of prosecution team and defense team expert witnesses involved in overturned medical evidence-related cases, the type of representation (public defender, private attorney, Innocence Project), the gender of defendant, and the gender of victim for medical evidence-related cases. Descriptive statistics (frequencies and percentages) were performed on all outcomes.

Qualitative analysis, using thematic analysis (Braun & Clarke, 2006), was conducted on all medical evidence-related overturned AHT/SBS convictions. The thematic analytic process included two authors (KB, KS) initially reading and re-reading the full appellate opinions of all medical evidence-related overturned convictions in order to code documents and identify potential medical themes. Once initially coded with medical themes, these coded cases were then forwarded to the primary author (SN) for review of theme coding. The second level of analysis involved these three authors independently reviewing initial codes and, while considering how to retain the diversity of the initial codes, using an inductive approach to develop larger, overarching themes. At the third level of analysis, we identified quotes that were congruent with and supportive of the overarching themes. In addition to thematic analysis, thematic frequencies and trends were examined.

Lastly, because overturned cases are remanded to the court (i.e., to be re-tried), we searched the online court database in each jurisdiction and/or contacted court clerks to obtain final rulings of remanded medical evidence-related cases.

3. Results

The Westlaw database search yielded 1431 unique AHT/SBS convictions that had appellate rulings since 2008 (Fig. 1). Of those, 49 convictions (3%) were overturned, and 1382 (97%) were affirmed/upheld. These cases represented a diverse geographic distribution,

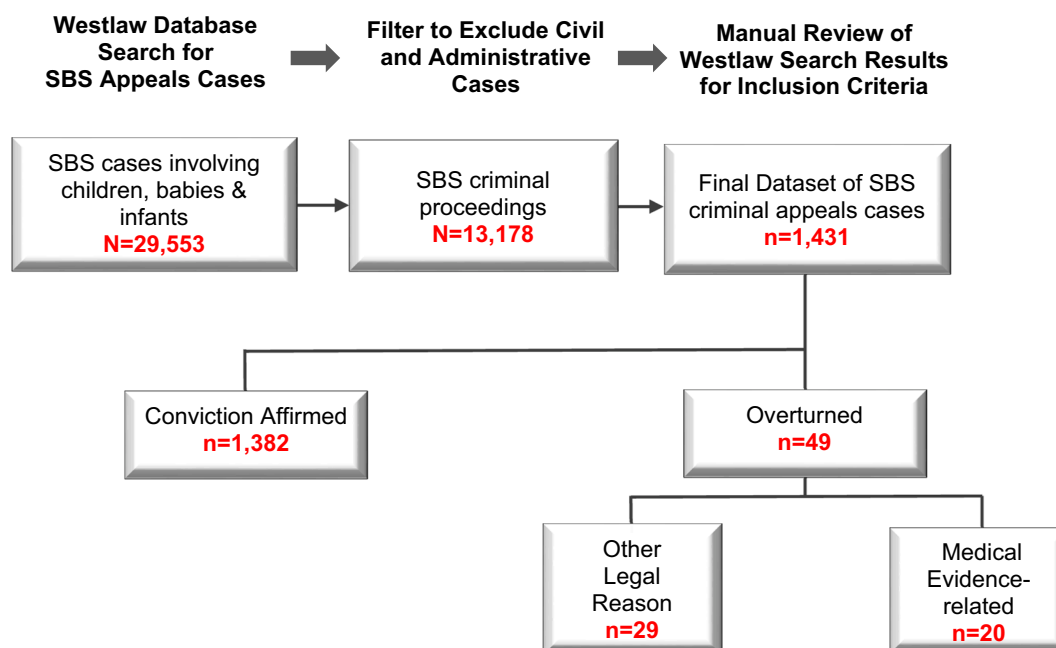


Fig. 1. Results of Westlaw database search for SBS criminal appellate cases, from the years 2008 to 2018.

with 30 states having at least one overturned AHT/SBS case in the last 10 years (Fig. 2).

Of the 49 overturned convictions, medical evidence-related arguments were successful in only 20 cases (41% of overturned convictions and 1% of all unique AHT/SBS appeals). Other legal reason arguments were successful in 29 cases (59% of overturned SBS convictions and 2% of all unique AHT/SBS appeals). Examples of other legal reasons were trial court procedural issues (e.g. improper jury instruction) and sufficiency of evidence arguments. Of the 20 medical evidence-related reversals, the rate of overturned convictions increased from 1 overturned case per year for the period 2008–2009, to 4.5 overturned cases per year for the period 2016–2017, indicating an increased rate of reversals.

The defendants in medical evidence-related overturned AHT/SBS convictions were male in 80% ($n = 16$) and female in 20% ($n = 4$) of cases. The gender of the child victim was available in 18 cases. Of those 18 cases, victims were male in 67% and female in 33%. Type of attorney representation data was also available in only 18 cases. Defendants were represented by public defenders only in 44% ($n = 8$) of cases, by private attorneys only in 22% ($n = 4$) of cases, by the Innocence Project only in 11% ($n = 2$) of cases, and by a mixture of representation (i.e., private attorney and public defender, private attorney and Innocence Project, public defender and Innocence Project, or all of the above) in 22% ($n = 4$) of cases.

Qualitative analysis of the medical evidence-related overturned convictions identified five main medical argument themes—1) controversy over the AHT/SBS diagnosis; 2) accidental injury mechanism; 3) alternative medical explanation; 4) timing of injury; and 5) new scientific discovery (Table 2). Seventy-four percent (74%) of the medical evidence-related reversals were associated with more than one medical argument theme. The most common medical argument themes were controversy over an AHT/SBS diagnosis ($n = 12$) and accidental injury mechanism ($n = 11$). In 10 cases, alternative medical explanation was identified as a theme, and timing of injury was identified in 7 cases. There was only one case in which a medical evidence-related argument was characterized in the court opinion as a new scientific discovery, i.e., a scientific theory for which objective laboratory data refuted the diagnosis presented at the original trial (Fig. 3). Rather, the aforementioned themes reflected alternative diagnoses/explanations based on new or revised expert testimony from that offered during the original trial.

3.1. Theme I: controversy over the AHT/SBS diagnosis ($n=12$)

This theme identified differences of opinion regarding the clinical validity of a diagnosis of AHT/SBS held from the original trial to the subsequent time of appeal. For example, in *State v Edmunds (2008)* the court stated:

The defense experts in the 1997 motion would have offered the existing theories in the medical community, disavowed by the mainstream, that shaking alone could not cause fatal injuries, that a previous brain injury can spontaneously re-bleed, and that an infant can experience a head trauma and have a significant lucid interval. In contrast, the defense experts who testified for the 2006 postconviction motion explained that in the past ten years, a shift has occurred in the medical community around

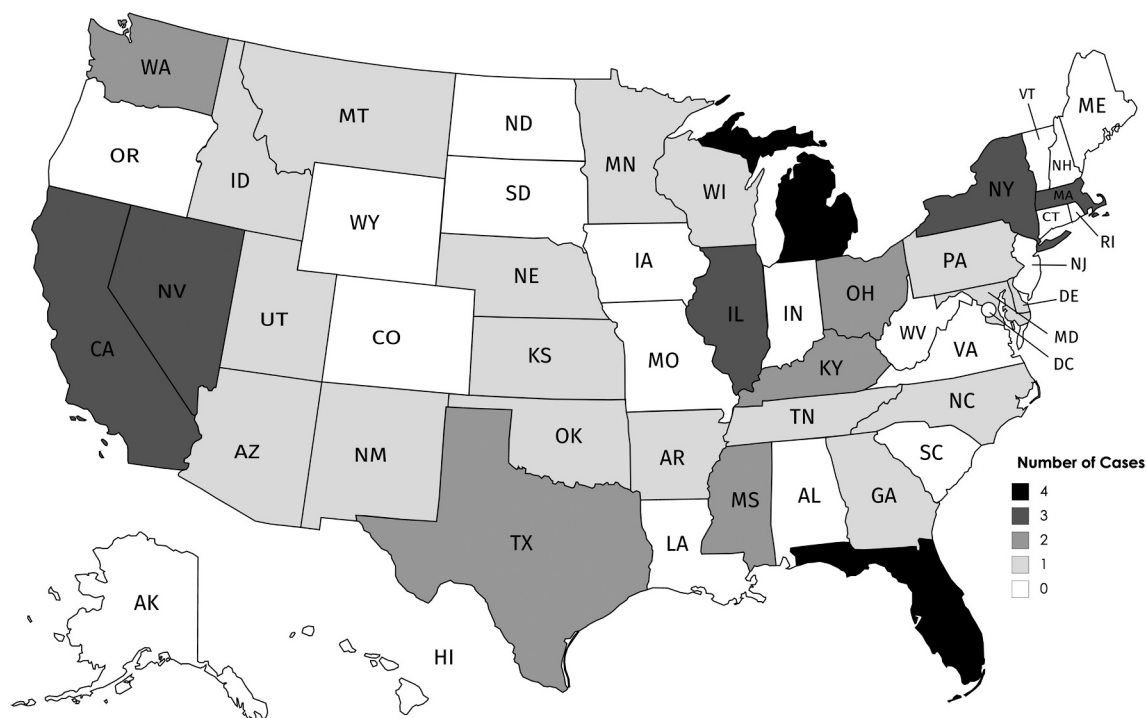


Table 2
Medical evidence themes

Theme	Description
New scientific discovery	A scientific discovery or theory for which objective laboratory data refuted the diagnosis presented at the original trial.
Controversy over the AHT/SBS diagnosis	Citation(s) of scientific literature, medical/scientific expert witness opinion, or media reports referencing the controversy over AHT/SBS diagnosis in support of an appellate ruling. Controversy refers to debate regarding the validity of a diagnosis of AHT or SBS.
Accidental injury mechanism	Legal argument(s) include a claim that a potential accidental event(s) such as a short distance fall contributed to, or caused, injuries.
Alternative medical explanation	Legal argument(s) include a claim that a non-traumatic medical etiology (i.e. vaccination, chronic subdural hemorrhage, pancreatitis) contributed to or caused injury.
Timing of injury	Legal argument(s) include a claim that a lucid interval occurred between time of incident and time of injury manifestation. The presence of a lucid interval raises questions regarding the timing of the injury event.

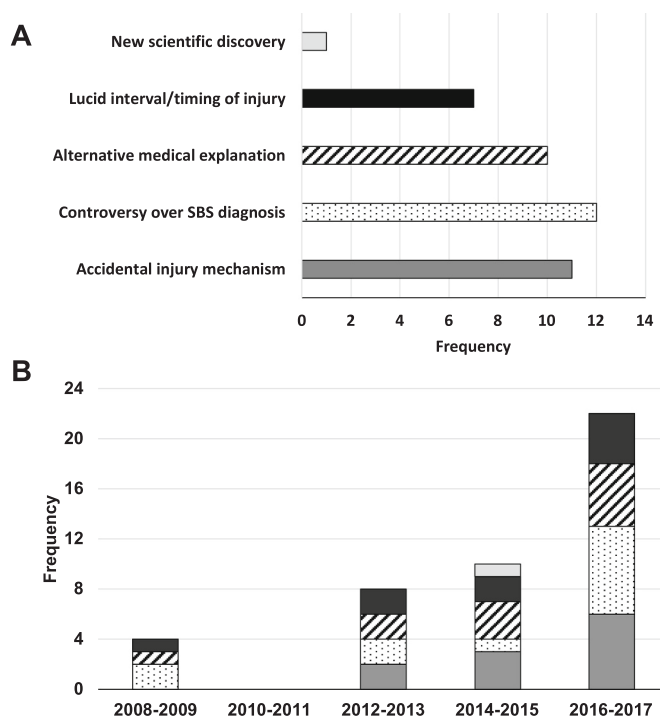


Fig. 3. Distribution of medical evidence-related argument themes. A) Frequencies of medical argument theme for all overturned SBS appellate cases, from the years 2008 to 2018 ($n = 20$), B) Frequencies of medical argument themes for each 2-year period. Our search revealed no new medical evidence cases in the Westlaw database in years 2010–2011 and 2018.

shaken baby syndrome, so that now the fringe views posited in 1997 are recognized as legitimate and part of a significant debate. (par. 12).

This quotation illustrates the position of the defense that opinions related to alternative diagnoses, deemed fringe opinions during the initial trial, have gained traction and are part of a “significant debate” at the time of appeal. Another example of such controversy is evidenced in [Commonwealth v Epps, 2016](#):

Dr. Scheller testified that shaken baby syndrome is the subject of heated debate and widespread disagreement among forensic pathologists, radiologists, pediatricians, ophthalmologists, and physicists and biomedical engineers. He stated that, although in 2006 every pediatrician and child abuse specialist he met believed strongly that shaken baby syndrome was a valid diagnosis, in the more recent past a “significant minority” has recognized that the science behind shaken baby syndrome is questionable. (par. 29).

This controversy theme had several different medical premises as support for the controversy: 1) that there was “widespread disagreement” ($n = 7$) in the medical community about the diagnosis; 2) that the diagnosis was predicated upon flawed or discredited science ($n = 7$); 3) that biomechanical literature ($n = 7$) confirmed the inability of humans to shake an infant hard enough to induce the findings (i.e., subdural hemorrhages) commonly seen in AHT/SBS; and, 4) that medical “mimics” ($n = 5$) were increasingly being recognized by medical providers, instead of trauma, as explanations for the findings (i.e., subdural hemorrhages and retinal hemorrhages) commonly seen in AHT/SBS. More than one medical premise was proposed in 64% of controversy theme cases. In 36% of cases

where a controversy over the SBS diagnosis was alleged, there was clear evidence of impact/blunt trauma to the head and/or body of the child.

3.2. Theme II: accidental injury mechanism ($n=11$)

This theme illustrated different accidental injury mechanisms that were alleged to cause harm. A majority of these cases identified an accidental short distance fall as the cause of injury (91%). Several short distance falls ($n = 4$) involved a fall from a couch or bed such as that in *Commonwealth v Oswelt* (2016):

The defendant, who was the baby's sole caretaker when she became unconscious, claimed that Jahanna accidentally fell backwards from the couch where she was sitting and landed on the wooden floor. (par. 1).

Other mechanisms included stair falls ($n = 2$), fall from a caregiver's arm ($n = 1$), fall from a car seat ($n = 1$), fall from a chair ($n = 1$). Additional mechanisms included CPR-related injury ($n = 1$) and unspecified accidental trauma ($n = 1$).

3.3. Theme III: alternate medical explanation ($n=10$)

This theme presented non-traumatic medical explanations for the cause of the child's medical findings. In cases where an alternative medical explanation was argued by the defense team, explanations varied and were unique. There was no predominant trend for a medical theory among those presented. The following quotation from *People v Liebich* (2016) illustrates the uniqueness of each case:

He explains, the "abdominal injury led to peritonitis (inflammation of tissue lining the abdomen), which led to pancreatitis (pancreatic inflammation), which led to a lack of oxygen in Steven's brain, which ultimately caused brain swelling, bleeding, and death." (par. 6).

Additional examples of alternative medical explanations included cortical venous thrombosis, viral myocarditis, central nervous system vasculitis, spontaneous re-bleed of chronic subdural hematoma, immunization side effect, hypercoagulation disorder and unspecified other medical causes.

3.4. Theme IV: timing of injury calls into question who injured child ($n=7$)

This theme highlighted the potential for the incident to have happened during a time period in which the child was not in the care of the defendant, as shown here in *People v Del Prete* (2017):

The problem with head injuries is a child can go unresponsive at a time that is remote—depending upon the type of injury—that is remote from the actual injury, and so if the child has been in the care of a number of different people, which one inflicted the trauma that eventually led to the child's collapse. (par. 27).

In 5 instances, this theme was identified in conjunction with the alternative medical explanation theme; in 2 cases, it was identified in conjunction with the accidental injury mechanism theme; and, in 5 cases, it was identified in conjunction with the controversy over

Table 3

Number of defense and prosecution experts by case ($n = 20$). Our search revealed no new medical evidence cases in the Westlaw database in years 2010–2011 and 2018

Title	Year	Original trial		Appellate trial	
		Defense	Prosecution	Defense	Prosecution
State v Edmunds	2008	1	6	6	4
Hamilton v Com	2009	1	4	0	0
Ex Parte Henderson	2012	0	2	6	5
Gregory Council v State	2012	1	UKN	1	UKN
McDonald v State	2012	0	4	1	UKN
Brown v State	2014	0	2	UKN	0
State v Rodriguez	2014	0	0	0	0
Isham v State	2015	0	3	2	0
State v Gallaway	2015	0	2	2	0
State v Pheils	2015	0	2	2	2
Wilkes v State	2015	0	9	1	0
People v Liebich	2016	2	4	9	0
Com v Millien	2016	0	4	1	2
Ceasor v Ocwieja	2016	0	2	4	0
Com v Epps	2016	0	1	1	0
People v Bailey	2016	1	2	8	5
Vanek v Wofford	2016	0	1	1	0
Robins v State	2016	0	2	2	0
People v Del Prete	2017	1	4	6	5
People v Roberts	2017	0	3	2	0
Mean number of experts		0.4	2.8	2.8	1.2

the AHT/SBS theme.

3.5. Theme V: new scientific discovery ($n=1$)

This theme identified new scientific or medical data that was not originally presented as evidence in the original trial.

In *Isham v State* (2015), defense experts presented laboratory results supporting a diagnosis of systemic lupus erythematosus (SLE), which they argued substantially contributed to the child's death:

He [defense expert] noted that Tommy had seven of the eleven ACR criteria for diagnosing LP (Lupus Panniculitis), and only four are required for diagnosis. His opinion concluded that the bleeding shown on Tommy's CT scans on May 12, 2012, were the result of SLE combined with minor accidental trauma occurring between May 8, 2012, and May 10, 2012. (par. 51).

As shown in Table 3, for cases in which data was available, the number of prosecution experts exceeded that of the defense team in 95% of initial trials. The mean number of experts for the prosecution and defense teams was 2.8 and 0.4, respectively. However, this situation was reversed during appellate trials, with the defense team utilizing more experts in 72% of trials; the mean number of experts for the defense during appellate trials was 2.8, while for the prosecution it was 1.2.

We were successful in obtaining subsequent re-trial outcomes for 19 of 20 medical evidence- related cases. In 8 cases (42%), the defendant either re-pled guilty to the same offense or was re-tried and found guilty again. An additional 2 (11%) pled no-contest at the re-trial. Of the remaining cases, the prosecution elected not to re-try 3 cases (16%); the court dismissed subsequent charges on 1 case (5%); 2 cases (11%) were undetermined, 1 case (5%) is still being tried, 1 case (5%) on subsequent appeal outside of the study timeframe was upheld, and in only 1 case (5%) the defendant was retried and found not guilty.

4. Discussion

Although prominent in the Innocence Network and media reports, AHT/SBS criminal convictions are rarely overturned for any legal basis (3% of all unique AHT/SBS appeals since 2008), and even more rarely on the basis of medical evidence (1% of all unique AHT/SBS appeals since 2008). According to the Bureau of Justice Statistics, 12% of all criminal appeals in U.S. State courts are either reversed, remanded, or modified a component of the trial court decision (Waters et al., 2015). Thus, our review indicates that AHT/SBS cases are four times less likely than other criminal convictions to be overturned on appeal.

In our search of the Westlaw database, since 2008, we found only 20 overturned convictions involving medical evidence out of 1431 AHT/SBS appeals. Our data challenges the claims of the Innocence Network and public media that wrongful convictions due to unreliable science approximate “hundreds” of cases (Cenziper, 2015). Perhaps the rarity of these appeals, within the context of a 12% criminal appeals success rate, forms some basis for the continued public media focus on these uncommon occurrences. The various rationales for continued public media focus on these cases has been aptly discussed by other authors (Hennink-Kaminski & Dougall, 2009). They include narratives that typically frame SBS as a questionable diagnosis, acts of abuse as unpreventable, and themes that focus on a criminal justice rather than a public health approach to SBS.

Our qualitative analysis identified five primary medical argument themes in AHT/SBS appellate opinions, but two that were most prevalent—controversy over the AHT/SBS diagnosis ($n = 12$) and accidental injury mechanism ($n = 11$). With regards to the controversy theme, while certainly some medical premises (i.e., the diagnosis is predicated on flawed or discredited science) are within the province of individual expert opinion or interpretation of the literature, other premises, such as “widespread disagreement” in the medical community, are not predicated upon data. Recent national surveys of academic physicians at large children's hospitals (Narang et al., 2016) and consensus statements (Choudhary et al., 2018) demonstrate widespread agreement in the medical community about the validity of the AHT and SBS diagnoses. Thus, any future similar legal arguments presented in court should provide medical experts an opportunity to educate the Court on the data surrounding general acceptance of the AHT and SBS diagnoses.

Additionally, we found it perplexing that “controversy” over the inability of shaking to cause harm to infants and the validity of the SBS diagnosis was still alleged in 36% of cases where there was clear evidence of impact/blunt trauma to the head and/or body of the child. For example, in *Commonwealth v Millien* (2016), the defense, through experts, alleged controversy over the SBS diagnosis, yet the child suffered a comminuted left parietal skull fracture, subdural hemorrhages, severe bilateral retinal hemorrhages, cerebral edema, compression fractures of the vertebrae, and healing rib and tibia fractures. That case was overturned because defendant's counsel was deemed ineffective for failing to procure a defense medical expert to allege such themes. In *People v. Leibich* (2016), the defense alleged controversy over the SBS diagnosis, yet the child suffered intracranial hemorrhage (both subarachnoid and subdural), retinal hemorrhages, cerebral edema, a perforated bowel, liver injury, pancreatitis, and “numerous contusion lines on his body” and “deep bruising”. That case was also overturned because defendant's counsel was deemed ineffective for failing to procure defense medical experts to counter the State's medical experts. Although it can be understandable for defense counsel to fervently represent their clients, our review highlights inconsistencies between legal arguments surrounding the shaking “controversy” and the medical facts of the case.

The accidental injury mechanism theme involved primarily short distance falls, but also included stairway falls, repetitive short fall events, and medical interventions, such as CPR. These histories are commonly presented histories in clinical cases of suspected maltreatment and accidental pediatric traumatic brain injury. Thus, the emergence of this theme in appellate cases was unsurprising. A variety of well-conducted research lines on short distance falls demonstrate the extreme rarity of such events to result in severe or fatal injury (Thompson et al., 2011; Chadwick et al., 2008; Lyons and Oates, 1993; Levene & Bonfield, 1991; Williams, 1991; Nimityongskul & Anderson, 1987; Helfer et al., 1977). As the clinical distinction of whether a case represents the extremely rare accidental injury that

results in serious injury (or death) to an infant child or abusive injury is case specific and nuanced, our review is not aimed at commenting upon the validity of individual expert opinions.

Of the medical evidence-related overturned convictions since 2008, the majority (75%) occurred recently - an increase in rate of reversals from 1 per year (2008–2009) to 4.5 per year (2016–2017). Although it is possible this increased rate could represent a temporal increase in case numbers in the appellate system, the etiology for this trend is likely multifactorial. These factors potentially include increased focus by defense attorneys on challenging these cases on appeal ([Innocence Network \[innocencenetwork.org\], 2019a, b](#)), increased legal controversy regarding the validity of the AHT/SBS diagnosis ([Findley et al., 2012](#); [Tuerkheimer, 2009](#)), increased public media reports ([Beiser, 2017](#); [Storr, 2017](#)), and increased medical commentaries/editorials challenging the AHT/SBS diagnosis ([Barnes, 2011](#); [Gabaeff, 2016](#); [Squier, 2008](#)). Although it is difficult to discern which factor is the most influential, it is likely that public media reports and medical commentaries/editorials are playing a role in appellate reversals, as appellate briefs and opinions are increasingly citing media reports and medical commentaries.

The legal axiom is that making AHT/SBS cases a “battle of the experts” improves a defendant's chance of success in those cases. Although our data suggests a positive relationship between increased numbers of experts and medical evidence-related overturned convictions, there are notable caveats to this observation. First, the legal process is weighted towards disproportionate expert utilization at the original trial and appellate trial levels because of varying burdens of proof at different legal stages. Typically, at the original trial level, the prosecution presents more expert witnesses because they bear the burden of proof at that stage. Conversely, at the appellate level, the defense presents more experts because they have the burden of proof. Second, if we accept the premise that a “battle of experts” represents a relatively similar number of experts for each side (i.e., either equivalent or plus-or-minus for one side or another), then our data actually identified only five instances (four at the appellate level, and one at the original trial level) where that occurred. This dataset was too limited for analysis. The vast majority of instances at either the appellate or original trial levels still had great disproportionality of experts for one side or another. Finally, and most importantly, our review did not examine the distribution of experts in cases for which a conviction was affirmed. As this cohort represents the largest pool of expert numbers data, conclusions about “battle of experts” associations with outcomes should be considered premature until that data is examined. Given that federal funding has been apportioned for more vigorous defense of SBS appeals, further research is warranted to understand the influence of numbers of experts on rulings.

However, we believe our data highlights a troubling and increasing trend in AHT/SBS cases— the feckless presentation of medical information by some experts. We base this statement on several observations. One, several of the accidental injury theme cases involved injuries that are far greater than those typically seen in clinical short fall cases, and, thus, to some degree, strain credulity. For example, in [Commonwealth v. Millien \(2016\)](#), defense experts proffered that the child's injuries could be attributable to a short fall event, and the child suffered a comminuted left parietal skull fracture, subdural hemorrhages, severe bilateral retinal hemorrhages, cerebral edema, compression fractures of the vertebrae, and healing rib and tibia fractures. In [State v. Gallaway \(2015\)](#), defense experts proffered that the child's injuries could be attributable to a short fall event, and the child suffered several skull fractures, intracranial hemorrhage, bruising under the chin, on her jaw, and on her forehead, a healing rib fracture, retinal and vitreous hemorrhages, abdominal trauma, and a previously fractured shoulder. And, in [Robins v. State \(2016\)](#), a defense expert proffered that CPR could explain the child's bruises on sternum and back, mesenteric hemorrhage, and transverse separation of the 11th vertebrae.

Two, some experts have offered alternative medical explanations (i.e., cerebrosinus venous thrombosis, hypoxia, and vaccines) that lack a strong evidence base and constitute “fringe opinions” within the medical community for being true clinical considerations in suspected AHT/SBS cases ([Choudhary et al., 2018](#); [Narang et al., 2016](#)). Three, some experts have suggested a “widespread disagreement” existed or currently exists in the medical community about the validity of the AHT/SBS diagnosis when there was either no data directly supporting that contention or data directly contradicting it ([Cina, 2012](#); [Narang, 2011](#); [Narang et al., 2016](#)). And, four, of the 20 convictions overturned on medical evidence-related grounds over 11 years, only one case was overturned secondary to either new scientific information (i.e., scientific information unavailable at the time of original trial) or a change in diagnosis based upon objective scientific tests (i.e., laboratory testing confirming a bleeding disorder, malignancy, or some other medical etiology). In that case, [Isham v State \(2015\)](#), a defense expert proffered that the child suffered from Lupus Panniculitis and had immunochemistry and laboratory values to support the SLE diagnosis.

We conclude that the legal basis of medical evidence-related reversals more accurately reflects a differing medical opinion, or an alternative medical explanation offered by an expert witness that was available but did not testify at the time of the original trial. A difference of expert opinion does not meet the standard of objective scientific data, nor is it equivalent to scientific information unavailable at the time of original trial. Thus, our data tends to support the concerns of other authors regarding irresponsible communication of medical information in AHT/SBS cases ([Leventhal & Edwards, 2017](#); [Albert et al., 2012](#)).

Finally, we found it disturbing that, despite an exhaustive appellate process, 42% of defendants either pled guilty or were found guilty again of the same offense at re-trial. An additional 11% of defendants pled “no-contest” at subsequent re-trial. Remarkably, two defendants, who successfully claimed “actual innocence” at the appellate level, pled guilty to the same offense at re-trial. Although it is unclear defendant motivations for pleading guilty at re-trials, it is reasonable speculation that subsequent sentence considerations (as a part of a plea deal) played a significant role. While this high re-conviction rate could represent differences in legal decision-making at the varying levels of U.S. judicial system, it could also highlight another consequence of the irresponsible communication of medical information in courts.

There are several limitations to our data. First, the database utilized for case-ascertainment, Westlaw, is not exhaustive. Despite being one of the largest legal resource databases, it, relies on legal professionals to voluntarily upload case materials. Thus, the number of AHT/SBS appeals in our sample (and our subset of overturned convictions) may be an underrepresentation of actual numbers. However, given the relatively low percentage of overturned AHT/SBS cases in relation to the total number of unique AHT/SBS appeals,

we have minimal concern that under capturing cases would significantly skew the percentages so as to undermine our general conclusion of the rare occurrence of this phenomenon. Second, our analysis thus far has only evaluated overturned AHT/SBS convictions. We have not yet evaluated the affirmed AHT/SBS convictions to determine what percentage of those involve medical evidence-related or other legal arguments. Third, our search terms (Table 1) may have missed some AHT/SBS cases. We believe our emphasis on the use of terms that closely approximate AHT/SBS in the legal context minimized this limitation. Finally, identification of themes for medical evidence-related arguments was reliant upon legal interpretation and description of the medical information. As legal personnel are sometimes unfamiliar with medical nosology, there could have been some misinterpretation and/or inaccurate description of medical information in appellate decisions. However, careful review of the full appellate opinions of all overturned cases leaves us less concerned that legal misunderstanding of medical information was a wholesale problem undermining the validity of the data.

5. Conclusion

AHT/SBS convictions are rarely overturned at the appellate level in the U.S. criminal justice system. Medical evidence-related arguments are less frequently the legal basis for these overturned convictions. The most common medical evidence-related arguments are controversy over the AHT/SBS diagnosis, and accidental injury mechanism. Overturned convictions based upon medical evidence-related arguments do not reflect new scientific discoveries, but rather alternative or differing medical opinions from the opinions offered at the original trial. Our data tends to support the concerns of other authors regarding irresponsible communication of medical information in AHT/SBS cases.

Declaration of competing interest

Dr. Narang and Dr. Gina Bertocci have served as paid consultants/experts in legal cases regarding abusive head trauma. The remaining authors have no potential conflicts of interest to declare.

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