

**HEADNOTE:***MOUSSA SISSOKO v. STATE*, NO. 613, SEPT. TERM, 2016

**ADMISSION OF EXPERT MEDICAL TESTIMONY—*FRYE-REED* GENERAL ACCEPTANCE TEST—RULE 5-702(3) RELIABILITY OF METHODOLOGY—OVERLAP OF *FRYE-REED* AND RULE 5-702(3)—SHAKEN BABY SYNDROME/ABUSIVE HEAD TRAUMA—REVIEW UNDER *FRYE-REED* STANDARD.**

In 2002, the appellant was convicted of first degree premeditated murder, child abuse, and child abuse resulting in death in the death of his 11-week old son Shane. The State theorized that the appellant killed Shane by shaking him, slamming him against a soft surface, or both. The appellant later was granted a new trial as post-conviction relief, upon a finding that his trial counsel had been ineffective for failing to introduce expert testimony to rebut the State's shaken baby syndrome expert testimony. Before his new trial, he moved to preclude the State from introducing expert medical evidence about shaken baby syndrome, by now called abusive head trauma, on the ground that it no longer was a generally accepted diagnosis in the absence of evidence of external injuries. The court held a *Frye-Reed* hearing and denied the motion, ruling that abusive head trauma is a generally accepted medical diagnosis and the State's experts could testify about it and that it was the cause of Shane's death. The court also ruled that the State's experts' testimony was admissible under Rule 5-702.

The appellant chose a bench trial. Both sides called experts about abusive head trauma. The evidence showed that, according to the appellant, Shane was fine on the morning of September 15, 2001, and was just sleeping on the appellant's bed when he suddenly started bleeding from his nose, stopped breathing, and became comatose. The appellant did not claim that any accident had occurred. 911 was called and Shane was rushed to the hospital. CT scans and MRIs showed subdural hematomas, retinal hemorrhages, and brain swelling that increased to the point that the cerebellum was herniating into the brain stem. Shane never regained consciousness and on day ten in the hospital was removed from life support and died. The State's experts opined that Shane suffered catastrophic brain injuries due to trauma that was inflicted on him, *i.e.*, abusive head trauma, even though there were no external injuries, because the medical evidence supported inflicted injuries, possible medical causes for his brain injuries were ruled out, and there was no evidence of an accidental cause for the injuries. The defense experts opined that Shane's brain injuries could have had medical causes, such as bleeding into a chronic subdural hematoma or a coagulation disorder.

The evidence also showed that the appellant was the only person with Shane when he suffered his catastrophic injuries; that the appellant had had to drop out of college due to his girlfriend's pregnancy with Shane; that he had purchased a \$750,000 life insurance policy on Shane's life in the weeks before Shane's death; that he had not told Shane's mother about that and had lied to her and her mother about facts surrounding the

acquisition of that policy; that he had paid the premium on the policy the day before Shane's catastrophic injuries; and that based on what the insurance agent had told him, he would have thought the policy went into effect when that first payment was made.

The court found the appellant guilty of first degree premeditated murder, child abuse, and child abuse resulting in death. The appellant noted an appeal in which he challenged the court's *Frye-Reed* ruling but not its Rule 5-702 ruling, and also argued that the evidence was legally insufficient to support his convictions.

*Held:* Judgments affirmed. The Court rejected the State's argument that whether the State's experts on abusive head trauma could testify at trial was solely a Rule 5-702 issue, not a *Frye-Reed* issue, and because the appellant only challenged the trial court's Rule 5-702 ruling on appeal, his appeal must fail. The *Frye-Reed* general acceptance test for scientific evidence has evolved so that, like the federal *Daubert* standard, it requires scientific methodologies *and* the scientific conclusions based on them to be generally accepted. In other words, there must not be an "analytical gap" between the basis for the scientific opinion and the opinion itself. As the Court of Appeals has recognized, this evolution has resulted in an overlap between the *Frye-Reed* general acceptance test and the reliable methodology prong of Rule 5-702(3). The admissibility of the State's expert witness opinions about abusive head trauma concerns reliable methodology and therefore falls within this overlap. Because the thrust of the appellant's argument is general, that is, not merely whether expert testimony about abusive head trauma is appropriate in this case but whether it ever is appropriate, the Court approached the issue as one under *Frye-Reed*, using a *de novo* standard of review.

The Court distinguished this case from *Clemons v. State*, in which the Court of Appeals held that a once generally accepted scientific methodology no longer was generally accepted, and from *Blackwell v. Wyeth* and the two *Chesson v. Montgomery Mutual* cases, in which the Court of Appeals held inadmissible expert opinions that were based on scientifically accepted methods, or methods usually accepted, but that did not bridge the analytical gap between those methods and the conclusions reached. Based on a review of the reliable scientific literature and the differential diagnosis method used by the State's experts to make the diagnosis of abusive head trauma, the Court held that abusive head trauma can be diagnosed in the absence of external injuries and the trial court did not err by admitting the State's expert medical opinion testimony. The Court further held that the evidence was legally sufficient to support all the convictions.

In the Circuit Court for Montgomery County  
Case No. 93709

REPORTED

IN THE COURT OF SPECIAL APPEALS

OF MARYLAND

No. 613

September Term, 2016

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MOUSSA SISSOKO

v.

STATE OF MARYLAND

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Eyler, Deborah S.,  
Kehoe,  
Arthur,

JJ.

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Opinion by Eyler, Deborah S., J.

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Filed: April 9, 2018

In this appeal, we consider the interplay of the *Frye-Reed* general acceptance test and Rule 5-702 as they apply to expert testimony that an infant's death was caused by abusive head trauma, the current medical nomenclature for what used to be known as shaken baby syndrome.

In 2002, a jury in the Circuit Court for Montgomery County convicted Moussa Sissoko, the appellant, of first-degree murder, child abuse, and child abuse resulting in death, in the death of his 11-week-old son, Shane. The State's theory of prosecution was that the appellant killed his son by violently shaking him, slamming him against a soft surface, or both. The court sentenced the appellant to life in prison, plus 20 years. In a post-conviction proceeding more than ten years later, he was granted a new trial on the ground that his trial counsel had been ineffective by failing to adduce expert medical testimony to rebut the State's expert medical testimony on abusive head trauma.

Before his retrial, the appellant filed a motion to preclude the State from introducing expert medical testimony that Shane's injuries and death resulted from abusive head trauma. After a five-day evidentiary hearing, the court denied the motion. Thereafter, the appellant elected a bench trial. The court convicted him on all three counts and sentenced him to life, all but fifty years suspended.

On appeal, the appellant presents two questions, which we have rephrased slightly:

- I. Did the trial court err or abuse its discretion by denying his motion to exclude expert medical testimony that Shane's fatal brain injuries resulted from abusive head trauma?
- II. Was the evidence legally sufficient to sustain the appellant's convictions?

For the following reasons, we shall affirm the judgments of the circuit court.

### **FACTS AND PROCEEDINGS**

The appellant began dating Tiffany Paris in 1999, when she was a senior in high school. In October 2000, Paris learned that she was pregnant. At that time, she was living at home with her mother, Patricia Sherman (known then as Patricia Paris), in Wheaton. The appellant was living at home with his mother, Danuta Guzowski, in Silver Spring. The appellant was planning to start community college in Florida in January 2001. He asked Paris not to tell his mother about the pregnancy because he feared she would refuse to pay his college tuition.

In January 2001, the appellant moved to Florida. For the next six months, he maintained only sporadic contact with Paris. The appellant's mother learned that Paris was pregnant and, as he had feared, informed him that she would no longer pay his college tuition and that he had to get a job.

In June 2001, the appellant returned to Maryland and moved into Sherman's house, with Paris. On June 29, 2001, Paris gave birth to Shane at Holy Cross Hospital. The vaginal delivery was uncomplicated and Shane was a healthy baby.

The appellant lived with Paris and Shane at Sherman's house for about two months. Paris returned to work in August, when Shane was 6 weeks old. The appellant began working as a locksmith. From Monday through Thursday, Shane was cared for by a babysitter at the babysitter's house. Paris was off on Fridays, but worked on Saturdays. The appellant or Sherman cared for Shane on Saturdays, at Sherman's house.

Near the end of August, the appellant moved out of Sherman's house and in with a friend.<sup>1</sup> By September 9, 2001, he was living at his mother's house.

Meanwhile, when Shane was less than two months old, the appellant contacted State Farm Insurance ("State Farm") about purchasing a life insurance policy on Shane. On August 18, 2001, the appellant met with State Farm agent Ronald Menza and applied for a \$750,000 "universal life" policy on Shane's life, with himself (the appellant) as the sole beneficiary. Because State Farm would not permit the appellant to apply for a policy on Shane's life unless he also applied for a policy on his own life, the appellant did so. He applied for a term life policy on his own life with a value of \$50,000, the minimum policy value offered by State Farm. He named his sister as the beneficiary on that policy. Menza advised the appellant that before the policy on Shane's life would be "bound," Shane would need to undergo a medical examination and the appellant would need to pay the first monthly premium.

The appellant arranged for Shane's medical examination to be performed on Saturday, August 25, 2001, when Paris would be at work and he would be caring for Shane at Sherman's house. He did not tell Paris that he had applied for life insurance for Shane. Paris and Sherman got home before the person who performed the examination had left. The appellant lied to them about the person's identity, saying he was an insurance agent who was there to discuss bundling renter's, auto, and health insurance.

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<sup>1</sup> Sherman testified that she asked the appellant to move out because it was too chaotic in her house. Sherman's adult daughter, Tina, and Tina's two young children also were living there, as was a boarder, Kenny, who was friends with Sherman.

He also lied to Paris about telephone messages from State Farm that were left for him at Sherman's house.

On September 14, 2001, the appellant mailed the first monthly premium payment on the policy on Shane's life, in the amount of \$134, to State Farm. That night, he stayed at Sherman's house with Paris and Shane.<sup>2</sup> Paris was scheduled to work the next day, a Saturday, and the appellant was supposed to watch Shane.

On the morning of September 15, 2001, the appellant fed Shane a bottle of formula at 6:00 a.m. and Paris fed him a bottle at 9:00 a.m. The appellant asked Paris to drop him and Shane off at his mother's (Guzowski's) house on her way to work, saying that his mother wanted to spend some time with Shane. As Paris testified, it was unusual for the appellant to care for Shane at his mother's house.<sup>3</sup> In fact, Guzowski did not know in advance that the appellant was bringing Shane to her house that morning.

Just after 10:00 a.m., Paris dropped the appellant and Shane off at Guzowski's house. According to Guzowski, Shane was "jolly." She played with him for a short time. When Shane became fussy, the appellant prepared a bottle of formula and took him to his (the appellant's) bedroom, on the second floor of the house. The appellant kept Shane there for several hours. Paris called the appellant twice to check on Shane, at 11:00 a.m.

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<sup>2</sup> Sherman was not there because she had traveled to Florida for business and could not get a flight home due to cancellations resulting from the terrorist attacks of September 11, 2001.

<sup>3</sup> The appellant and Shane stayed at the appellant's mother's house in early July 2001, when Paris was hospitalized for an appendectomy, and visited her house for six hours in early August 2001.

and 12:20 p.m. Both times, the appellant told her that Shane was fine. Guzowski, who was cleaning the house and making stew, walked by the appellant's open bedroom door at one point and observed Shane lying on the appellant's bed on his back, moving his hands.

Around 1:00 p.m., the appellant went downstairs, got some stew for lunch, and took it to his bedroom to eat. Shane was still on the bed. An hour later, the appellant went back downstairs and told Guzowski that Shane's nose was bleeding and that he might need to go to the hospital. Guzowski and the appellant rushed upstairs. Guzowski wiped mucous and blood off Shane's nostrils. Shane did not react and did not appear to be breathing. Guzowski yelled for the appellant to call 911. She straddled Shane and began performing CPR. In his call to 911 (at 2:04 p.m.), the appellant told the operator: "My baby stopped breathing, and there's blood coming out of his nose." When asked when Shane had stopped breathing, the appellant replied: "I don't know. I just started seeing blood come out of his nose. He was sleeping, and then blood just started rushing out of his nose."

Emergency personnel responded to the house in minutes. They found Shane in full cardiac arrest, bleeding from his nose and mouth. His lips were turning blue, he was not breathing, and he had no pulse. There were petechial hemorrhages on his forehead.<sup>4</sup> He was transported by ambulance to Holy Cross Hospital, arriving at 2:27 p.m.

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<sup>4</sup> Petechial hemorrhages are "nonraised, perfectly round purplish red spot[s] caused by intradermal or submucous hemorrhage." *Dorland's Illustrated Medical Dictionary*, 1422 (32nd ed. 2012) ("*Dorland's*").

(Continued...)

Just before 5:00 p.m., at Holy Cross Hospital, the appellant was interviewed by Detective Kenneth Penrod, with the Montgomery County Police Department's Homicide/Sex Division.<sup>5</sup> Detective Penrod reduced the appellant's oral statement to writing. The appellant made corrections to the written statement and initialed it. In the statement, the appellant said that after he took Shane into his bedroom at his mother's house, he put him on the bed. He and Shane were alone in his bedroom for over an hour, during which time he watched television. Shane "became 'fussy,'" so the appellant gave him 6 ounces of formula. He then placed Shane back on the bed, on top of the comforter and a baby blanket. Shane fell asleep. The appellant left Shane "for 1 minute & got some soup." When he returned, Shane was "still laying in the same position." The appellant noticed "blood [and] 'snot'" coming out of Shane's nose. The appellant "ran" to the kitchen to get his mother and called 911 while his mother began CPR. Shane had been healthy and had "suffered no falls to [the appellant's] knowledge." The appellant had never struck, shook, or dropped Shane. Shane was colicky, "very, very active," and often "scream[ed at] the top of [his] lungs."

At 6:12 p.m., Shane was transported to Children's National Medical Center ("Children's") for admission to its pediatric intensive care unit.

The appellant made an additional oral statement to Detective Penrod that evening while at Children's. He told the detective that Shane had been "active and alert all day,"

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<sup>5</sup> At trial, the parties stipulated that this interview was "voluntary and non-custodial."

that he “did not have any unusual behavior,” and that he “ate the normal amount of food which was 4-6 ounces of formula.”<sup>6</sup>

Just after 7:00 p.m., Shane underwent a CT scan of his brain that revealed bilateral subdural hematomas, subarachnoid hematomas, and possibly mild edema.<sup>7</sup> The next day, Shane’s treating physicians asked Allison Jackson, M.D., a hospital-based pediatrician who specializes in child abuse pediatrics, to consult on Shane’s case.

A CT scan of Shane’s brain performed two days later showed significant cerebral edema that was causing herniation of the cerebellum into the brain stem. The next day, an MRI showed “diffuse, severe cerebral edema.” An ophthalmology examination revealed bilateral, diffuse retinal hemorrhages. Shane never regained consciousness. On September 25, 2001, he was taken off life support and died.

The autopsy was performed by Michael Pollanen, M.D., a visiting forensic pathologist with the Office of the Chief Medical Examiner in Washington, D.C., and was supervised by Jonathan Arden, M.D., the Chief Medical Examiner. Dr. Pollanen concluded that Shane’s cause of death was shaken baby syndrome and that his manner of death was homicide. Dr. Arden signed off on the autopsy.

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<sup>6</sup> The parties also stipulated that this statement was voluntary and non-custodial.

<sup>7</sup> Two membranes surround the brain: the “dura” is the outer membrane and the “arachnoid” is the inner membrane. A subdural hematoma is a collection of blood between the dura and the arachnoid. *Dorland’s* at 1790. A subarachnoid hematoma is a collection of blood between the arachnoid and the brain. *Id.* at 1789. Edema is the presence of abnormally large amounts of fluid in the intercellular tissue spaces of the body. *Id.* at 593.

In the Circuit Court for Montgomery County, the appellant was indicted for first-degree murder and related charges. As noted, following a jury trial in 2002, he was convicted of all charges. This Court affirmed the judgments on direct appeal, in an unreported opinion. *See Sissoko v. State*, Case No. 2478, Sept. 2002 Term (filed Apr. 5, 2004).

In 2014, the appellant filed his first and second amended petitions for post-conviction relief in the circuit court, arguing that his trial counsel had been ineffective.<sup>8</sup> He asserted that his trial counsel's representation had been deficient because he did not call a pediatric neuroradiologist to testify, based on the MRI and CT scans of Shane's brain, that Shane's brain injury and death resulted from a rebleed of a chronic subdural hematoma, not from abusive head trauma. On March 15, 2015, after a three-day evidentiary hearing, the circuit court granted the appellant's second amended petition for post-conviction relief, vacated his convictions, and granted him a new trial. The State's application for leave to appeal was denied.

On August 13, 2015, in preparing for his retrial, the appellant filed a motion to "Obtain a Hearing to Exclude the State's Expert Testimony Supporting a Diagnosis of Abusive Head Trauma" under *Reed v. State*, 283 Md. 374 (1978). Emphasizing that abusive head trauma is a "rule out" or "differential diagnosis," he argued that the established method physicians use to diagnose abusive head trauma is not "reliable" because they use only the "triad"—three findings highly correlated with abusive head

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<sup>8</sup> His original petition was filed on June 20, 2005. At the appellant's request, that petition was held in abeyance pending the filing of an amended petition.

trauma: subdural hematomas, retinal hemorrhages, and brain swelling—to make the diagnosis when there are “alternate causes” for the triad that have not been “explain[ed] away.” Relying upon *Clemons v. State*, 392 Md. 339 (2006), the appellant argued that the “underlying assumptions [regarding abusive head trauma are now] sufficiently disputed within the relevant scientific community” so as to make the theory that it can be diagnosed based upon the triad, absent other evidence of trauma, no longer generally accepted. He maintained that although it is generally accepted that violent shaking of an infant can cause brain injury, it also is generally accepted that the amount of force required for shaking to bring about brain injury necessarily will result in “serious and obvious injury to the neck and cervical spine long before producing [subdural hematoma] or [retinal hemorrhage].” Therefore, when there is no neck or spinal cord injury, abusive head trauma is not a generally accepted diagnosis.

The State responded that its expert witnesses would testify that Shane died as a result of injuries from head trauma, with some of them opining that the injuries necessarily were sustained within a certain time frame, others opining that the injuries were inflicted and non-accidental, and others merely opining that the injuries were caused by trauma. The State maintained that the *Frye-Reed* general acceptance test was not implicated by its medical expert testimony because medical causation testimony is admissible so long as the expert holds his or her opinion to a “reasonable medical

probability” and because a diagnosis of abusive head trauma is not novel or controversial within the pertinent medical/scientific community.<sup>9</sup>

Over five days in October, November, and December 2015, the court held an evidentiary hearing to determine the admissibility of the State’s medical expert testimony about the cause of Shane’s brain injuries and death.<sup>10</sup> At the outset, the court and the parties sought to clarify what was in dispute. The prosecutor explained that she understood that the appellant was challenging the State’s medical expert testimony on the ground that “the triad . . . is [not] supportive enough for . . . shaken baby syndrome or abusive head trauma in order to make it generally acceptable in the medical community.” The court noted that, in its view, the factual basis for the State’s medical experts’ opinions also was at issue, implicating the court’s discretion over admitting expert testimony under Rule 5-702(3). The court opined that admissibility under *Frye-Reed*

really goes to the . . . methodology employed, the underlying assumptions that are made in terms of the science; and [Rule 5-702(3)] basically goes more to whether or not there are sufficient facts that they have available to them or they’ve sufficiently considered alternatives that they’re capable of expressing opinions that . . . I should permit to be presented to the jury, assuming the methodology is sound.

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<sup>9</sup> The State also responded that its medical experts would not be identifying the appellant (or any individual) as the person who inflicted Shane’s fatal head injuries. We note that criminal agency was not a contested issue in this case, in that the appellant was the only person with Shane when the brain injuries were sustained and the appellant offered no accident defense, for example that Shane had fallen, likely because there was no evidence of an accident. The case boiled down to whether Shane’s brain injuries were inflicted or were a natural occurrence.

<sup>10</sup> At the same hearing, the court also considered the State’s cross-motion *in limine* to preclude defense medical expert testimony that Shane died as a result of rebleeding of a chronic subdural hematoma.

Defense counsel responded that the Maryland appellate decisions addressing the admissibility of expert medical testimony discuss the general acceptance of the underlying methodologies *and* the reliability of the specific conclusions being drawn from those methodologies “in tandem.” He posited that in this case it would be difficult to “parse . . . out” the reliability and/or acceptance of a hypothetical abusive head trauma diagnosis without also getting into the factual basis for those opinions.

The State moved the court to take judicial notice, under *Frye-Reed*, that the “methodologies employed” by its experts were generally accepted in the relevant medical communities. The court denied the motion and, ultimately, the parties proceeded to present evidence bearing on the diagnosis of abusive head trauma, generally, and that diagnosis in Shane’s case, specifically.

The State called five witnesses at the *Frye-Reed* hearing: Mark Dias, M.D., a pediatric neurosurgeon; Louis Vezina, M.D., a pediatric neuroradiologist; Mohammed Jaafar, M.D., the pediatric ophthalmologist who examined Shane at Children’s; Dr. Jackson, the child abuse pediatrician who treated Shane at Children’s; and Dr. Pollanen, the forensic pathologist who performed Shane’s autopsy. We summarize their pertinent testimony below.

Dr. Dias is chief of pediatric neurosurgery at Penn State Children’s Hospital, as well as a professor of pediatric neurosurgery at Penn State College of Medicine. The court accepted him as an expert in that general field and also in the specific field of

traumatic brain injury. Before testifying he reviewed Shane's medical records, all of the relevant expert reports, and the pertinent testimony from the first trial.<sup>11</sup>

Dr. Dias testified that shaken baby syndrome was identified as a cause of traumatic brain injury in the 1970s. At that time, the prevailing view in the medical community was that violent shaking, and only violent shaking, caused the injuries to infants associated with shaken baby syndrome. Since then, scientific studies have revealed that between 30% and 70% of shaken baby syndrome cases involve impact to the infant's skull as well. In the late 1980s, some pediatricians and pediatric neurologists began using the term abusive head trauma, instead of shaken baby syndrome, because it is broad enough to encompass any traumatic brain injury "inflicted or caused by a person, typically a caregiver," whether by shaking, impact, or a combination of the two. According to Dr. Dias, the change in terminology reflected developments in medical research, not rejection of shaking as a cause of infant brain injury and death.

Dr. Dias explained the methodology treating physicians employ to diagnose abusive head trauma. When an infant presents with an unexplained brain injury, the physicians "generate what's called a differential diagnosis" and attempt to eliminate

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<sup>11</sup> Dr. Dias reviewed the emergency medical technicians' records from September 15, 2001; Shane's medical records from Holy Cross and Children's; the autopsy report; Dr. Pollanen's supplementary report prepared in 2015; Shane's pediatrician's records; 2002 trial testimony from Dr. Jaafer, the pediatric ophthalmologist, Guzowski, and the appellant; reports attached to the appellant's post-conviction petition prepared by Patrick Barnes, M.D., a pediatric neuro-radiologist, and Dr. Arden; and reports prepared relative to the retrial by Dr. Vezina; a report prepared by another State's expert who ultimately did not testify at the retrial; and reports prepared by all of the defense experts who testified at the retrial.

possible causes of the injury through laboratory tests and diagnostic studies. He identified certain findings that are “highly correlated” with abusive head trauma, including the triad. Subdural hematoma is a hallmark of abusive head trauma, as it is present in 80% to 85% of cases. Likewise, retinal hemorrhages are found in 80% of abusive head trauma cases. Neck injuries or injuries to the cervical spine also are prevalent, being found in 70% of abusive head trauma cases. Ligamentous injuries, particularly injuries to the ligaments between the skull and the second vertebra, are found in 78% of abusive head trauma cases involving infants. However, there is no single finding (or combination of findings) pathognomonic, *i.e.*, uniquely present, in abusive head trauma. The treating physicians consider all the pertinent findings together with the clinical history. Only after eliminating alternative causes and mechanisms of injury do they reach a diagnosis of abusive head trauma.

After reviewing all the relevant materials in Shane’s case, Dr. Dias concluded that Shane sustained his brain injuries sometime between 10:15 a.m. and 2:00 p.m. on September 15, 2001. Shane was fully functioning and “jolly” when he arrived at Guzowski’s house around 10:15 a.m.; by 2:00 p.m., he was not breathing and was comatose. That was highly suggestive that “something significant had happened neurologically during that time.” The findings of subdural hematomas and retinal hemorrhages supported the diagnosis of abusive head trauma. The presence of numerous retinal hemorrhages “in all four quadrants” was the “most highly correlative” abusive

head trauma finding.<sup>12</sup> The location of the subdural hematomas in the back part of Shane's brain also was consistent with abusive head trauma.

Dr. Dias opined that Shane's treating physicians ruled out metabolic disorders that can be "mimics" for abusive head trauma, and there was no evidence that Shane had any of the various types of coagulation disorders that can cause brain hemorrhages.<sup>13</sup> He further opined that there were no findings to support the defense theory that Shane died as a result of rebleeding of a chronic subdural hematoma. That theory, as Dr. Pollanen later summarized it, was that during an otherwise uncomplicated vaginal delivery a baby could develop a subdural hematoma from compression of the skull; the subdural hematoma could become chronic; and the chronic subdural hematoma might later spontaneously rebleed, resulting in brain injury and death. Dr. Diaz agreed that it is not unusual for the mere trauma of an ordinary vaginal delivery to cause a subdural hematoma in an infant, and indeed around 26% of otherwise healthy infants develop a birth-related subdural hematoma. These infants tend to be completely asymptomatic, however, and, "as a rule," an asymptomatic subdural hematoma usually resolves within

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<sup>12</sup> Dr. Dias mistakenly believed that Shane also had retinal thickening, known as retinal folds. Dr. Jaafar later testified that retinal folds were not found during the ophthalmology exam, however. They were found during Shane's autopsy, but as Dr. Pollanen testified, the manner by which the eye is prepared for dissection creates retinal folds. As such, the presence of retinal folds cannot be considered in determining the cause of death.

<sup>13</sup> Shane's laboratory test results showed that he had disseminated intravascular coagulopathy ("DIC"). DIC is commonly caused by brain trauma. Thus, the presence of DIC was consistent with the coagulopathy being the result of, not the cause of, the brain trauma.

4-6 weeks.<sup>14</sup> A rebleed into a subdural hematoma could occur as a result of trauma, abusive or accidental, but it could not cause a brain injury significant enough to cause death. Dr. Dias opined that there was “not a shred of evidence to . . . support” the theory that rebleeding of an otherwise asymptomatic chronic subdural hematoma could cause brain collapse, coma, and death.

According to Dr. Dias, Shane’s subdural hematomas and retinal hemorrhages were caused by trauma, that is, shaking and/or impact on a soft surface, but his subdural hematomas were too small to have caused his death in and of themselves. Rather, the inflicted trauma also caused “transient concussion” at the cervical medullar junction, where the base of the brain stem and the cervical spine connect. That injury, in turn, caused apnea (disordered breathing); the apnea caused hypoxia; and the hypoxia caused brain swelling, which ultimately caused Shane’s death.

In forming his opinions, Dr. Dias relied upon numerous studies and literature reviews, including a 2011 article published in the Houston Journal of Health Law and Policy, entitled “*A Daubert Analysis of Abusive Head Trauma/Shaken Baby Syndrome*,” by Sandeep K. Narang, M.D., J.D. (hereinafter “*Narang P*”); and a 2004 article published in the Archives of Pediatric Adolescent Medicine, entitled “*Analysis of Perpetrator Admissions to Inflicted Brain Injury in Children*,” by Suzanne P. Starling, M.D., *et al.* (hereinafter “*Starling*”).

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<sup>14</sup> Dr. Dias did not express an opinion as to whether Shane had an asymptomatic birth-related subdural hematoma.

Dr. Vezina, a pediatric neuroradiologist at Children's, was accepted by the court as an expert in that field. He reviewed Shane's CT scans from September 15, 2001, and September 17, 2001, as well as an MRI of Shane's brain and cervical spine from September 18, 2001. These studies showed that Shane had multiple hemorrhages in the subdural and subarachnoid spaces surrounding the brain. Dr. Vezina opined that the hemorrhages were acute (*i.e.*, not chronic) and all of the same age, and that they had occurred sometime between September 5, 2001, through the afternoon of September 15, 2001. The first CT scan showed slight, if any, cerebral edema, but the second CT scan revealed "tremendous edema." The progression of the edema between the first and second CT scans narrowed the window of time during which a traumatic injury could have occurred to the 24-hour period before the first CT scan was performed, at 7:00 p.m. on September 15, 2001.

Dr. Vezina opined that Shane's brain edema resulted from severe hypoxic ischemic encephalopathy ("HIE"), *i.e.*, brain injury due to oxygen deprivation. Absent a medical explanation for the swelling, such as evidence of a disease process, the combination of subdural hematomas, subarachnoid hemorrhages, and severe brain swelling evidenced trauma. Dr. Vezina saw "no convincing evidence that there was a preexisting subdural [hematoma]" that predated the acute injuries he observed. He opined, however, that even if Shane had a chronic subdural hematoma, that would not explain all the imaging findings that he saw. According to Dr. Vezina, rebleeding of a chronic subdural hematoma almost never causes subarachnoid hemorrhages. Moreover, a rebleed of a chronic subdural hematoma usually happens slowly and does not produce

catastrophic brain injury. Shane’s injuries were simply “not something that we see in spontaneous rebleeding of subdural hemorrhages.”

Dr. Pollanen is the chief of the Ontario Forensic Pathology Service. In 2001, he was a visiting medical examiner in Washington, D.C. He testified that a forensic pathologist will expect to see some combination of the following “major observations” on autopsy when the cause of death is head trauma: “scalp bruising, skull fracture, subdural hemorrhage, retinal hemorrhage, retinoschisis,<sup>[15]</sup> [HIE], and traumatic brain or spinal cord injury.” He explained that some disease processes can mimic traumatic brain injury. For example, blood clotting disorders, such as hemophilia, can cause subdural hematomas. Dr. Pollanen opined that the “weight of the evidence . . . in the [medical] literature” supports the view that “shaking can cause . . . . [f]atal head injury” “but it’s rare.” In his testimony, Dr. Pollanen carefully avoided using the terms shaken baby syndrome or abusive head trauma because, in his view, both “presuppose how the head injury has occurred.”

With respect to Shane, Dr. Pollanen explained that he had concluded in 2001 that the cause of death was shaken baby syndrome and he continued to hold the opinion that Shane died as a result of inflicted brain injury. The “diagnosis of a fatal head injury rest[ed] upon the presence of subdural hemorrhage, retinal hemorrhage and [HIE].” He balanced those diagnostic criteria “against no direct evidence of traumatic injury to the scalp, skull, brain, spinal cord, or eye.” In 2001, Dr. Pollanen had opined that “axonal

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<sup>15</sup> “Retinoschisis” is the splitting of the retinal layers.

swelling” in Shane’s brain stem and cervical spinal cord evidenced “trauma” caused by “abnormal motion or movement of the neck.” He had since reconsidered that opinion. Subsequent research had revealed that axonal swelling can be caused by trauma, lack of oxygen supply to the brain, or both. Therefore, given the “lack [of] specificity” in the finding of axonal swelling on autopsy, Dr. Pollanen no longer believed that that finding supported the conclusion that Shane died as a result of abusive head trauma. It was not inconsistent with that being the cause of death, however.

Dr. Pollanen explained that autopsy findings of “retinal folds” or “retinoschisis, which is where the retina peels away from the back of the eye,” did not evidence trauma either because the way that an eyeball is “process[ed]” for an autopsy actually “produces folds in the retina.” Dr. Pollanen found no evidence on autopsy of a cerebrocortical injury, despite there being “some indication” in the “neuroimaging reports . . . [of the presence of] actual brain damage from trauma.” Finding that type of injury would be “very unusual . . . in an infant head injury case.”

According to Dr. Pollanen, “fatal head injury” remained the “best unifying diagnosis” in Shane’s case because of the findings of subdural hematomas, retinal hemorrhages, and HIE, coupled with the “accumulated negative evidence in the autopsy.” In other words, the absence of evidence of a disease process or other mechanism for the injuries to Shane’s brain supported a finding that his injuries and death were caused by head trauma. Dr. Pollanen noted that although the conclusion that Shane died as a result of head trauma was not speculative, as it was supported by the medical literature, the evidence supporting that conclusion was “indirect” and “minimally adequate,” by

comparison to an ordinary cause of death opinion in a homicide case. The conclusion would be “stronger” with evidence of external trauma to Shane’s scalp or skull. Dr. Pollanen was unable to opine as to exactly how the head injury occurred. Based upon his literature review, however, he considered the injury to be consistent with shaking or “impact on a soft deformable surface.”

Dr. Pollanen added two caveats. First, given the “level of certainty issues” it would be reasonable to classify the cause of Shane’s death as “undetermined.” Nevertheless, head trauma remained the “most likely determination” in light of the medical literature. Second, although he had determined the cause of death to be homicide, he did not intend that opinion to “be interpreted as medical proof of criminality.”

Regarding the timing of Shane’s injuries, Dr. Pollanen opined that, on autopsy, Shane’s subdural hematomas appeared to be in the very early healing phase. This was consistent with Shane’s having had acute subdural hematomas when he was admitted to the hospital, on September 15, 2001, that began to heal during the ten-day hospitalization preceding his death. Thus, Shane’s subdural hematomas were not chronic. Dr. Pollanen otherwise was unable to offer an opinion about the timing of the head injury that caused the acute subdural hematomas.

Like Dr. Dias, Dr. Pollanen rejected the defense theory that Shane’s death could have been caused by a rebleed of a chronic subdural hematoma. Although the theory was “not entirely unreasonable,” he could not find “a single peer reviewed published case report of fatal rebleeding of a chronic subdural hemorrhage in an infant.” In light of the

complete absence of evidence to support the theory, he could not conclude that it was a possible cause of Shane's injury.

Dr. Jaafar is a pediatric ophthalmologist at Children's who treated Shane in 2001. At that time, he observed multiple retinal hemorrhages in both eyes, of different sizes and across multiple layers of the retina. He opined that it is "universally" accepted among pediatric ophthalmologists that multiple, multilayered, bilateral retinal hemorrhages like Shane's are highly correlated with abusive head trauma.

Dr. Jackson testified that "[a]busive head trauma is injury to the head and its contents as a result of an inflicted event or events." The shift from the use of the term shaken baby syndrome to abusive head trauma was a reflection of the medical (and scientific) consensus that "there can be a variety of mechanisms that take place for any given child or different children."

Dr. Jackson explained that the process she uses as a child abuse pediatrician to diagnose abusive head trauma is "really no different than anything else in medicine." She considers the child's clinical history, looks at lab reports and other diagnostic studies performed, recommends further tests or studies, as necessary, and then "pools all of that information" to "formulate a diagnosis." That process includes ruling out other medical diseases and conditions that can mimic the internal findings often associated with abusive head trauma. Dr. Jackson emphasized that she never has used the term "triad" in her work, nor does she believe that the presence of subdural hematomas, retinal hemorrhages, and brain swelling (or the absence of some of those findings) necessitate a diagnosis of abusive head trauma (or a rejection of that diagnosis).

In Shane's case, she was asked to evaluate him when he was at Children's. She examined Shane, reviewed his radiological scans and his chart, and spoke to Paris and the appellant about Shane's clinical history. At her recommendation, testing was performed to rule out a metabolic disease "which can be a mimicker of abus[ive] head trauma." After considering all of that information, she concluded that "Shane had injuries consistent with shaken baby syndrome and that there were other findings observed by EMS and at the hospital when he initially presented that were concerning for possible suffocation," including the petechiae on his forehead, as well as a report of blood in his mouth.

Upon reviewing her 2001 diagnosis in 2015, Dr. Jackson did not alter her conclusion that Shane's injuries were consistent with abusive head trauma, and that other signs were indicative of possible suffocation. She opined that the internal findings of subdural hematomas, subarachnoid hemorrhages, widespread bilateral retinal hemorrhages, and cerebral swelling were unexplained by Shane's clinical history. She concluded that the injuries were "consistent with a mechanism of rotational acceleration and deceleration," *i.e.*, shaking, but that she could not "rule[] out . . . impact" against a soft surface.<sup>16</sup>

John Plunkett, M.D., the only defense witness called at the pre-trial hearing, testified by video deposition. Dr. Plunkett is a pathologist. He formerly was the

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<sup>16</sup> She also continued to hold the view that the presence of petechiae on Shane's forehead was consistent with suffocation and was inconsistent with "bleeding abnormalities" because the petechiae would not have been "isolated to the head" in the latter scenario. Suffocation did not "account for all of [Shane's] injuries," however.

laboratory and medical education director at a community hospital in Minnesota. He also had been the medical examiner in several counties in that state.

Dr. Plunkett testified that “it was [his] opinion that shaking could not cause brain injury.” He based this opinion on biomechanical studies that show, in his view, that the acceleration caused by shaking is much less than that caused by impact, even minor impact. Dr. Plunkett opined that, alternatively, to the extent that shaking an infant can cause brain injury, the injury would be to the infant’s neck, which would produce further injury to the cervical spine and the brain stem.

Dr. Plunkett opined that it is possible for rebleeding from a chronic, asymptomatic subdural hematoma to cause a seizure and apnea, resulting in HIE and brain collapse. After reviewing Shane’s autopsy report, he concluded that, on September 25, 2001, Shane had a small, chronic subdural hematoma that was “at least two or three weeks old.” He conceded that any rebleeding of a chronic subdural hematoma in Shane’s case had been “small,” but maintained that even a small amount of subdural bleeding could cause a “critical increase” in intracranial pressure, resulting in a seizure or apnea or both.

Dr. Plunkett disagreed with the State’s experts that the presence of retinal hemorrhages are indicative of abusive head trauma. He opined that intracranial pressure, not shaking, causes retinal hemorrhages. Moreover, the type of retinal hemorrhages that Shane had—white-centered as opposed to red-centered—is correlated with disease rather than with trauma. Dr. Plunkett’s ultimate opinion was that Shane’s manner of death was undetermined. The existence of a chronic subdural hematoma was the most “significant finding,” but he could not say that it caused Shane’s death.

On January 15, 2016, the court reconvened to announce its decision from the bench. It ruled that “the opinions tendered by the State’s experts” met the *Frye-Reed* standard in that they are “generally accepted within the scientific community.” In addition, the opinions satisfied the “test under [Rule] 5-702” because the experts were “offering opinions that are based upon reasonable scientific analysis as well as facts that are available to those experts.”<sup>17</sup>

After the court made its ruling, the appellant elected a bench trial. The trial was held over nine days in February 2016. The State called twenty witnesses, including Paris; Sherman; Guzowski; Menza; and all of the medical experts who had testified at the pretrial hearing. Drs. Dias and Jackson opined to a reasonable degree of medical certainty that Shane’s brain injuries and resulting death were caused by abusive head trauma. Dr. Jaafar opined that the “most probabl[e]” cause of Shane’s retinal hemorrhages was “non-accidental trauma.” Dr. Vezina opined that the “constellation of findings [in Shane’s case], the subarachnoid hemorrhages, the subdural hemorrhages, the

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<sup>17</sup> The court found that it was a much closer question whether defense medical experts should be permitted to testify that Shane’s death was caused by rebleeding from a chronic subdural hematoma. The court reasoned that although it is generally accepted in the medical community that an asymptomatic, chronic subdural hematoma can rebleed, and that a rebleed can cause “problems,” it is not generally accepted that a rebleed can cause “a severe collapse, coma, or death[.]” The court ruled that the defense medical experts would be permitted to “set forth the negative proposition,” *i.e.*, that a rebleed of a chronic subdural hematoma could not be “ruled out” as a contributing factor in Shane’s brain injury, but they would not be permitted to “express the positive or the affirmative of that proposition” “that a rebleed into an existing subdural hematoma, either spontaneously or as a result of a trivial injury, can cause severe brain injury, collapse, and death.”

acute severe cerebral swelling, absent a medical reason, . . . , more likely than not, this is a picture of a traumatic insult to the brain accompanied by hypoxic ischemic injury to the brain.” Dr. Pollanen opined that “the best unifying diagnosis in [Shane’s] case is fatal head injury.”

The appellant did not testify. He called one lay witness (a friend of the family who visited Shane in the hospital); played Dr. Plunkett’s video deposition; and called four additional expert medical witnesses: Dr. Arden, who as mentioned, was the forensic pathologist who supervised Shane’s autopsy; Patrick Barnes, M.D., a pediatric neuroradiologist; Michael Laposata, M.D., a pathologist; and Joseph Scheller, M.D., a pediatric neurologist.

The appellant’s expert medical witnesses disagreed about the cause of Shane’s death but agreed to a reasonable degree of medical probability that it was not abusive head trauma. Dr. Arden opined that Shane’s cause of death was “undetermined.” He pointed to the lack of evidence of impact to Shane’s skull, broken ribs, or a neck injury, aside from the axonal injuries that could have resulted from hypoxia. In his view, in the absence of such external injury evidence, subdural hematomas and retinal hemorrhages were not specific enough findings to support a diagnosis of abusive head trauma. He further opined that Shane had a chronic subdural hematoma that predated his hospitalization on September 15, 2011, and that, when he was admitted to the hospital, there was evidence of a small amount of acute rebleeding into that existing subdural hematoma. Dr. Arden acknowledged that because the rebleed was “mild and small” and did not “press on the brain,” it could not have caused Shane’s brain collapse and death.

Rather, the presence of the chronic subdural hematoma was another piece of evidence that, in his view, cast doubt upon the State's theory that Shane died as a result of acute, inflicted trauma.

Dr. Barnes opined that Shane died as a result of HIE, but that it could not be determined with any certainty whether accidental or non-accidental external trauma or an internal mechanism caused that condition.

Dr. Laposata testified that Shane suffered from "hereditary hemorrhagic telangiectasia, or HHT," a "reasonably rare" coagulation disorder. HHT causes blood vessels to leak and sometimes to collapse entirely. Dr. Laposata based his opinion on evidence that Shane had experienced "chronic bleeding," including the presence of a chronic subdural hematoma and a finding of a "scleral hemorrhage," at his two-month well-visit.<sup>18</sup> Dr. Laposata was aware that the appellant's father had had a brother who died in infancy from an arteriovenous malformation, which might have indicated a family history of coagulation disorders.<sup>19</sup> In addition, Shane's presentation on September 15, 2001, was consistent with HHT, according to Dr. Laposata. In particular, bleeding from the nose and petechiae on the forehead both are diagnostic criteria for HHT, although these symptoms more often present in adolescence.

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<sup>18</sup> The sclera is the "white outer coat of the eyeball." *Dorland's*, at 1678. A "scleral hemorrhage" is a broken blood vessel on the sclera.

<sup>19</sup> An arteriovenous malformation is an abnormal development of arteries or veins. *Stedman's Medical Dictionary*, 1147 (28th ed. 2006).

Dr. Scheller opined that Shane died as a result of a hypoxic injury to his brain resulting from a seizure that, in turn, resulted from a subarachnoid hemorrhage. In his view, the subarachnoid hemorrhage was caused by a bleeding disorder, not by trauma. He based his opinion on the absence of evidence of head impact; the widespread nature of the hemorrhages; and the fact that Shane had an elevated PTT while at Holy Cross Hospital.<sup>20</sup> Dr. Scheller did not dispute that shaking can cause brain injury and death in a child of Shane's age, but disagreed that that is what happened to Shane.

On rebuttal, the State recalled Drs. Jackson and Pollanen. Dr. Jackson opined that HHT is an autosomal dominant genetic blood clotting disorder, meaning that one of Shane's parents would have to have had the condition in order to pass it to Shane. There had been no evidence presented that the appellant or Paris had been diagnosed with HHT. In addition, HHT usually presents much later in life and one of the diagnostic criteria is the presence of an arteriovenous malformation, which Shane did not have. Dr. Pollanen opined that there was "no basis for [a] diagnosis [of HHT] in [Shane's] case, and . . . [he had] exclude[d] it." Specifically, there were no findings of an arteriovenous malformation or telangiectasia on autopsy,<sup>21</sup> two of the four diagnostic criteria;<sup>22</sup> therefore, HHT was ruled out as a diagnosis.

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<sup>20</sup> PTT stands for "partial thromboplastin time." *Dorland's*, at 1551. It is a blood test that measures the time it takes a patient's blood to clot. See [www.medicine.mcgill.ca/physio/vlab/bloodlab/PT\\_PTT.htm](http://www.medicine.mcgill.ca/physio/vlab/bloodlab/PT_PTT.htm)., available at <https://perma.cc/RB9T-M7KL> (last visited Jan. 18, 2018).

<sup>21</sup> According to Dr. Pollanen, telangiectasia are "small malformed blood vessels," located most often on the lips, tongue, fingertips, and, occasionally, internal organs.

On March 24, 2016, the court reconvened and ruled from the bench. It found, beyond a reasonable doubt, that “shaking and/or soft impact trauma inflicted upon an infant can cause subdural hematomas, subarachnoid hematomas and hypoxic brain injury resulting in death.” In this case, beyond a reasonable doubt, “the defendant inflicted abusive head trauma upon [Shane], that was the cause of his death by either shaking and/or causing soft impact trauma to the child.” The State had “excluded any medical process except abusive head trauma to the extent that that might be viewed as a medical process as the cause of Shane’s death based upon the testimony of [its] experts.” The State also had “excluded any accidental trauma” as the cause of Shane’s death.<sup>23</sup>

The court stated that it was not persuaded by the testimony of the defense medical experts. It found that they displayed significant bias in that they were advocates for a change in the prevailing view in the medical community that abusive head trauma is an accepted diagnosis. In addition, the opinions of the defense experts were “not . . . well founded in the medical literature[.]” By contrast, the opinions of the State’s experts were “well within the mainstream and [were] well supported by the facts and the medicine.”

The court emphasized that the presence of subdural hematomas, subarachnoid hematomas, and bilateral, diffuse retinal hemorrhages is highly correlated with abusive head trauma and that Shane had all of these diagnostic findings. The defense experts did

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<sup>22</sup> The other two diagnostic criteria are “recurrent spontaneous . . . nosebleeds” and a “first-degree relative diagnosed with the disorder.”

<sup>23</sup> As noted, the defense never took the position that Shane’s injuries resulted from an accident.

not dispute that those findings in combination were suggestive of abusive head trauma, but pointed to other possible explanations for each finding. The main defense theory—that Shane’s brain collapse was caused by rebleeding of a chronic subdural hematoma—was, in the court’s view, a “tempest in a teapot.” Even if there were evidence that Shane had a chronic subdural hematoma and that he suffered a rebleed of that subdural hematoma, there was no evidence of a causal connection between that and his catastrophic brain injury. The court also rejected the defense theory that Shane’s brain injury was caused by an arteriovenous malformation that spontaneously ruptured or by a genetic blood clotting disorder, such as HHT.

The court found Dr. Pollanen’s testimony to be the most persuasive because he was very careful in framing his opinions to ensure that he explained his level of certainty appropriately. Nevertheless, Dr. Pollanen opined that it was more likely than not that Shane died as a result of head trauma.

Turning to the non-medical evidence, the court found that the circumstances surrounding the appellant’s purchase of a \$750,000 life insurance policy on Shane’s life was strong evidence of motive. The court found the evidence, from Menza, that the appellant said he was purchasing the policy as a savings plan for Shane on the advice of his mother (Guzowski), to defy credulity.<sup>24</sup> Indeed, Guzowski had testified that she had advised the appellant against doing so. Moreover, the monthly premium for the policy

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<sup>24</sup> The trial judge mistakenly stated that the appellant made this remark to the State Farm claims’ adjuster, when he actually made it to Menza. Menza no longer remembered the appellant having made that statement, but agreed that he probably had if Menza reported it to the claims’ adjuster in 2001.

equaled ten percent of the appellant's monthly income. And, if the appellant had purchased the policy innocently, he would have had no reason to lie to Paris and to Sherman about doing so. The timing of the payment of the first premium, the day before Shane suffered the brain injury that led to his death, also supported a finding of guilt. The court found that the appellant "reasonably would have believed" from what Menza had told him that the policy became effective on that date, even though that belief turned out to be erroneous.

For all of those reasons, the court found the appellant guilty of first-degree premeditated murder, child abuse resulting in murder, and child abuse.

## **DISCUSSION**

### **I.**

#### **Expert Medical Testimony**

##### **A. Contentions**

The appellant maintains that for decades, including at the time of his first trial, it was generally accepted in the relevant medical communities that abusive head trauma could be inflicted on young children without any external trauma and that abusive head trauma was the "only plausible explanation" for the "triad" of internal findings—subdural hematomas, retinal hemorrhages, and encephalopathy—absent a reported history of a car accident or other serious traumatic event. Recently, he asserts, "significant controversy" has developed in the relevant medical communities about using the triad of internal findings as a basis to diagnose abusive head trauma, because studies have shown that "natural disease processes" can mimic those findings; accidental trauma can cause the

same findings; and “researchers have been unable to demonstrate that the injuries present in shaken baby cases can be caused by shaking.” The appellant contends the circuit court erred by ruling, under *Frye-Reed*, that abusive head trauma remains a generally accepted diagnosis in the relevant medical communities and, in particular, that it can be diagnosed based on internal findings alone. Therefore, he argues, the court erred by denying his motion to preclude the State’s medical experts from testifying at trial.

The State responds that the appellant’s challenge to its medical experts’ testimony did not implicate the *Frye-Reed* general acceptance test because the appellant did not contest that abusive head trauma is a legitimate and accepted diagnosis, nor did he argue that any of the diagnostic tests performed on Shane were unreliable or not generally accepted in the relevant medical communities. According to the State, the appellant’s principal contention, which “appears to be that the amount and/or type of evidence that the experts relied upon *in this case* did not permit a diagnosis of [abusive head trauma],” is a Rule 5-702 factual basis challenge, not a *Frye-Reed* challenge. (Emphasis in original.) The State asserts that the appellant has waived any Rule 5-702 challenge, however, because he does not argue that the court abused its discretion by admitting the medical experts’ testimony under the rule. Alternatively, if *Frye-Reed* is implicated, the State maintains that abusive head trauma remains generally (and, in fact, overwhelmingly) accepted as a valid and reliable diagnosis when internal findings consistent with trauma are unexplained by an infant’s clinical history and other disease processes have been excluded, notwithstanding the absence of external findings of trauma.

## B.

### *Frye-Reed*

In *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923), the Court of Appeals for the District of Columbia considered the admissibility, under the federal common law of evidence, of expert testimony that a systolic blood pressure lie detector test showed that Frye was innocent of the murder he was charged with committing. Frye had confessed to the murder but later claimed his confession was false.<sup>25</sup> His lawyers sought to call William Marston, Ph.D., a psychologist and inventor of what he dubbed the “deception test,” to testify about the test and that, when administered to Frye, it had revealed that Frye was telling the truth when he said he did not commit the murder. The trial court refused to allow Dr. Marston to testify. Frye was convicted and thereafter appealed.

The appellate court affirmed, opining:

Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.

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<sup>25</sup> We glean much of the background facts in *Frye* from an article discussing its fascinating history. See Kenneth J. Weiss, M.D., Clarence Watson, J.D., M.D., Yan Xuan, M.D., *Frye’s Backstory: A Tale of Murder, a Retracted Confession, and Scientific Hubris*, J. Am. Acad. Psychiatry L., Vol. 42, at 226–233 (2014).

*Id.* at 1014. Concluding that the challenged deception test “had not yet gained” such general acceptance, the court upheld the trial court’s ruling.<sup>26</sup>

Over the next several decades, the majority of state appellate courts adopted the *Frye* general acceptance test as the standard for admissibility of expert testimony about a novel scientific technique. *See Reed*, 283 Md. at 382 (collecting cases). The Maryland Court of Appeals did so in *Reed*. In that case, soon after she was raped by a stranger, the victim began receiving telephone calls from her perpetrator. She reported the calls to the police and, with their assistance, recorded one of them. The defendant was arrested for the rape and gave voice exemplars. An expert in voice identification spectrography, otherwise known as “voiceprints,” used a spectrograph machine to compare the voice on the telephone recording to the defendant’s voice exemplar. He concluded from the result that the voices were the same. The trial court admitted that expert testimony, and the defendant was convicted.

The case reached the Court of Appeals, which reversed. It explained that the question whether expert testimony will give ““appreciable help”” to the jury is within the discretion of the trial judge to decide, because the answer will depend upon “the particular circumstances of each case” and cannot be reached by reference to “a rule or set of rules.” *Id.* at 380 (quoting 7 *Wigmore on Evidence* § 1923 (Chadbourn rev. 1978)). When expert testimony is “based on the application of [a] new scientific technique[,],” however, the court must make a threshold finding that “the particular scientific method is

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<sup>26</sup> Dr. Marston went on to gain fame, in 1941, for creating the Wonder Woman comic book character. *Id.*

itself reliable.” *Id.* Because “the question about the reliability of a scientific technique or process does not vary according to the circumstances of each case[,]” it is “inappropriate to view this threshold question of reliability as a matter within each trial judge’s individual discretion.” *Id.* at 381.

If the validity and reliability of a novel scientific technique is broadly and generally accepted in the scientific community, the trial court can take judicial notice of that fact. *See id.* at 380 (“On occasion, the validity and reliability of a scientific technique may be so broadly and generally accepted in the scientific community that a trial court may take judicial notice of its reliability.”). Likewise, the court can take judicial notice of the fact that the validity and reliability of a scientific technique is broadly and generally rejected by the scientific community. *Id.* If neither situation applies, the court must take evidence, and may independently consider publications and other sources of information, and use the *Frye* general acceptance test to determine whether the evidence is admissible. “*Frye* was deliberately intended to interpose substantial obstacle to the unrestrained admission of evidence based upon new scientific principles . . . .” *Id.* at 386 (quoting *People v. Kelly*, 549 P.2d 1240, 1245 (Cal. 1976)).

In the first two decades following the *Reed* decision, most of the “*Frye-Reed*” cases decided by this Court and the Court of Appeals fit nicely within the “new scientific technique” mold of *Frye* and *Reed*. *See Kelley v. State*, 288 Md. 298, 302 (1980) (applying *Frye-Reed* general acceptance test to hold that “testimony which directly or indirectly conveys the results of [a polygraph] test[] should not be admitted”); *State v. Collins*, 296 Md. 670 (1983) (applying *Frye-Reed* test to hold that expert opinion about

hypnotically enhanced witness testimony is inadmissible); *U.S. Gypsum Co. v. Mayor and City Council of Baltimore*, 336 Md. 145, 182–83 (1994) (applying *Frye-Reed* test to hold that surface dust sampling to determine asbestos contamination levels is a generally accepted technique); *Schultz v. State*, 106 Md. App. 145 (1995) (holding that the *Frye-Reed* test does apply to horizontal gaze nystagmus field sobriety tests, and taking judicial notice of the general acceptance of those tests); *Keene Corp., Inc. v. Hall*, 96 Md. App. 644 (1993) (applying *Frye-Reed* test to hold that polarized light microscopy, while generally accepted as a technique to detect asbestos fibers in building materials, is not generally accepted as a technique to detect those fibers in human tissue).

Meanwhile, in 1993, the United States Supreme Court rejected the *Frye* general acceptance test as the sole measure of admissibility for expert scientific testimony in the federal courts. In *Daubert v. Merrell Dow Pharmaceuticals*, 509 U.S. 579 (1993), the Court held that Federal Rule of Evidence (“FRE”) 702, adopted in 1975, superseded the *Frye* test and governed the admission of such evidence. When *Daubert* was decided, that rule provided that “a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify . . . in the form of an opinion or otherwise” about “scientific, technical, or other specialized knowledge [that] will assist the trier of fact to understand the evidence or to determine a fact in issue.” The Court read FRE 702 to mandate a threshold determination as to whether the “scientific testimony” at issue is “not only relevant, but reliable.” *Id.* at 589. The Court announced a non-exclusive list of factors that may be pertinent to that determination: (1) “whether a theory or technique . . . can be (and has been) tested”; (2) “whether [it] has been subjected to peer review and

publication”; (3) “the known or potential rate of error”; and (4) whether it is “general[ly] accepted” within the relevant scientific community. *Id.* at 593–94. The Court intended the *Daubert* analysis to be more flexible than the “uncompromising ‘general acceptance’ test” and to give trial courts greater discretion to admit scientific expert testimony that is relevant and founded on sound principles, even though novel or controversial. *Id.* at 596.

Since *Daubert* was decided, most state courts have adopted its multi-factor analysis in place of the *Frye* general acceptance test. *See Savage v. State*, 455 Md. 138, 178–79 & n.3 (2017) (Adkins, J., concurring, joined by Barbera, C.J., and McDonald, J.) (discussing the nation-wide trend toward adopting *Daubert* and advocating for Maryland to do so). Although Maryland has not done so, our jurisprudence nevertheless has “drift[ed]” toward the *Daubert* standard, *id.* at 187, in that the Court of Appeals 1) has used the *Frye-Reed* test “not only to evaluate scientific methods, but also to assess scientific conclusions”; and 2) has applied the *Frye-Reed* test to established, as well as novel, scientific methods. *Id.* at 180–81.

The drift toward applying *Frye-Reed* to scientific conclusions, not just techniques, was forecast in *Wilson v. State*, 370 Md. 191 (2002), in which the Court held that an expert opinion based on a statistical rule that was not accepted in the scientific community was not admissible. And in *State v. Smullen*, 380 Md. 233, 266 (2004), although in *dicta*, the Court observed that “[m]ost appellate courts that have considered . . . syndromes [such as battered spouse/child] have quite properly regarded them as *in the nature of* novel scientific theories and thus have subjected them to analysis under” *Frye* or *Daubert*. (Emphasis added.) The Court fully embraced this expansion of *Frye-Reed*

in *Montgomery Mutual Ins. Co. v. Chesson*, 399 Md. 314 (2007) (“*Chesson I*”); *Blackwell v. Wyeth*, 408 Md. 575 (2009); and *Chesson v. Montgomery Mutual Ins. Co.*, 434 Md. 346 (2013) (“*Chesson II*”).

*Chesson I*, a workers’ compensation case, concerned the admissibility of expert general medical causation opinion testimony that exposure to mold causes a cluster of neurocognitive and musculoskeletal symptoms known as “sick building syndrome.” The plaintiffs’ expert employed medical tests to reach a conclusion on medical causation that was not so widely accepted as to be the proper subject of judicial notice. In the Court’s view, the case involved more than a generally accepted medical opinion and diagnosis. It held that a *Frye-Reed* hearing was necessary to determine “whether the medical community generally accepts the theory that mold exposure causes the illnesses that respondents claimed to have suffered, and the propriety of the tests [the expert] employed to reach his medical conclusions.” 399 Md. at 328.

The expert opinion testimony at issue in *Blackwell* concerned the general medical causal relationship, if any, between thimerosal, a preservative used in childhood vaccines, and autism. The trial court had ruled the plaintiff’s expert’s testimony inadmissible under *Frye-Reed* (and Rule 5-702). The case reached the Court of Appeals, which framed the “essence” of the issue before it as whether the *Frye-Reed* test applies “to the analysis undertaken by an expert where the underlying data and methods for gathering this data are generally accepted in the scientific community but applied to support a novel theory” of medical causation. 408 Md. at 596. Because the Court had “not in the past had occasion to scrutinize the analytical phase of a scientific process underlying a novel

scientific opinion, where the underlying data may otherwise be generally accepted in the scientific community,” it looked to the decisions of federal courts that had done so under the *Daubert* standard. *Id.* at 604–05.

In particular, the *Blackwell* Court adopted the “analytical gap” concept, described by the Supreme Court in *General Electric Co. v. Joiner*, 522 U.S. 136, 146 (1997) (affirming, under *Daubert*, the exclusion of expert testimony that PCBs caused a plaintiff’s lung cancer because there was “too great an analytical gap between the data and the opinion proffered”). Emphasizing that “[g]enerally accepted methodology . . . must be coupled with generally accepted analysis in order to avoid the pitfalls of an ‘analytical gap,’” the *Blackwell* Court affirmed, holding that the plaintiff’s expert’s medical causation opinion was not generally accepted in the scientific community and therefore was not admissible, notwithstanding that it was based on generally accepted methods. 408 Md. at 608.

In *Chesson II*, an appeal after remand of the *Chesson I* mold/sick building syndrome case, the Court reaffirmed its endorsement of the *Joiner/Daubert* “analytical gap” concept, stating that “[a] trial judge . . . cannot admit expert testimony based on scientific methodology without consideration of whether the analysis itself is flawed and posits an ‘analytical gap.’” 434 Md. at 357. On remand, the trial court had held a *Frye-Reed* hearing and ruled the plaintiffs’ proposed expert opinion testimony on medical causation admissible. This Court reversed, and the Court of Appeals affirmed our decision. It held that the process the expert had used to reach his opinion on medical causation, although described as a differential diagnosis, which is a generally accepted

diagnostic method, was a distortion of that methodology. Neither the methodology nor the expert's conclusion based on that methodology were generally accepted, and therefore the expert testimony was not admissible.

Most recently, in *Savage v. State*, a defendant shot and killed one of a group of people accompanying his ex-wife to pick up their children from his house. In support of his defenses of perfect and imperfect self-defense, he sought to admit expert testimony by a neuropsychologist that prior traumatic injuries to his brain would have caused him to perceive as threatening conduct that was not in fact threatening and to react accordingly. The trial court held a *Frye-Reed* hearing and excluded the proposed evidence. This Court affirmed, as did the Court of Appeals. It held that the expert's analysis "did not bridge the 'analytical gap' between the data available to him and his ultimate conclusions." 455 Md. at 158. Specifically, although the expert had administered tests that were generally accepted in his field, his "ultimate opinions, that 'under such conditions of chaos and stress' [the defendant] 'would be more likely to perceive himself to be facing an imminent threat and have greater difficulty controlling his reactions[,]'" and that "[the defendant] views the world through an untrusting and suspicious perspective, and often is hyper-vigilant to possible threats[,]'" are conclusory." *Id.* at 164.

On the record before us . . . we are unable to conclude that [the expert] adequately 'connected the dots' between the empirical foundation from his study of [the defendant] and the [expert's] ultimate opinions. We emphasize that, in passing on whether there exists an 'analytical gap' between the data and the expert's conclusions, we may take as given the general acceptance of the expert's methods.

*Id.* at 170.

The second change in the Court of Appeals’s application of the *Frye-Reed* test—to old, as well as new, scientific methods, *see id.* at 186–87 (Adkins, J., concurring)—was more abrupt. As we shall discuss in greater detail below, in *Clemons*, 392 Md. at 371, the Court held that comparative bullet lead analysis (“CBLA”), a forensic test generally accepted in the pertinent scientific community for forty years, was no longer generally accepted and therefore CBLA test results were not admissible.

Whether proposed expert opinion testimony must be subjected to the *Frye-Reed* test at all and, if so, whether the proposed testimony satisfies the *Frye-Reed* test are purely legal issues. Accordingly, we review trial court decisions on those issues *de novo*. *See Wilson v. State*, 370 Md. at 201 n. 5; *Addison v. State*, 188 Md. App. 165, 180 (2009) (“[W]e . . . review the record and independently apply the *Frye/Reed* test *de novo*.”). In doing so, we can perform our own research to determine the scientific consensus. *See, e.g., Clemons*, 342 Md. at 359.

## C.

### **Rule 5-702**

In 1994, the Court of Appeals adopted the Maryland Rules of Evidence, including Rule 5-702, which governs the admission of expert testimony. That rule provides:

Expert testimony may be admitted, in the form of an opinion or otherwise, if the court determines that the testimony will assist the trier of fact to understand the evidence or to determine a fact in issue. In making that determination, the court shall determine (1) whether the witness is qualified as an expert by knowledge, skill, experience, training, or education, (2) the appropriateness of the expert testimony on the particular subject, and (3) whether a sufficient factual basis exists to support the expert testimony.

Thus, the trial court must make the determinations set forth in the rule before ruling on the admissibility of expert testimony, but its decision as to whether to admit the testimony is discretionary. For that reason, we review that decision for abuse of discretion, *Rollins v. State*, 392 Md. 455, 500 (2006), and a court’s “action in admitting or excluding such testimony will seldom constitute a ground for reversal.” *Bryant v. State*, 393 Md. 196, 203 (2006) (citations omitted).

In *Rochkind v. Stevenson*, 454 Md. 277 (2017), the Court of Appeals closely examined the third, “sufficient factual basis,” prong of Rule 5-702. It explained that there are two sub-factors to that prong. First, the expert opinion testimony must be founded on an adequate supply of data. And second, it must be based on a reliable methodology. *Id.* at 286. Absent either, the opinion is ““mere speculation or conjecture.”” *Id.* (quoting *Exxon Mobil Corp. v. Ford*, 433 Md. 426, 478 (2013)); *see also Roy v. Dackman*, 445 Md. 23, 42–43 (2015).

At issue in *Rochkind* was the trial court’s ruling admitting an expert witness’s general medical causation opinion that childhood exposure to lead paint can cause ADHD. The Court held that the trial court erred in admitting that opinion testimony because it did not satisfy the “sufficient factual basis” prong of Rule 5-702. Specifically, the opinion was not based on an adequate supply of data because it was founded on an epidemiological study documenting a *correlation* between lead paint exposure and ADHD but not showing a *causal connection* between the two. The expert did not provide any information to show that the plaintiff’s symptoms met the diagnostic criteria for ADHD, as set forth in the *Diagnostic and Statistical Manual of Mental Disorders 59* (5th

ed. 2013), nor did she rule out other behavioral disorders with symptoms similar to ADHD. The Court observed:

In equating attention deficits and hyperactivity with a clinical ADHD diagnosis, [the expert] painted an inaccurate picture of the scientific research regarding lead poisoning—she overstated the known effects of lead exposure. *Her testimony suffers from the same “analytical gap” described in [General Electric Co. v.] Joiner.*

*Id.* at 291 (emphasis added). Having found that the expert opinion testimony did not satisfy the adequate supply of data sub-factor, the Court did not go on to address the reliable methodology sub-factor. It also declined to address the second question it had taken on *certiorari*, whether the trial court should have held a *Frye-Reed* hearing on the expert’s general ADHD causation testimony, because, the Court explained, expert opinion testimony that does not satisfy the criteria for admissibility under Rule 5-702 is not admissible even if it satisfies the *Frye-Reed* general acceptance test.

The concurring opinion in *Savage*, published a month after *Rochkind*, pointed out that an overlap now exists between the third prong of Rule 5-702 and the *Frye-Reed* test as it has evolved in the past decade. In particular, “a trial court may have to analyze the reliability of an expert’s methodology twice—once under *Frye-Reed* and again under Rule 5-702(3).” 455 Md. at 184 (Adkins, J., concurring). Thus, “[t]he evolution of our *Frye-Reed* doctrine to both maintain the general acceptance test and include a check for an ‘analytical gap’ has muddied our approach to expert testimony.” *Id.* at 186. That was

one reason cited by the concurring members of the Court in *Savage* in advocating for Maryland to adopt the *Daubert* multi-factor test in place of the *Frye-Reed* test.<sup>27</sup>

#### D.

#### Analysis

Because it could be outcome determinative, we begin with the State’s counter-argument that Rule 5-702, not the *Frye-Reed* general acceptance test, controlled the admissibility of its expert medical causation testimony. The court ruled on both, but the appellant only has appealed the *Frye-Reed* ruling. The State maintains that the *Frye-Reed* ruling is immaterial, as *Frye-Reed* did not control, and the Rule 5-702 ruling also is immaterial, for our purposes, as it stands unchallenged on appeal.

To advance its position, the State relies upon *Myers v. Celotex Corporation*, 88 Md. App. 442 (1991), *cert. denied*, 325 Md. 249 (1992), and *CSX Transportation, Inc. v. Miller*, 159 Md. App. 123 (2004), *cert. granted*, 384 Md. 581, *cert. dismissed*, 387 Md. 351 (2005). In *Myers*, we held that a medical expert’s opinion that the plaintiff’s exposure to asbestos caused his lung cancer was not subject to the *Frye-Reed* general acceptance test because the premise underlying the opinion—“[t]hat exposure to asbestos

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<sup>27</sup> As noted above, in *Daubert*, the Supreme Court held that the *Frye* standard had been superseded by FRE 702. The committee note to Rule 5-702 states:

This Rule is not intended to overrule *Reed v. State*, 283 Md. 374 (1978) and other cases adopting the principles enunciated in *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923). The required scientific foundation for the admission of novel scientific techniques or principles is left to development through case law. Compare *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 113 S. Ct. 2786 (1993).

may cause cancer”—was not “novel or controversial.” 88 Md. App. at 458. Moreover, the expert’s opinion about “*how* asbestos causes cancer,” which he had formed from his “personal observations and professional experience,” was admissible so long as it could be stated to a “reasonable degree of medical probability.” *Id.* (emphasis in original).

Similarly, in *Miller*, we held that a medical expert’s opinion that the plaintiff railroad worker’s osteoarthritis of the knees was caused by “years of walking on mainline ballast,” 159 Md. App. at 186, was not subject to the *Frye-Reed* test.

A doctor’s opinion as to the etiology of his patient’s arthritis is simply not the type of thing contemplated by the phrase ‘new and novel scientific technique.’ What is contemplated are new, and arguably questionable, techniques such as lie detector tests, breathalyzer tests, paraffin tests, DNA identification, voiceprint identification, as in the *Reed* case itself, and the use of polarized light microscopy to identify asbestos fibers . . . .

*Id.* at 187. The opinion was admissible as long as it was expressed to a reasonable degree of medical certainty. *See also Giddens v. State*, 148 Md. App. 407 (2002), *cert. denied*, 374 Md. 83 (2003) (pathologist’s expert opinion about victim’s time of death was not subject to *Frye-Reed* test for admissibility).

These cases are not helpful to the State’s position because they were decided before the Court of Appeals extended the reach of *Frye-Reed* beyond the bounds of novel scientific tests and techniques. We do not mean to suggest that if they were decided today their outcomes would differ, only that the analyses employed necessarily would be more expansive.

As we see it, for the trial court to rule on the admissibility of the State’s expert opinion testimony in this case, it needed to determine whether those experts had used,

and were using, a “reliable methodology” in diagnosing abusive head trauma, and that determination fell within the common element overlap that has developed between the *Frye-Reed* test and Rule 5-702(3). As all the experts explained it, an abusive head trauma diagnosis is made in real time by health care providers in the relevant fields taking a history and making clinical findings, from which they generate a list of hypothetical causes, *i.e.*, a differential diagnosis. They then conduct diagnostic tests and, using those results and all the information they have gathered, engage in a process of elimination by which diagnoses in the differential that do not fit are removed and the correct diagnosis is reached. Non-treating experts use the same method, although they also may make use of reference materials not available at the time of actual diagnosis. The defense in this case did not take the position that the differential diagnosis process, including the underlying fact gathering process, is not a generally accepted diagnostic methodology. Indeed, it could not have, as the differential diagnosis method is well-established. *See, e.g., Chesson II*, 434 Md. at 346 (assuming the reliability of the practice of differential diagnosis, but holding that the diagnostic criteria for the illness at issue—sick building syndrome—were not generally accepted). Rather, the defense took issue with the analysis in which the experts engaged—their thought processes—as they ruled diagnoses in and out.

In Rule 5-702(3) terms, the admissibility issue is whether the State’s experts’ opinions “provide[d] a sound reasoning process for inducing [their] conclusion[s] from the factual data” and had “an adequate theory or rational explanation of how the factual data led to [their] conclusion[s].” *Ford*, 433 Md. at 481 (explaining what is necessary for

an expert opinion to satisfy the reasonable methodology prong of Rule 5-702(3)) (citations omitted). In *Frye-Reed* terms, the admissibility issue is whether “the expert[s] bridged the ‘analytical gap’ between accepted science and [their] ultimate conclusions in [this] particular case.” *Savage*, 455 Md. at 160. Given that the differential diagnosis methodology and the underlying science (for example the tests performed and the autopsy) are accepted science/medicine, the questions are the same: did the experts engage in a well-grounded analysis to reach the conclusion that Shane’s death was the result of abusive head trauma?

The trial court ruled on *Frye-Reed* and on Rule 5-702(3) with respect to the State’s expert witness testimony, so both issues were decided below and either or both were preserved for challenge on appeal. Although the admissibility issue fell in the overlap between *Frye-Reed* and Rule 5-702(3), we cannot say that the *Frye-Reed* test, in its evolved form, was not appropriate for the court to apply. We harken back to the observation by the Court of Appeals in *Reed* that a trial court’s decision on reliability of scientific expert testimony under the Maryland common law of evidence, which later became Rule 5-702(3), focuses on whether the testimony will assist the jurors in deciding the case before them, while its decision on the reliability of scientific evidence under *Frye-Reed* focuses on the reliability of a scientific method across the board, not simply in that particular case. With the evolution of *Frye-Reed* to include scientific analysis, perhaps the two are now melded into one. But in any event, the appellant’s attack on abusive head trauma as a diagnosis is argued as a general one that would apply to all such cases, not just the case at bar.

Accordingly, the appellant's *Frye-Reed* issue is viable in this appeal. We agree with the trial court that the present controversy over abusive head trauma, which is the reason the appellant was granted a new trial on post-conviction, is sufficient to dispose with judicial notice of it as a reliable diagnosis and to embark on a *Frye-Reed* hearing. And we shall review the court's *Frye-Reed* ruling using the *de novo* standard that governs those rulings. As we shall explain, ultimately we reject the appellant's argument that the controversy over the diagnosis of abusive head trauma makes it no longer a generally accepted diagnosis in the absence of external findings. That controversy exists largely in the legal community, not in the medical communities relevant to our inquiry.

We begin by summarizing the history of shaken baby syndrome/abusive head trauma as described in the reliable medical literature. In 1860, Auguste Ambroise Tardieu, a renowned French forensic physician, published *Étude Médico-Légale sur les Sévices et Mauvais Traitements Exercés sur des Enfants*, which translates as *Forensic Study on Abuse and Ill-Treatment of Children*. *Narang I*, at 523. He documented 32 cases of suspected child abuse, including cases where infants with no external signs of injury died and were found on autopsy to have bleeding on the surface of the brain.<sup>28</sup> *Id.* Midway into the next century, with the great advancements in medicine, evidence began to build for a connection between trauma and the presence of subdural hematomas in young children. In 1946, John Caffey, M.D., published a study examining the correlation

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<sup>28</sup> Until the advent of radiological scans, subdural hematomas only could be detected upon autopsy.

in infants between long bone fractures, which often are associated with abuse, and subdural hematomas. *Id.* at 526. In several of the cases, retinal hemorrhages also were present. After ruling out medical causes, Dr. Caffey attributed all the radiological findings to trauma. He did not reach any conclusions about the traumatic mechanism involved, however. *Id.* In 1962, C. Henry Kempe, M.D., a pediatrician, and colleagues published *The Battered-Child Syndrome*, 181 J. Am. Med. A'ssn 105 (1962), identifying unexplained bruises, fractures, and subdural hematomas as findings that should lead physicians to consider child abuse as a possible etiology. *Narang I* at 527.

A little over a decade later, Dr. Caffey and others began to hypothesize that shaking was the mechanism of abuse that was producing subdural hematomas in infants and young children who also had long bone fractures. He and Norman Guthkelch,<sup>29</sup> a neurosurgeon, theorized that the “multiple acceleration and deceleration events, caused by head shaking, resulted in the intracranial injuries,” including subdural hematomas and retinal hemorrhages. *Id.* at 528.<sup>30</sup> Originally called “parent-infant traumatic stress syndrome,” and later “whiplash shaken infant syndrome,” the syndrome soon became commonly known as shaken baby syndrome. Christopher S. Greeley, *Abusive Head*

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<sup>29</sup> Dr. Guthkelch is now an abusive head trauma skeptic and often testifies for the defense in criminal trials where the theory of prosecution is that a defendant shook or slammed an infant.

<sup>30</sup> Drs. Caffey and Guthkelch hypothesized that even benign shaking, such as might occur during burping or play, could cause brain injury. It is now widely accepted that to injure a child the shaking must be violent and forceful.

*Trauma: A Review of the Evidence Base*, 204 Am. J. of Roentgenology 967, 968 (May 2015) (hereinafter *Greeley*).

In the latter decades of the 20th century, it became widely accepted in the involved medical communities that shaking was the likely mechanism of brain injury when infants and young children presented with subdural hematomas, retinal hemorrhages, and brain swelling, but without external evidence of trauma or a reported history of a significant traumatic event. Initially, it was theorized that the shaking caused the brain to accelerate and decelerate within the skull, rupturing bridging veins<sup>31</sup> and retinal blood vessels, and injuring nerve fibers, called axons, throughout the brain (“diffuse axonal injury”.) See Keith Findley, et al., *Shaken Baby Syndrome, Abusive Head Trauma, and Actual Innocence: Getting It Right*, 12 Hous. J. Health L. & Policy 209, 224 (2012) (hereinafter “*Findley*”) (discussing the history of abusive head trauma).<sup>32</sup> Further research revealed that the diffuse axonal injury seen on autopsy in suspected child abuse deaths was a sequelae of hypoxic injury. See J.F. Geddes, et al., *Neuropathology of Inflicted Head Injury in Children, I. Patterns of Brain Damage*, 124 Brain 1290 (2001). The lack of an adequate oxygen supply to the brain and resulting cerebral edema, not the tearing of axons, caused the catastrophic brain collapse. *Id.* (As explained above, inflicted trauma,

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<sup>31</sup> Bridging veins are veins within the dura that carry blood to larger sinus veins.

<sup>32</sup> Two of the co-authors – Findley and David A. Moran, are attorneys who work with law school-based Innocence Projects. The other two authors are Dr. Barnes, the appellant’s neuroradiology expert medical witness, and Waney Squier, M.D., a neuropathologist.

evidenced by subdural hematomas and retinal hemorrhages, caused the apnea, which in turn caused the hypoxia, brain swelling, collapse, and death.)

There were some in the biomechanical scientific community who disputed that shaking could produce forces sufficient to cause the injuries seen in shaken baby syndrome cases, however. See Ann-Christine Duhaime, et al., *The Shaken Baby Syndrome: A Clinical, Pathological, and Biomechanical Study*, 66 J. Neurosurgery 409, 409 (1987).<sup>33</sup> In part as a result of the biomechanical studies and in part because of perpetrator confessions in cases that involved shaking and slamming of infants, scientists began to consider whether impact on a soft surface, independent of or in combination with shaking, also could be a mechanism for some of the intracranial findings in abuse cases.

In 2009, the American Academy of Pediatrics (“AAP”) issued a policy statement recommending that pediatricians “use the term ‘abusive head trauma’ rather than a term that implies a single injury mechanism, such as shaken baby syndrome, in their diagnosis and medical communications.” C.W. Christian, R. Block, and Committee on Child Abuse and Neglect, *Abusive Head Trauma in Infants and Children*, 123 Pediatrics 1409, 1411 (2009). The AAP emphasized that it did not intend “to detract from shaking as a mechanism of [abusive head trauma] but to broaden the terminology to account for the multitude of primary and secondary injuries that result from [abusive head trauma], some

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<sup>33</sup> The Duhaime study and others like it received significant criticism, however. When scientists altered the models used by Duhaime, they found that shaking *does* exceed injury thresholds, to the extent those thresholds can be calculated with any precision.

of which contribute to the often-permanent and significant brain damage suffered by abused infants and children.” *Id.* at 1410. The term shaken baby syndrome, it noted, was “sometimes used inaccurately to describe infants with impact injury alone or with multiple mechanisms of head and brain injury and focuses on a specific mechanism of injury rather than the abusive event that was perpetrated against a helpless victim.” *Id.* Abusive head trauma is now the accepted umbrella term for “those constellations of injuries that are caused by the directed application of force to an infant or young child, resulting in physical injury to the head and/or its contents.” *Narang I* at 570 (quoting Antonia Chiesa & Ann-Christine Duhaime, *Abusive Head Trauma*, 56 *Pediatrics Clinic N. Am.* 317 (2009)).

One *Frye-Reed* argument the appellant advances is that the shift in terminology from shaken baby syndrome to abusive head trauma was an attempt to shore up a diagnosis against erosion by a body of research casting doubt on its underlying assumptions. Relying primarily on *Clemons v. State*, 392 Md. at 339, he asserts that the existence of a growing minority of physicians and scientists who reject abusive head trauma as a diagnosis makes it no longer generally accepted in the relevant medical communities.

As mentioned earlier, in *Clemons*, the Court held that CBLA is no longer generally accepted in the forensic science community. CBLA is a “three-step process that involves the comparison of the elemental composition of bullets in an effort to determine whether different bullets originated from the same vat of lead.” 392 Md. at 347. In *Clemons*, CBLA testing was used to link bullets in a gun found in the

defendant's possession to bullets found in the body of a murder victim. The defendant challenged his second degree murder conviction on appeal on the ground that the CBLA testing should not have been admitted under *Frye-Reed*.

The Court of Appeals conducted an independent review of the admissibility of CBLA testing, examining the bullet manufacturing process and the history and methodology underlying CBLA, which was developed in the 1960s and became a widely accepted forensic tool by the 1980s. CBLA testing's accuracy was "premised upon three assumptions: the [bullet] fragment being analyzed is representative of the composition of the source from which it originated; the source from which the sample is derived is compositionally homogenous; and no two molten sources are ever produced with the same composition." *Id.* at 368 (internal quotation marks omitted).

The latter two assumptions had "come under attack" by those in the "relevant scientific community of analytical chemists and metallurgists." *Id.* Recent studies had found that a single molten source could vary greatly in its composition depending upon whether a sample was taken at the beginning, middle, or end of the bullet pouring process. *Id.* Another study found "false positives and negatives . . . of twenty-five to thirty-three percent." *Id.* at 370–71. These studies had prompted the FBI laboratory that conducted all of the CBLA testing in the United States to cease performing the tests. Given that the scientific premises upon which CBLA was based had been undermined by many in the relevant scientific community, the Court held that CBLA testing no longer was "generally accepted within the scientific community as valid and reliable." *Id.* at 359.

The controversy over abusive head trauma differs significantly from the controversy over CBLA. A wide range of relevant medical (and scientific) communities study abusive head trauma. Disciplines participating in research include: “biomechanics, pathology, radiology, ophthalmology, neurosurgery, and general pediatrics.” Sandeep K. Narang, M.D., J.D., 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. & Policy 203, 2286 (2013) (hereinafter “*Narang II*”). The underlying methodologies used to study and diagnose abusive head trauma—radiological scans, ophthalmologic exams, autopsy of the brain and eyes—are not even controversial. Indeed, most abusive head trauma skeptics, including Dr. Plunkett and others who testified for the defense at trial, acknowledge that it is possible for brain injury and death to be caused by child abuse. To the extent a controversy exists, it concerns the mechanism by which brain injury can happen and the specificity of the findings necessary for a diagnosis of abusive head trauma. They do not undercut the diagnosis completely, which is what one would have to see to draw a direct comparison between *Clemons* and the case at bar.

It remains the prevailing view within the relevant medical communities that there are some internal findings that are highly correlated with abusive head trauma, even in the absence of external findings; and when those internal findings are coupled with an inconsistent clinical history or one that is inadequate to explain them, and cannot be explained medically, a diagnosis of abusive head trauma is supported. *See Narang I* at 574–76 (listing organizations that endorse abusive head trauma as a medical diagnosis, including the American Association for Pediatric Ophthalmology, the American College

of Radiology, the American Association of Neurologic Surgeons, the World Health Organization, and the Royal College of Paediatrics and Child Health). External findings associated with abusive head trauma include bruising or swelling of the scalp or other parts of the body. Internal findings include skull fractures; long bone fractures; rib fractures; retinal hemorrhages; subdural hematomas; subarachnoid hemorrhages; brain swelling; and cervical spine injuries. As noted, the consensus is that no single finding or combination of findings is pathognomonic for abusive head trauma. Rather, a differential diagnosis must be made based upon the totality of the circumstances in each individual case. A congruence of multiple findings, each of which independently correlates with abusive head trauma, narrows the field of potential diagnoses significantly, however, and absent a clinical history of accidental trauma or evidence of a disease process consistent with those findings, a diagnosis of abusive head trauma may be made. *See Greeley* at 969.

The “cardinal intracranial finding [for] abusive head trauma is [subdural hematoma].” *Greeley* at 969; *see also* J.F. Geddes, et al., *Neuropathology of inflicted head injury in children, I. Patterns of brain damage*, 124 *Brain* 1290 (2001) (31 out of 37 infants in study group of “well-documented” cases of non-accidental head trauma<sup>34</sup> had

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<sup>34</sup> The authors of the study considered a case “well-documented” when one of the following diagnostic criteria were met: 1) confession by the perpetrator; 2) conviction in a criminal court, coupled with unexplained extracranial injuries; 3) cases without a conviction, but with unexplained injuries elsewhere on the body; 4) conviction in a criminal court, but without any extracranial injuries; and 5) cases with a “major discrepancy” between the clinical history given by the caregiver and the injuries and/or a  
(Continued...)

subdural hematoma). Although there are other causes of subdural hematomas in infants—including birth trauma and certain coagulation disorders—head trauma is the most common cause. *See Narang I* at 542 (discussing epidemiological study that found that trauma caused over 60% of subdural hematomas seen in children ages 0 to 2 in the United Kingdom and Ireland over a 12-month period). Subdural hematomas are “strongly associated with [abusive head trauma],” *Greeley* at 969, because within the subset of subdural hematomas that do not have a medical cause, the vast majority result from trauma that is not attributable to an accident. *See also Narang I* at 541 (“there is *not one* clinical study that demonstrates a greater statistical association of . . . subdural hemorrhages . . . with accidental trauma over abusive head trauma”) (emphasis in original); *see also Greeley* at 969 (explaining that accidental head injury is more likely to cause epidural hemorrhage and skull fractures). And significantly, numerous studies have shown that subdural hematomas in cases of abusive head trauma differ in location and appearance from those present in accidental injury cases. *See Narang I* at 546–547 (discussing a 2002 retrospective study and several other studies confirming those results). In cases of abusive head trauma, subdural hematomas typically are “[m]ultifocal,” “interhemispheric,” and “located at the front or back ‘curves’ of the brain.” *Id.*

Retinal hemorrhages likewise are highly correlated with abusive head trauma, particularly when they are diffuse, bilateral, and “extend to the outer margins of the retina (ora serrata retinae).” *Greeley* at 969; *Starling* at 456 (84% of cases involving admitted

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clinical history that was inconsistent with the child’s developmental stage (*i.e.*, a non-rolling infant rolling off a bed).

shaking were positive for retinal hemorrhage and 94% of cases involving admitted shaking and impact were positive for retinal hemorrhage). Retinal hemorrhages rarely are seen in cases involving “linear falls resulting in cranial impact,” *i.e.*, typical accidental injury cases. *Starling* at 457. Research has not revealed any association between severe retinal hemorrhages and increased intracranial pressure, increased intrathoracic pressure, birth trauma, or cardio-pulmonary resuscitation (“CPR”). *Narang I* at 551–53. In addition, computational model studies have demonstrated that “rhythmic shaking significantly increases the stress on the retina,” particularly at the “posterior pole and the periphery,” the locations of retinal hemorrhages found in many cases of suspected abusive head trauma. *Narang II* at 261. A 2010 “systematic review of the diagnostic accuracy of [retinal hemorrhages] in abusive head trauma” found that retinal hemorrhages have a “specificity of 94% for abuse.” *Narang I* at 557–58 (quoting Gaurav Bhardwaj, *et al.*, *A Systematic Review of the Diagnosis of Ocular Signs in Pediatric Abusive Head Trauma*, 117 *Ophthalmology* 983, 984 (2010)).

The main controversy over abusive head trauma involves a minority of physicians and other scientists who posit that changes in the understanding of the biomechanics of shaking, coupled with evidence that the confluence of subdural hematomas, retinal hemorrhages, and brain swelling is not unique to abusive head trauma, make it impossible to reliably conclude that any particular child’s injuries or death were caused by inflicted (non-accidental) trauma, as opposed to accidental trauma or medical causes, such as clotting disorders. Nevertheless, they do not dispute that the presence of subdural hematomas, retinal hemorrhages, and encephalopathy is consistent with abusive head

trauma. *See Findley*, at 213 (“there is general agreement that child abuse was historically under-recognized and that abuse can produce subdural hemorrhage, retinal hemorrhage, and brain damage—the ‘triad’ of medical findings that has traditionally been used to confirm shaking or other forms of abuse”). They also do not dispute that “violently shaking a child is unacceptable and could cause serious injury or even death.” *Id.* Rather, they take issue with what they see as the misapprehension that “the presence of the triad alone—or its individual components” is sufficient to diagnose abuse. *Id.* In their view, the triad or its components “is not enough to diagnose abuse.” *Id.*

It is in this context that we must assess whether a differential diagnosis of abusive head trauma satisfies *Frye-Reed*. It is well-established that “unanimity” of opinion is not required for an expert opinion to be generally accepted for purposes of *Frye-Reed*. *Chesson II*, 434 Md. at 356 (“General acceptance does not equate to unanimity of opinion within a scientific community, nor universality, and is not subject to a quantum analysis.”). However, a scientific principle or methodology, or conclusions drawn from that principle or methodology, that are subject to “widespread disagreement” or a “genuine controversy” are not “generally accepted” under *Frye-Reed*. *Wilson*, 370 Md. at 210.

In *Blackwell* and *Chesson II*, the Court of Appeals excluded as not generally accepted expert opinions that were outliers with virtually no support in the relevant medical or scientific communities. The plaintiff’s expert witness in *Blackwell* was going to testify at trial that a study he had conducted with his son supported a medical causal link between thimerosal in vaccines and autism. That was the only study to have found

such a causal connection. Peer reviewed articles had rejected as unsound the study's methodology and the expert's analysis based on it. The Court concluded that there was an "analytical gap" between the expert's opinion and its basis, so that the opinion amounted to "no more than hypothesis and conjecture." 408 Md. at 618.

Similarly, in *Chesson II*, the plaintiff's expert on medical causation linking "toxic mold exposure" to the "sick building syndrome" constellation of symptoms was the only purveyor of a particular technique to detect mold exposure in individuals. That technique had been criticized for failing to take into account the level of mold exposure detected, had no support in the relevant medical/scientific community, and was not backed up by any peer reviewed studies. The circuit court had ruled the expert's opinions to be generally accepted merely because he described the process by which he made his "sick building syndrome" diagnosis as being a differential diagnosis. The Court of Appeals reasoned that this was not sufficient; what mattered was that the study underlying the expert's diagnostic protocol was flawed, which led to a flawed analysis.

In the case at bar, the opinions expressed by the State's medical experts were not outlier opinions within the relevant medical communities. Quite the contrary, the opinion that abusive head trauma is a legitimate and reliably-made diagnosis is shared by the overwhelming majority of physicians within the relevant medical fields. The testimony of the State's expert witnesses did not amount to conjecture, but was drawn directly from the scientific literature discussed *supra* that supports the conclusion that multi-focal subdural hematomas in an 11-week old infant are usually traumatic in origin and that

multi-layered bilateral retinal hemorrhages are highly associated with inflicted trauma and, more specifically, with acceleration-deceleration trauma.

Moreover, we emphasize that the aspect of the abusive head trauma controversy over the mechanics of brain injuries in infants and children might have significance in cases, unlike this one, where there is a genuine issue of accidental versus non-accidental brain injuries and death. In those cases, the dispute usually centers on whether the injuries/death could have been caused by the claimed accident instead of by abuse. That aspect of the abusive head trauma controversy is irrelevant here. According to the appellant's statement to the police, there was no accident; Shane was perfectly fine and was lying safely on the appellant's bed when he suddenly stopped breathing and lost consciousness. Whether there are legitimate studies showing that infants can suffer serious brain injury causing death from short falls or similar accidents does not matter here, where there clearly was not an accidental cause for Shane's brain injuries and death. That is why the defense in this case focused solely on alternative medical causes.

We note that in *Blackwell* and *Chesson II*, the Court of Appeals considered it relevant that other courts had rejected the same theories of causation from the same expert witnesses. *See Blackwell*, 408 Md. at 616 (quoting the trial court judge's opinion, stating: "It is noteworthy that other courts have acknowledged that Dr. Geier's methodology of differential diagnosis is fundamentally flawed, because he improperly "rules in" thimerosal as a potential cause of autism, and he cannot rule out the high likelihood that autism in any given individual was caused purely by genetic factors that do not require an environmental trigger."); *Chesson II*, 434 Md. at 379 ("We would note

that other jurisdictions have determined that Dr. Shoemaker’s theory, based on his “Repetitive Exposure Protocol,” is neither generally accepted nor reliable.”). The opposite is true with regard to the abusive head trauma diagnosis: other courts that have considered the threshold admissibility of expert medical testimony that a child victim’s injuries or death resulted from abusive head trauma have held that, despite criticism, it remains an accepted and reliable diagnosis. *See Wolfe v. State*, 509 S.W.3d 325, 337 (Tex. Crim. App. 2017) (affirming the trial court’s ruling that expert testimony that a baby presenting with subdural hematoma and retinal hemorrhages suffered abusive head trauma satisfied *Daubert* because that theory was “accepted within the pediatric medical community”; the experts were qualified; and the literature, in particular *Narang I*, supported the validity of the diagnosis); *Futrell v. Commonwealth*, 471 S.W.3d 258, 282-86 (Ky. 2015) (child abuse pediatrician’s expert testimony that victim died as a result of abusive head trauma was admissible under *Daubert*, and citing *Narang I*); *In re Morris*, 355 P.3d 355, 360 (Wash. App. 2015) (holding that “[a]busive head trauma as a diagnosis, and shaking as a cause of such injuries, are generally accepted theories in the relevant scientific community” and satisfy *Frye*); *Day v. State*, 303 P.3d 291, 296 (Okla. Crim. App. 2013) (denying a request for a *Daubert* hearing on the admissibility of expert testimony relative to shaken baby syndrome/abusive head trauma and opining that the proposition that that diagnosis had been “discredited by other scientific evidence” was an “exaggeration” in that the “most the record . . . show[ed was] that experts disagree[d]” as to the reliability of the diagnosis absent evidence of impact), *cert. denied* \_\_ U.S. \_\_, 134 S.Ct. 1303 (2014); *State v. Leibhart*, 662 N.W.2d 618, 628 (Neb. 2003) (affirming the

trial court's determination to admit expert testimony relative to shaken baby syndrome after a *Daubert* hearing and explaining that the theory that violent shaking can cause brain injury in infants was "clinically tested and peer reviewed . . . and the findings were generally accepted within the field of pediatrics"); *see also People v. Schuit*, 67 N.E.3d 890, 918 (Ill. App. 2016) (holding that expert testimony that a baby's injuries were caused by shaken baby syndrome/abusive head trauma was "pure opinion testimony based upon clinical experience" and was not subject to the *Frye* general acceptance test) (citation omitted).<sup>35</sup>

In considering the aspect of the controversy concerning what specific findings support a valid diagnosis of abusive head trauma, we find helpful the author's summary of the differential diagnosis process in *Narang II*:

In abusive head trauma/shaken baby syndrome cases, the differential diagnosis depends on the findings presented. Soft tissue injuries (such as bruises) have a differential diagnosis. Fractures (either long bone or skull) have a differential diagnosis. And intracranial findings (such as [subdural hematomas] or cerebral edema) and ophthalmologic findings (such as [retinal hemorrhages]) also have a differential diagnosis. It is the physician's task to parse through the historical information, the physical examination, and the laboratory and radiologic results to arrive at a unifying diagnosis that satisfies the criteria of "adequacy," "parsimony," and "coherency . . . [I]n many cases, but obviously not all, the unifying diagnosis will be trauma. From there, the physician will again utilize the historical information, the physical examination, the laboratory/radiology results, the medical literature, and his/her experience to distinguish between accidental and non-accidental trauma.

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<sup>35</sup> All the cases the appellant cites arose in the post-conviction posture. Those cases concerned whether evidence of the "controversy" over abusive head trauma was newly discovered evidence entitling a defendant to a new trial or whether trial counsel had been constitutionally ineffective by failing to present expert testimony rebutting that theory at trial. None of these cases engaged in a threshold admissibility analysis.

*Narang II* at 304–05 (footnotes omitted). The three criteria mentioned have the following meanings:

“Adequacy” is when the remaining working hypothesis reasonably accounts for all the patient’s findings, both normal and abnormal. “Coherency” is when the patient’s findings are consistent with the altered pathophysiology of the hypothesized disease. “Parsimony” is the simplest explanation for all of the patient’s findings.

*Id.* at 304 n. 634 (citing John B. Wong, et al., *Fed. Judicial Ctr Reference Guide on Medical Testimony*).

The process of reaching a diagnosis of abusive head trauma thus is nuanced and fact-specific. Physicians presented with an infant suffering from suspected head trauma will rely on positive and negative clinical, historical, and test-generated pieces of evidence, each of which can support or detract from a diagnosis, including a diagnosis of abusive head trauma. None of the State’s expert witnesses testified that he or she arrived at a diagnosis of abusive head trauma (or of head trauma) based merely upon the presence of the “triad,” as the defense maintained. Four of the State’s experts reached the diagnosis of abusive head trauma by considering possible causes of Shane’s reported history of sudden apnea, nose bleeding, and collapse and the intracranial findings—subdural hematoma, subarachnoid hemorrhage, bilateral retinal hemorrhages, and severe cerebral edema—and after ruling out potential medical causes for those conditions. Dr. Pollanen agreed that head trauma was the “best unifying diagnosis.” None of the State’s experts were able to testify conclusively whether shaking alone, impact on a soft surface alone, or a combination of both mechanisms caused the injuries.

The analyses used by the State's expert witnesses (treating and non-treating) who concluded that Shane's brain injuries and death resulted from inflicted head trauma "connected the dots," to use the phraseology of the Court of Appeals in *Savage*. Until September 15, 2001, Shane was a normal, healthy baby. That morning, he fed well and was acting normally. As the appellant, the only witness to what happened, described it, Shane was fine and then suddenly he stopped breathing and became comatose. Shane's clinical symptoms in the hospital were consistent with a severe brain injury. CT scans and an MRI showed subdural hematomas in the locations associated with inflicted trauma and progressive swelling of brain tissue, consistent with an acute injury to the brain. Laboratory tests ruled out medical conditions, such as clotting disorders, as the cause of his brain injury. A chronic subdural hematoma either did not exist or was so small that it was medically incapable of causing the catastrophic brain injury. Testing of Shane's eyes showed bilateral retinal hemorrhages, diffusely located in a manner consistent with inflicted trauma. All of this information and the medical literature supported a diagnosis of brain trauma and, in the absence of any accident, inflicted brain trauma, *i.e.* abusive head trauma. There was no analytical gap in the reasoning of the State's expert witnesses in reaching their diagnosis of abusive head trauma.

For all of these reasons, we hold that the diagnosis of abusive head trauma remains generally accepted in the relevant medical/scientific communities and that the analyses employed by the State's expert witnesses to support their opinions that Shane's brain injury and death was caused by abusive head trauma satisfied the *Frye-Reed* test. The circuit court did not err by admitting that testimony into evidence at trial.

## II.

### Sufficiency of the Evidence

The appellant also contends the evidence at trial was legally insufficient to support any of his convictions. This contention overlaps with and is dependent upon his first contention.

The appellant argues that even though the abusive head trauma diagnosis is no longer generally accepted, it was used to prove the *actus reus* of his crimes—that he violently shook or slammed Shane onto the bed, causing his brain injury and resulting death; the *mens rea* of his crimes—that he acted willfully and with the intent to cause bodily harm; and criminal agency—that he was the only person with the opportunity to inflict injury on Shane in the period in which the injury must have been inflicted. Because the abusive head trauma diagnosis is now discredited, he argues a conviction based on abuse cannot be sustained where abusive head trauma is “the *only* evidence of abuse.” (Emphasis in original.) He asserts:

No rational fact finder could conclude, beyond a reasonable doubt, that [he] ever lay a hand on his son, because, on these facts, there is no way to determine with any medical or legal certainty—much less beyond a reasonable doubt—that Shane’s injuries were inflicted, as opposed to accidental, or as a result of a natural disease process (or some combination thereof, as with re-bleeding into a chronic subdural hemorrhage).

The State responds that because abusive head trauma is a generally accepted medical diagnosis and had a sound factual basis in this case, the expert medical testimony it presented was sufficient to show, beyond a reasonable doubt, that Shane sustained brain injuries and ultimately death as a result of intentionally being violently shaken,

slammed against a soft surface, or both; and that its expert testimony and other evidence established to the requisite standard of proof that the appellant was the person who committed the violent acts that caused Shane's death.

Our standard of review of the sufficiency of the evidence in a criminal case is well-established:

The standard for appellate review of evidentiary sufficiency is whether, after viewing the evidence in the light most favorable to the prosecution, any rational trier of fact could have found the essential elements of the crime beyond a reasonable doubt. Weighing the credibility of witnesses and resolving any conflicts in the evidence are tasks proper for the fact finder. In addition, we give due regard to the [fact finder's] finding of facts, its resolution of conflicting evidence, and, significantly, its opportunity to observe and assess the credibility of witnesses.

*Larocca v. State*, 164 Md. App. 460, 471–72 (2005) (internal citations omitted). First-degree premeditated murder is the intentional killing of a person that is deliberate, premeditated, and willful. Md. Code (2002, 2012 Repl. Vol.), § 2-201(a)(1) of the Criminal Law Article (“CL”); *see also Handy v. State*, 201 Md. App. 521, 560 (2011). “Abuse” as defined in the crime of “Child abuse” in CL section 3-601 is “physical injury sustained by a minor as a result of cruel or inhumane treatment or as a result of a malicious act under circumstances that indicate that the minor’s health or welfare is harmed or threatened by the treatment or act.” CL § 3-601(a)(2). Child abuse resulting in death includes abuse by a minor’s parent that results in the minor’s death. CL § 3-601(b)(1)(i). And child abuse includes abuse inflicted against a minor by his or her parent. CL § 3-601(d)(1)(i).

As we already have discussed, the State's expert medical testimony, which the court credited, demonstrated that Shane suffered a catastrophic brain injury and collapse that was not caused by an accident or a medical disease or condition, and therefore had to have been inflicted upon him. Other evidence showed that Shane was observed by people other than the appellant to be a healthy and normal baby up until the late morning on September 15, 2001; that as of 2:04 p.m. that day when 911 was called he was not breathing and comatose; that in that interval the appellant was the only person alone with Shane, and was the person with him when he suffered his catastrophic collapse. The evidence further showed that the appellant altered his routine on September 15, 2001, by taking Shane to his mother's house, ostensibly because she wanted to see him, although she testified that she did not know her son was bringing Shane to her house that day.

The State's evidence further showed that in the month before Shane's death, the appellant had secretly purchased a \$750,000 life insurance policy on Shane's life, with himself as the beneficiary; that when State Farm required him to also purchase a policy on his own life, he chose one for \$50,000 that did not name Shane (or Paris) as the beneficiary; that he had lied to Paris and Sherman about events surrounding his purchase of the policy on Shane's life, in order to cover up that he had done so; and that the appellant reasonably would have believed that that insurance policy on Shane's life was in effect as of September 14, 2001, the day before Shane sustained his catastrophic brain injuries.

From all of this evidence, a reasonable fact-finder could find beyond a reasonable doubt that on September 15, 2001, the appellant violently shook and/or slammed Shane,

inflicting catastrophic brain injuries that resulted in his death ten days later, and that he did so deliberately, with the intent to kill, and with premeditation. All of this evidence, coupled with the medical evidence establishing that Shane suffered abusive head trauma, was plainly sufficient to sustain his convictions for first-degree murder, child abuse, and child abuse resulting in death.

**JUDGMENTS AFFIRMED. COSTS  
TO BE PAID BY THE APPELLANT.**