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COMMENTARY

"Shaken baby syndrome" and forensic pathology

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The controversy [1] that has surrounded abusive head trauma (AHT) for the past decade is, at its core, fabricated. The premise that the vigorous shaking of an infant is dangerous to that infant is agreed upon by all but the most adamant critics. The complex features of AHT are often disparagingly distilling simply to "The Triad"; a term devoid of any real clinical meaning and not used at all in practice. There are two primary drivers of the current debate over AHT. Firstly, there are alternative hypotheses that have seemingly been developed primarily for use in court, as opposed to a clinical or scientific need. These theories serve to create confusion in the courtroom and distract attention from AHT as a cause of injury or death. Secondly, the medical literature is misused in ways to create an illusion of evidence to support these novel and tangential theories. This misuse results in a mélange of support for otherwise speculative theories that are often unrecognizable to clinicians caring for children and creating confusion for families.

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False controversy

As the court process is adversarial, it creates a false dichotomy requiring participants to "choose a side." Outside the spotlight of the courtroom, even ardent critics of the theory of AHT clearly agree that shaking of an infant is dangerous [2–8]. Away from the legal/judicial environment, the debate regarding the fundamental underpinning of the concepts behind AHT is quite small. Without the shadow of the courtroom the "raging debate" would be downgraded to a "spirited discussion." If there is broad agreement that shaking is indeed dangerous, then what is the source of friction? The debate is not really that shaking itself is dangerous; it is the reverse. If an infant is shaken, what injuries would occur, and what is the probability that a finding typically associated with AHT was indeed due to shaking (with or without an impact) of that specific child? Or, as applied to a legal matter, is shaking true in *this* case?

Alternative theories

One of the cornerstones of the judicial process is to set the bar low for competing theories of causation. Courts, like the media, go to lengths to "show the other side," independent of its relative merits. This false equity allows for the birth of many unsupported and fringe theories (for example scurvy [9], vaccines [9, 10], coughing [11, 12], macrocrania in males infants [13], vomiting [14–16], partially treated meningitis [17], rebleeding of a quiescent birth related subdural hemorrhage (SDH) [17], "resuscitated SIDS" [18], and pyloric stenosis [14]) to explain the clinical features of AHT. Theories appear to have been created not with a clinical gap to fill, but explicitly to be used in court—to be "backwards compatible," from the courtroom into clinical relevance. An

example of an attempt at a "backwards compatible" theory was published as a case report in 2010. Barnes and colleagues [15] published a report of a 4-month-old who unexpectedly collapsed and was noted to have extensive retinal hemorrhages (RH), subdural and subarachnoid hemorrhage, and fatal cerebral edema. The authors attributed the infant's death to "dysphagic choking." In the face of the ubiquity of infant reflux (two-thirds of all 4 month olds regurgitate daily [19]), the authors provide no data demonstrating how reflux killed this infant when neither death nor retinal hemorrhages, subdural hemorrhage or subarachnoid hemorrhage has been described in prior reports. Additionally, what was not included in the case report was that each of the authors served as expert witnesses for the defense in the trial which convicted the infant's father. It is also noteworthy that this report was not peer reviewed, and that the authors excluded important information, such as a healing rib fracture, from their report. The authors declined to clarify either their roles or the exclusions from the report when these points were presented [20, 21].

Misuse of the medical literature

As many alternative theories are generated out of the courtroom process, the medical literature is regularly distorted to create an impression that there is evidence to support these theories. The most common ways in which the medical literature is misused are cherry picking and the over emphasis of case reports.

Cherry picking within the literature occurs when literature favorable to a theory is referenced while literature that counters (or even disproves) the theory is obscured or omitted. For example, despite the presence of many high-quality systematic reviews of the literature [22–27], critics of AHT [2, 15, 17, 28, 29] will cite only a single, lower quality [20] review that is skeptical of the evidence supporting the occurrence of AHT [30]. Another example of cherry picking occurs when articles berating the methodology of certain studies supporting AHT as poor [28, 29, 31] (e.g. circular reasoning, retrospective, including convictions within the abuse group, subjects collected non-sequentially, poor case ascertainment) will glowingly cite articles (e.g. Geddes et al. [32, 33] or Matshes et al. [34]) with the exact same methodological flaws that are critical of AHT [8, 18, 28, 29].

Case reports can provide some valuable evidence within clinical medicine, particularly in generating hypotheses and studying disease mechanisms [35]. It is important, though, not to over interpret the implications of a case report. Case reports are, by their inherent uniqueness, outliers (or, as in Barnes et al. [15] above, incomplete or even untrue). One example involves a case report of a 1-year-old with a traumatic cervical spine injury from a motor vehicle collision [36]. Despite the case report not mentioning the presence of SDH or RH, it is used to "prove" that shaking cannot cause SDH or RH [6]. Using this case report to "prove" that shaking cannot cause RH or SDH is akin to proposing that because there has been a report of survival from a plane crash [37] that all plane crashes are safe. For example, while there exists a report of short falls leading to death of toddlers and children [38], anyone who cares for children, or anyone who reads the relevant epidemiologic literature [39–42], knows that short falls are *nearly* universally safe in children. Whether it is a case of a crush injury causing retinoschisis [43], or an infant with a whiplash injury without RH or SDH [6], or an infant with raised intracranial pressure from an arteriovenous malformation having unilateral RHs [44], case reports should serve as cautionary tales and prompt further high-quality research—nothing else. Showing that something *can* happen is not the same as proving that it did (or always) happens.

Conclusion

In summary, when stripped of the legal context there is little controversy about the dangers of shaking an infant. Quite the opposite—there is near complete agreement. The sham debate has resulted from the development of disparate theories of causation generated for use in the legal arena. These theories have similar pedigrees and are often bolstered by a substantial misuse of the medical literature to craft an aura of evidence. While hypotheses are important to generate research, they are just that—hypotheses.

Skepticism of a scientific theory is quite different from developing or endorsing a theory for the sake of the courtroom. To be clear, debate within the scientific community is not only welcome, it is critical. In many cases advances in understanding are made as current paradigms are challenged [45]. Uncertainties remain regarding aspects of AHT, for example the frequency and duration of lucidity after a fatal injury in infants, the role of neck injury in suspected AHT patients, or the differences between single and repeated episodes of brain injury. Only rigorously obtained, independently reproduced, clearly analyzed and presented data that is placed in the context of what is already known will advance the field. Simply claiming something is true does not make it so.

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