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SUPERIOR COURT OF NEW JERSEY

HONORABLE PEDRO J. JIMENEZ, JR., J.S.C.
CRIMINAL DIVISION

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January 7, 2022

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Re: State of New Jersey vs. Darryl Nieves
Indictment No. 17-06-00785; Prosecutor File No. 17000837

Dear Counsellors:

Please find attached to this correspondence my decision concerning the defense motion to bar the admission of testimony regarding "Shaken Baby Syndrome/Abusive Head Trauma." An Order reflecting this decision also accompanies this correspondence.

Respectfully submitted,

P. J. Jimenez J.S.C.

Honorable Pedro J. Jimenez, Jr., J.S.C.
Superior Court of New Jersey

PJJ/EM
Encl. 1 Order

HONORABLE PEDRO J. JIMENEZ, JR., J.S.C.
SUPERIOR COURT OF NEW JERSEY
MIDDLESEX VICINAGE
CRIMINAL DIVISION

DECISION OF THE COURT

STATE OF NEW JERSEY **VS.** **DARRYL NIEVES** **Defendant**	**INDICTMENT NO. 17-06-00785** **PROSECUTOR FILE NO. 17000837** **CRIMINAL ACTION**

FOR THE STATE: Jody Carbone, Esq., Assistant Prosecutor

FOR THE DEFENDANT: Danice L. Rue, Esq., Assistant Deputy Public Defender
Caroline Bielak, Esq., Assistant Deputy Public Defender

DATE: January 7, 2020

FACTUAL BACKGROUND

D.N. is the biological son of Lucy Pham and the defendant, Darryl Nieves. Born on March 9, 2016, he was born prematurely at twenty-five (25) weeks due to complications Ms. Pham began experiencing during her pregnancy. Those complications were triggered by a rear-end automobile collision she was involved in approximately two (2) weeks before D.N. was born, complications which took the form of severe preeclampsia[1] which resulted in her having to be hospitalized. Ms. Pham ultimately gave birth through an emergency caesarian-section procedure because of those complications.

[1] Preeclampsia is high blood pressure in a pregnant woman that can damage the mother's organs and cause death. Preeclampsia often causes premature birth. Ms. Pham suffered pre-eclampsia during her first pregnancy resulting in the birth of her first child, C.P., who was also born prematurely.

D.N. survived the birth but almost immediately began experiencing a plethora of medical issues resulting from premature birth. For example, D.N. was born with underdeveloped lungs and had to be placed on a ventilator with an endotracheal tube in order to breathe. Breathing issues would remain constant with D.N. throughout the first year of his life. In addition to respiratory issues, D.N. suffered from problems with his eyes, his digestive tract, and his development in general. D.N. also had a serious heart condition that required him to undergo two (2) cardiac surgeries within four (4) months of his birth. Ultimately, D.N. remained in hospital care -- between St. Peter's University Hospital and the Children's Hospital of Philadelphia -- until October 2016, a time period accounting for the first seven (7) months of his life.

Once home, D.N. required intense medical attention. The defendant and Ms. Pham were both familiar with the difficulties of raising a premature infant, having previously cared for Ms. Pham's first-born child, C.P. Ultimately things progressed to a point where Ms. Pham returned to working outside the home to support the family while the defendant remained a stay-at-home father to care for the children and the household. During that time, D.N. remained on a well-regulated feeding and medication schedule, which included oxygen being administered at home and regular visits to multiple specialists to aid in his development.

D.N. was progressing until early February 2017, when he was eleven (11) months old. On February 3, the defendant went to change D.N.'s diaper and while doing so, D.N. suddenly went limp and passed out. The defendant attempted CPR by blowing into D.N.'s mouth but without success. An ambulance was called after the defendant subsequently contacted Ms. Pham, but by the time paramedics arrived D.N. was already revived and alert. Refusing the option presented by paramedics to have D.N. brought to the emergency room for further evaluation,

the defendant and Ms. Pham opted to bring D.N. to his pediatrician for examination. The next day, the defendant and Ms. Pham took D.N. to his pediatrician, who advised them that the episode could be caused by D.N.'s "GERD"[2] diagnosis or chronic lung problems.

A few days later, the defendant was again changing D.N.'s diaper when D.N. again went limp and seemed to lose consciousness. Those symptoms were resolved by the defendant administering oxygen to D.N. through the use of the nasal cannula device they had been provided with by the hospital.

A third episode occurred on February 10 while both the defendant and Ms. Pham were home. That morning, the defendant woke up to find D.N. tightening his jaw and appearing unresponsive in his bassinet. He picked up D.N. and brought him to Ms. Pham to show her the symptoms he was observing wherein D.N. would alternate between going stiff then going limp while appearing unresponsive to stimulation. As they called 911, Ms. Pham managed to get a video on her cell phone of the episode D.N. was having. Upon their arrival EMS paramedics administered oxygen to D.N. and transported him to St. Peter's Hospital during which time D.N. regained consciousness as the oxygen was being administered.

Once at the hospital, D.N. was subjected to a myriad of tests which resulted in findings of both old and new subdural hemorrhages, as a result of an imaging of D.N.'s brain doctor's ordered, and extensive multilayered retinal hemorrhages involving both of D.N.'s eyes, as a result of a pediatric ophthalmological evaluation conducted. These physical injuries raised concerns for abusive head trauma since both the defendant and Ms. Pham denied D.N. sustaining any accidental injuries. As a result, a child abuse pediatrician consult was requested to determine

[2] GERD is gastroesophageal reflux disease, which is acid reflux that occurs frequently.

whether D.N.'s acute neurological signs and symptoms, in light of his prior medical history of limpness and unconsciousness, originated from an organic disorder preceding D.N.'s complex neonatal history or from inflicted head trauma, since subdural hemorrhages, retinal hemorrhages, and neurological impairment[3] form the "triad" symptoms pediatricians use to diagnose "Shaken Baby Syndrome/Abusive Head Trauma" (hereinafter "AHT").

Ultimately, Dr. Gladibel Medina, M.D., Medical Director of the Dorothy B. Hersh Regional Child Protection Center, was the pediatrician consulted. Upon reviewing D.N.'s medical records, she concluded in a report she drafted dated April 26, 2017, that despite D.N.'s medical history "Abusive Head Trauma" was strongly supported by the medical facts and caretaker information provided. In her, Dr. Medina concluded that D.N. had been abused due to the presence of the triad symptoms. She concluded her report with her diagnosis of "Child Physical Abuse…specifically abusive head trauma, as occurs with a shaking event with or without impact has been made within a reasonable degree of medical certainty."

Both the defendant and Ms. Pham were subsequently interrogated at the New Brunswick Police Station. The defendant told officers he had not harmed D.N. nor ever shook him. Ms. Pham, likewise, told officers she has never seen the defendant act roughly toward D.N. The defendant has not had contact with the D.N. since February of 2017.

PROCEDURAL HISTORY

On June 30, 2017, Defendant was indicted by a Middlesex County grand jury for second-degree Aggravated Assault in violation of *N.J.S.A.* 2C:12-1b, and second-degree Endangering the Welfare of a Child in violation N.J.S.A. 2C:24-4a. The defendant was subsequently arraigned

[3] Represented by D.N.'s prior episodes of going limp and slipping into unconsciousness.

before the Honorable Judge Rea on July 1, 2017. On July 2, 2018 the defendant filed a motion requesting a *Frye*[4] Hearing to challenge the reliability of Dr. Medina's diagnosis. The State filed its response on August 29, 2018. This Court initially granted the motion on November 2, 2018, but the State filed a motion for reconsideration on July 11, 2019. On September 11, 2019, the Court granted the State's motion and reversed its prior order, however, on October 1, 2019, the Defendant filed a notice for leave to appeal with the Appellate Division.

On October 29, 2019, the Appellate Division vacated this Court's order granting the State's motion to reconsider and remanded the matter for a *Frye* hearing. On September 24, 29, and 30, 2020, and October 12 and 13, 2020, this Court conducted the hearing. The State presented one witness, the testimony of Dr. Medina who, as cited above, diagnosed D.N. with SBS/AHT. The defense presented the testimony of three witnesses: Dr. Joseph Scheller, a pediatric neurologist; Dr. Julie Mack, a radiologist, and Dr. Chris Van Ee, a biomechanist.

SUMMARY OF EXPERT TESTIMONY

I. Dr. Gladibel Medina, MD, CAP

Dr. Gladibel Medina, MD, CAP, serves as Child Abuse Pediatrician and the Medical Director of the Dorothy B. Hersh Regional Diagnostic and Treatment Center. She has served in that capacity for the past 21 years, a tenure which also includes her serving as an Assistant Clinical Professor with the Department of Pediatrics at Drexel Medical School and Rutgers Medical School, as well as Clinical Director of Outpatient Pediatric Faculty Group at St. Peter's University Hospital. She attended the University of Medicine and Dentistry of New Jersey Robert Wood Johnson Medical School, where she also completed her residency in Pediatrics. She is certified

[4] *Frye v. United States,* 293 F. 1013 (D.C. Cir. 1923).

by the American Board of Pediatrics with a subspecialty in Child Abuse Pediatrics. With over twenty-five (25) years of experience in the field of pediatrics, Dr. Medina testified on behalf of the State and was qualified without objection as an expert in the field of "Pediatrics and Child Abuse Pediatrics." Employed by St. Peter's Hospital for over twenty (20) years, she is the professional called upon to clinically evaluate children when there is a concern that they have been subjected to some form of child abuse or neglect. During her employment, she has evaluated approximately four thousand (4,000) cases of suspected child abuse or neglect, diagnosing physical abuse in approximately one thousand, five hundred (1,500) cases. She has also evaluated approximately two hundred and fifty (250) cases for allegations of "Abusive Head Trauma," and has diagnosed this condition in approximately seven percent (7%) of those cases evaluated. She testified that approximately ninety percent (90%) of cases she evaluates are referred to her by the New Jersey Division of Child Protection and Permanency (DCPP).

Qualified in "general pediatrics," Dr. Medina testified that she is also qualified in a sub-specialty identified as "child abuse pediatrics," one only recognized as a sub-specialty by the American Board of Pediatrics in 2009. She testified that under this specialty she is trained to evaluate "child maltreatment" based on her familiarity with, and training in, the biomechanics of trauma through the yearly educational and training conferences she is required to attend in order to complete her medical and professional education credits.

Dr. Medina began direct examination by defining AHT pursuant to the definition set by the Center for Disease Control (CDC) – an inflicted injury of the skull or intracranial contents in an infant or a child under five years caused by violent shaking, blunt head impact or a combination of both. She explained that AHT can include injury, as defined by bruises and

contusions, to the skull; injury to the intracranial structures, which involve the brain; and the vasculature[5] inside the skull, causing hemorrhaging; and injury to nerve tissue. There may also be associated injury with the spinal cord, both the skeleton and appendicular skeleton[6], and sometimes the extremities including bruising. Dr. Medina stated that the presenting symptoms of AHT – what doctors can see an observe on a child – are most frequently altered mental status. Less common are external bruises or physical injuries, but also may include intracranial structure bruising inside the globe of the eye, specifically the retina.

Dr. Medina testified that the initial evaluator identifying AHT is usually a child's pediatrician or an emergency room doctor who sees the child for the first time. On cross-examination, she elaborated that child abuse pediatricians are asked to consider why a child may exhibit certain symptoms or injuries. They go through all the child's records to see whether those symptoms and/or injuries amount to AHT and to rule out every other possible cause before coming to a conclusion.

To diagnose AHT a comprehensive evaluation of the child's medical history is necessary – that is the clinical information regarding what brought the child in to begin with, what the child's demeanor and behavior immediately prior to being seen was, and how the child usually presents. There is also a physical examination followed by consultations with multiple subspecialties in the field of pediatrics and trauma to conduct a comprehensive evaluation of other possible findings that might coexist with how the child is presenting. Dr. Medina further stated that there is an evaluation of possible medical issues that might be a contributing factor to what the child

[5] Meaning the vascular system, also called the circulatory system, which is made up of the vessels that carry blood and lymph through the body. See, https://www.hopkinsmedicine.org/health/conditions-and-diseases/overview-of-the-vascular-system (last visited Jul. 21, 2021).
[6] The appendicular skeleton is the spine and ribcage.

presents with, along with any other findings observed, such as consultation with geneticists when bones are a concern or metabolic disorders, a hematologist, radiologist, or ophthalmologist. These specialists work together to provide child abuse pediatricians a full history of the child's health: medical history, physical findings, laboratory tests, imaging studies, and so on.

Dr. Medina then testified to the origins of AHT. She attested that SBS/AHT has been recognized in medicine for about 160 years. Published medical literature began around the middle of the 19th century with Dr. Auguste A. Tardieu, a French pathologist who identified injuries in children that were believed to be associated with maltreatment by care givers. About 80 years later an English neurosurgeon by the name of Dr. Norman Guthkelch, identified subdural hematoma[7] in children without any external signs of trauma, strongly believed to be associated with physical abuse. Then, in the United States in 1960, Dr. C. Henry Kempe coined the term "battered child syndrome" after observing fracturing and other injuries together with intracranial trauma in children. In the 1970's, Dr. John A. Caffey coined the term "shaken baby syndrome", which was the term used to refer to inflicted trauma in infants caused mainly by a shaking type of injury, but not limited to shaking of the head and/or the upper torso.

Dr. Medina attested that in 2009 the American Academy of Pediatrics broadened the terminology to include all mechanism of injury, not just shaking, officially calling it "abusive head trauma" in a policy statement to include inflicted injury to the head caused by shaking, a combination of shaking and inflicted injury, and crushing injury. Since then, child abuse

[7] A collection of blood surrounding membranes in the brain. See, Medical Dictionary, Merriam-Webster, https://www.merriam-webster.com/medical/subdural%20hematoma (last visited Jul. 7, 2021).

pediatricians use AHT as a diagnosis. However, on cross-examination, Dr. Medina answered affirmatively that there are no specific diagnostic criteria to define AHT: there are only symptoms a child may exhibit when looking to see whether to diagnose AHT.

Despite that, Dr. Medina attested that AHT is widely accepted within the medical community and its validity as a diagnosis has not changed in the past 160 years. It is accepted by all the pediatric subspecialties involving intracranial injury: General Pediatrics, Pediatric Ophthalmology, Pediatric Neurology, Pediatric Neurosurgery, Pediatric Radiology, And Pediatric Neuroradiology. She also testified to the many national and international societies involved in validating the established diagnosis of AHT as causing injuries to the intracranial structures. Those are the American Academy of Pediatrics, the American Academy of Ophthalmology, the American Academy of Pediatric Ophthalmology and Strabismus, the Royal College of Ophthalmology, the Royal College of Pediatrics and Child Health, the Norwegian, Japan and Swedish Pediatric Societies, the American and European Societies for Radiology and Neuroradiology, the Latin American Society for Pediatric Regulatory, the American Professional Society for the Abuse of Children, the World Health Organization, and the CDC.

Still, Dr. Medina stated on the record that while the medical community accepts and has not changed AHT as a medical diagnosis, it has been challenged in terms of the mechanism of shaking within the scientific community studying biomechanics. The original study was conducted in 1968 by Dr. Ayub K. Ommaya[8]. He used adult monkeys as his subjects and exposed them to a single cycle whiplash[9] event without any impact. Dr. Ommaya found that single whiplash event caused concussions in addition to small bruises and subdural bleeds in the

[8] Ayub K.Ommaya, Whiplash Injury and Brain Damage, 204 J.A.M.A. 285, 285-86 (1968).
[9] Dr. Medina explained whiplash or shaking injury is a back-and-forth movement, done violently, at least once.

monkeys. From his study the injury threshold[10] for intracranial injury was established. The force required to generate a concussion for brain injury in a monkey was scaled to adult humans and then attempted to be scaled to infants. The controversy is whether shaking, which has been established to cause injury in primates, can cause the forces needed to generate intracranial injury in infants.

On cross-examination, defense counsel inquired whether it was fair to say that Dr. Ommaya was looking for injuries in his study. Dr. Medina answered, "[t]hat's all we can say." Defense counsel then asked whether there were any eye injuries noted in the Ommaya exam, to which Dr. Medina responded, "[n]o. It was a study on concussion." However, when asked about the studies conducted by John W. Finnie,[11] which used lambs as test dummies on two sperate occasions, Dr. Medina was unsure of the results. She agreed that all of the lambs had spinal injury and two of them had retinal hemorrhages but did not know that when it was recreated for a second time none of the lambs presented with retinal hemorrhages.

Dr. Medina also testified to other biomechanical studies inspired by Dr. Ommaya using different animal models and anthropomorphic dolls[12] subjecting them to shaking injuries. In 1987, Dr. Ann-Christine Duhaime conducted a study[13] using a crash dummy. Dr. Duhaime shook the apparatus to see if shaking alone could reach the thresholds established by the Ommaya study, but found that shaking alone did not generate enough rotational force but shaking with impact did. She concluded that severe forms of AHT causing near fatality necessarily included

[10] Dr. Medina explained the threshold is the amount of force required to generate concussion.

[11] John W. Finnie, et. al., Neuropathological changes in a lamb model of non-accidental head injury (the shaken baby syndrome), Journal of clinical neuroscience: official journal of the Neurosurgical Society of Australasia, 19(8), 1159–1164 (2012).

[12] Dr. Medina stated anthropomorphic dolls are computerized models or crash dummies.

[13] Ann-Christine Duhaime, et al., The Shaken Baby Syndrome: A Clinical Pathological, and Biomechanical Study, 66 J. Neurosurg. 409, 411 (1987).

impact, not just shaking. Dr. Medina continued on that the Duhaime study was confirmed by Michael T. Prange[14], who in 2003 used a different computerized model to conclude that the threshold for intracranial injury by vigorous shaking must produce force like that involved in a short (or higher) distance fall.

On-cross examination, Dr. Medina attested that in 2010 Dr. Duhaime conducted a similar study using different models and attained the same conclusion. She also agreed that since Duhaime's study there has been much debate about whether shaking alone can reach the threshold for injury. Further, Dr. Medina acknowledged that a statement put forth by Dr. Arabinda K. Choudhary[15] also recognizes that there is debate as to whether shaking alone can cause injury, but Dr. Medina attested that there is no debate in the medical community, but rather controversy.

However, Dr. Medina cited to two individual 2016 studies conducted by Carole A. Jenny[16] and C.Z. Cory[17], using different models and changing the shaking pattern. Instead of shaking the doll forwards and backwards, they shook the model in such a way that the head moved in different planes. They also varied the biomechanics of the doll allowing for chin-to-chest impact and occiput-to-back impact. Those studies surpassed the injury thresholds produced by the original Ommaya study. According to Dr. Medina, altering the forces caused discrepancy from a biomechanics standpoint as to what forces cause the minimum established threshold.

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[14] Michael T. Prange, et al., Anthropomorphic Simulations of Falls, Shakes, and Inflicted Impacts in Infants, 99 J. Neurosurg. 143 (2003).
[15] Choudhary, A. K., et. al. Consensus statement on abusive head trauma in infants and young children, Pediatric radiology, 48(8), 1048–1065 (2018).
[16] Carole A. Jenny, et al., Biomechanical Response of the Infant Head to Shaking: An Experimental Investigation, 34 J. of Neurotrama 1 (2017).
[17] C.Z. Cory & M.D. Jones, Can Shaking Cause Fatal Brain Injury? A Biomechanical Assessment of the Duhaime Shaken Baby Syndrome Model, 318 Med. Sci. Law 317 (2003).

The doctor further attested that the Swedish Agency for Health Technology Assessment and Assessment of Social Services (SBU) Report published in 2016 by Niels Lynøe[18] acknowledged that no conclusion can be drawn from biomechanical studies as to the minimal amount of force required to cause infants intracranial trauma. However, Dr. Medina acknowledged that the SBU report only accepted medical literature for its study that could be validated in terms of inflicted trauma in children: that is, it only relied on video recordings, tapes, or confessions of abuse. The SBU report also did not include an ophthalmologist or a neuro-ophthalmologist in its evaluation of the evidence, even though retinal hemorrhages was one of the main findings disputed. Also, Dr. Medina pointed out during her testimony that out of all the literature reviewed only two pieces were qualified for use – separate studies conducted in 2010 by Catherine Adamsbaum[19] and Matthieu Vinchone[20]. Still, Dr. Medina continued her testimony by reading part of the SBU report, "The studies by Adamsbaum and Vinchone were deemed to be of moderate quality. Although both studies have methodological limitations, they support the hypothesis that isolated traumatic shaking can give rise to the triad."[21]

Lastly, as it pertains to medical studies, Dr. Medina testified that a 2019 study conducted by Angell Shi[22] found that the conclusions from the various biomechanical studies are so diverse that there cannot be a true consensus as to the necessary force needed to produce the threshold. The scaling down of intracranial trauma from primates to adult human brains has not been

[18] N. Lynøe, et. al., Insufficient evidence for 'shaken baby syndrome' - a systematic review. Acta Paediatr 2017; 106: 1021-7.
[19] C. Adamsbaum, et. al., Abusive Head Trauma: Judicial Admissions Highlight Violent and Repetitive Shaking, Am. Acad. Pediatrics, 2010; 126: 546-55.
[20] M. Vinchone, et. al., Confessed Abuse Versus Witnessed Accidents in Infants: Comparison of Clinical, Radiological, and Ophthalmological Data in Corroborated Cases. Childs Nerv. Syst., 2010; 26: 637-45.
[21] Dr. Medina testified that the triad identifies subdural bleeding, retinal hemorrhages, and neurologic signs (or encephalopathy) as symptoms associated with inflicted head injury in infants, *infra*.
[22] Angell Shi, et al., Retinal Findings in Young Children with Increased Intracranial Pressure from Nontraumatic Causes. *Pediatrics*. 2019; 143(2); e20181182.

validated. Neither has it been from adult human brains to infant brains and infant brains are significantly different than adult brains. Thus, in terms of biomechanics, the injury threshold required to cause injury to an infant's brain is unknown. Therefore, Dr. Medina stated that both physicians and scientists can only scale down and make assumptions. Regardless of the controversy in the field of biomechanics, Dr. Medina attested that the medical community still recognizes AHT, and it is accepted as a mechanism of injury for intracranial trauma in children.

Dr. Medina continued her testimony discussing the medical diagnosis called Benign Enlargement of the Subarachnoid Space or BESS, which is known for putting infants who are less than two years old at increased risk for subdural trauma[23]. BESS is a known medical diagnosis associated with trauma to bridging veins with minimal movement. It is called benign because it does not cause any outward signs of trauma in the child.

Using a diagram of the intracranial structure – the brain and skull – provided for by the State's Exhibit marked "S11," Dr. Medina explained how BESS effects infants. The brain sits in a space surrounded by three layers of membranes, the closest membrane to the brain is the pia, which tightly adheres to the brain itself. Above the pia is the arachnoid membrane, a space between the pia and the dura that is filled with cerebrospinal fluid. Above the arachnoid membrane is the top layer of membrane, the dura, which protects the dural sinus[24]. The arachnoid membrane usually carries four millimeters of cerebrospinal fluid in infants, however a child who presents with BESS shows an increase in fluid of about seven millimeters or higher.

[23] Dr. Medina explained subdural trauma is trauma to bridging veins that connect from the brain to the dura (the sinus drainage).
[24] Any of numerous venous channels (as the sagittal sinuses, straight sinus, and transverse sinuses) that are situated between the two layers of the dura mater, that have no valves, and that drain blood from the brain and the bones forming the cranium and empty it into the internal jugular vein. See, Medical Dictionary, Merriam-Webster, https://www.merriam-webster.com/medical/sinus%20of%20the%20dura%20mater (last visited Jul. 7, 2021).

Further, there are many bridging veins that traverse the surface of the brain to the dural sinus, which run in a sagittal direction in the head. When the arachnoid membrane is increased even by just a few millimeters there are about fifty or so bridging veins under tension which can sometimes spontaneously break. As a result, doctors believe that movement of the brain in the intracranial cavity are more likely to injure infant brains. Although it is uncommon, a child who presents with BESS may have been predisposed to trauma because the vessels are under stress and movement of the brain within the intracranial cavity can tear with movement.

Dr. Medina attested, however, that BESS is usually not associated with an altered mental state. So even though both BESS and shaking can produce stretching and tension causing breakage, there is a difference in the diagnosis. To make an assessment, one must look at the entire clinical picture. A doctor should never make a diagnosis of AHT based on one finding, e.g.: if a child presents with an enlarged subarachnoid space but is otherwise healthy, has subdural trauma of unknown etiology, the parents have no explanation, and there is no history of trauma that would not be considered AHT.

As Dr. Medina previously stated in her testimony, *supra*, to flag a concern for AHT medical professionals rely on the "triad" to conduct further investigation. The triad presents as (1) subdural hemorrhages, (2) severe retinal hemorrhages, and (3) any neurological presentation, known as encephalopathy, which presents as unresponsiveness, apnea, seizures or altered mental status. A subdural hemorrhage or hematoma is bleeding collecting outside of the vasculature under the dural membrane, most commonly from minor or significant trauma. Normally, there is only a subarachnoid space in the membrane – there is no subdural space.

However, there is potential for a subdural space to be created when there is blood vessel damage, leakage of blood from blood vessels, and collection of blood in that area.

Dr. Medina attested, that there are different types of subdural hemorrhages and hematomas as it pertains to the cause of the bleeding, but not in terms of the location. A subdural is unique to the subdural space (or creation of the same) mostly caused by trauma from birth. About 1/3 of infants born whether by vaginal delivery, caesarean section or assisted delivery will have a subdural hemorrhage. Those usually resolve a month after birth. A subdural associated with trauma in terms of motor vehicle accidents or falls, like those associated with BESS that are incidentally found with no concerns for the wellbeing of a child's physical presentation, is also common. Subdural hematomas on their own are not a diagnosis of abuse, but they can be when combined with other abnormalities, such as retinal hemorrhages.

Dr. Medina continued her testimony explaining the eye and retinal hemorrhages. She described the eye as a globe, with the color of the eye in the center, surrounded by three walls, which is the retina. In the center of the color is the vitreous, which is a jelly-like substance attached to the macula. That is the back of the eye. Retinal blood vessels traverse the periphery of the back of the eye all the way to the front. Retinal hemorrhages are bleeding from blood vessels in the macula that extend to the front of the eye. In medical literature[25] retinal hemorrhages are associated with acceleration/deceleration rotational forces created by shaking and some posterior impact to the head. The vitreous pulls against the retina causing rupture of

[25] Dr. Medina referenced, Exhibit S-18, a 2015 official statement by the American Academy of Ophthalmology, to validate her testimony that the presence of severe retinal hemorrhages of the pattern she described is specific to inflicted head injury when all else has been taken into consideration and ruled out.

the retinal vessels. That is the most common form of retinal hemorrhages when it comes to trauma.

Dr. Medina attested that subdural hemorrhages identified in a child with severe[26] retinal hemorrhages raise a greater concern for AHT. While retinal hemorrhages can also be caused by disease[27], illness, accidental trauma, or inflicted injury, the doctor stated there is no disease, illness, or condition that yields the pattern[28] that is seen in traumatic injury, unless it is hyperacute intracranial pressure[29], e.g.: a ruptured aneurysm. The retinal hemorrhage pattern in traumatic injury is seen in all three layers of the retina and are too numerous to count. It is not just confined to the back of the eye where the optic nerve[30] comes in but also to the periphery all the way to the front of the eyeball[31]. Further, because retinal hemorrhages clear rapidly doctors can presume that when intraretinal hemorrhages are found in the eye an insult took place within two weeks[32].

[26] Dr. Medina qualified severe as retinal hemorrhages that are multi-layered or too numerous to count.
[27] Dr. Medina referenced Exhibit S-14,"Prevalence of retinal hemorrhages in critically ill children," by Shruti Agrawal, M.D., et. al, from a 2012 medical article to corroborate that children who presented to intensive care units from illness with severe multi-layer retinal hemorrhages were rare.
[28] Dr. Medina also referenced Exhibit S-13, "The Eye in Child Abuse: Key Points on Retinal Hemorrhages and Abusive Head Trauma" published in 2014, by Gil Binenbaum, M.D., et. al., to corroborate that retinal hemorrhages have been described in both accidental and non-accidental trauma, as well as illness, and disease, but the patterns present different.
[29] Dr. Medina referenced Exhibit S-16, "Retinal Findings in Young children with Increased Intracranial Pressure from Non-Traumatic Causes," published in 2019 by Angell Shi, M.D., et. al., to support the conclusion that retinal hemorrhages rarely occur in the absence of a sign of increased intracranial pressure, e.g.: an aneurysm. The rapid increase in intracranial pressure accounts for the retinal hemorrhages seen in those scenarios, whereas, when a child is brought in with subdural bleeding and no other observable injuries by MRI or CT and there is a pattern of retinal hemorrhages – no intracranial pressure - something else had to occur to cause that pattern of retinal hemorrhage.
[30] The optic nerve is a paired cranial nerve that transmits visual information from the retina to the brain. See, Medical Dictionary, Merriam-Webster, https://www.merriam-webster.com/dictionary/optic%20nerve. (last visited Jul. 9, 2021).
[31] Dr. Medina named the three layers of the retina – preretinal, intraretinal and subretinal.
[32] Dr. Medina referred to Exhibit S-15, "The natural history of retinal hemorrhage in pediatric head trauma", by Dr. Gil Binenbaum, et. al., published in 2013, that concludes intraretinal hemorrhages clear rapidly – within days or up to two weeks. Other types of hemorrhages, such as, subretinal, preretinal, etc. take longer. Therefore, when intraretinal hemorrhages are found in the eye, doctors can presume that an insult took place within two weeks.

During both direct and cross examination, Dr. Medina testified that retinal hemorrhages have a strong association with shaking to a specificity of 96% in confessions by perpetrators who only shook a child. However, she conceded the retinal hemorrhages were only found in cases where abuse was already confessed to law enforcement. Dr. Medina attested that because retinal hemorrhages were already found in those cases, it is the strongest evidence to support the association between retinal hemorrhages and shaking. Nevertheless, on cross-examination when defense counsel mentioned the nanny cam study by Randy Papetti[33] where no confessions were given but video footage showed different children being shaken and upon their physical examination no retinal hemorrhages where found, Dr. Medina testified that not every case of shaking will present with retinal hemorrhages. When further asked by defense if she believed that pure shaking could cause subdural hematomas, even though in the nanny cam cases not one child who was shaken presented with severe retinal hemorrhages, Dr. Medina answered yes.

As it pertains to the matter at hand, Dr. Medina testified that she was asked to conduct an evaluation of D.J. on February 15th, 2017, five days after he was admitted to St. Peter's Hospital. D.J. was brought to the hospital on the February 10th due to an episode of unresponsiveness at home while under the care of his parents. He was eleven months old at the time and remained hospitalized for three weeks thereafter. His parents reported that he was getting a diaper change and suddenly went limp. They contacted 9-1-1 because he appeared to be having a seizure-like episode. D.J. was then brought to the hospital. A CT scan was performed where doctors found subdural, subacute, and chronic subdural hemorrhages. This raised concern

[33] Randy Papetti, Paige Kaneb & Lindsay Herf, *Outside the Echo Chamber: A Response to the "Consensus Statement on Abusive Head Trauma in Infants and Young Children"*, 59 Santa Clara L.Rev. 299 (2019).

because seizures are usually not a cause for subdural hemorrhages, even though subdural hemorrhages can cause seizures.

Dr. Medina attested that doctors started to evaluate D.J., looking for any other potential abnormalities. He had an ophthalmological exam that revealed severe multilayered retinal hemorrhages in both eyes. That is when the hospital contacted the Department of Child Protection and Permanency (DCP&P), and both contacted the Dorothy B. Hersh Child Protection Center at St. Peter's Hospital to assist in the evaluation of D.J., were Dr. Medina works. On cross-examination, Dr. Medina agreed that DCP&P requested Dr. Medina determine the nature of D.J.'s injuries based on the diagnoses already established by specialist. She denied being brought in to look for abuse, rather she attested she was brought in to ensure a comprehensive evaluation of the case. However, she did affirm child abuse pediatricians are called on when there is a concern of abuse to make a diagnosis.

Dr. Medina testified that when she initially[34] examined D.J. she found he was developmentally delayed, as expected for a preemie[35]. On redirect, she testified that in cases of AHT the developmental age is important because kids that are ambulatory have higher incident rates for accidental impact without the parents knowing or being aware of it. Developmentally D.J. was about 3 to 4 months even though he was 11 months old chronologically. At that developmental age, infants cannot really ambulant so any history of an accident would have to have been observed by the caretakers. Dr. Medina further attested that also had a condition called global hypotonia, which is low muscle tone due to his prematurity. Dr. Medina stated that

[34] Once the subdural and the retinal bleeding were identified, Dr. Medina first met with his parents and evaluated D.J.
[35] For example, on record, Dr. Medina stated D.J. was smiling and babbling, but at eleven-months-old, developmentally he was only at the stage of a three-to-four-month-old, e.g.: he was starting to roll over, but did not have good head control.

in terms of inflicted injury, D.J. did not have the strength of his muscles, particularly in his neck, meaning that if he was shaken his head would go in different places easier than an older baby, leaving more potential for injury.

She recommended D.J. have a comprehensive metabolic evaluation completed. She asked the treating medical team to have a geneticist look for a metabolic condition that could potentially be associated with subdural bleeding and retinal hemorrhages. Additionally, because of the bleeding abnormalities, D.J. required a full hematological consultation to ensure that he did not have any underlying coagulation issues that could account for the retinal and subdural bleeding identified.

Dr. Medina stated that D.J. was diagnosed by neuroradiology with subdural bleeding. He also had some areas of atrophy[36] on his brain, which could predispose him to having subdural collections. A pediatric ophthalmologist diagnosed him with severe retinal hemorrhages consistent with inflicted head injury. D.J. was also evaluated by neurosurgery and neurology by way of video electroencephalogram (EEG), which records electrical activity of the brain, because he was originally brought into the hospital for seizure-like activity. There were no seizures recorded on video EEG. Further, during the three-week period that D.J. was hospitalized neither the neuroradiology department, treating staff, nor floor staff observed any at any point in time. However, on cross-examination Dr. Medina affirmed that while the EEG did not find any evidence of seizure like activity, D.J. was admitted into the emergency room because he presented with seizure-like activity, including vomiting.

[36] Volume loss

Dr. Medina attested that D.J. had a follow-up ophthalmological study with the retinal specialist revealing no new retinal hemorrhages, only residual retinal hemorrhages from the specialist's previous finding. D.J. also had a follow-up with hematology. There was no metabolic disorder that was identified impacting D.J.'s physical findings, nor did hematology find evidence of a bleeding disorder contributing to his bleeds.

On cross-examination, Dr. Medina acknowledged that assessing AHT is a multi-disciplinary team effort for which all possible causes are considered by her in this case, the child abuse pediatrician, the ophthalmologist who reported on D.J.'s retinal hemorrhages and the neuroradiologist who reported on his subdural hemorrhages. She further affirmed that no biomechanist was part of this team, nor was one consulted. When asked by the defense whether the team ever sat down and meet, Dr. Medina answered no. However, she testified that she did speak to all the specialist, except for the retinal specialist, even though nowhere in her report did she indicate having spoken to any of the experts. She later attested that it is part of her routine practice to talk to the multi-disciplinary team that takes care of the child.

Also, during cross-examination, Dr. Medina was asked about her meeting with D.J.'s parents. Specifically, if she had asked them whether D.J. had been in an accident or had any accidental injuries. She attested that they could not think of any, but that they both had mentioned that D.J.'s half-brother had been jumping in the crib with him the month prior. On re-direct, Dr. Medina explained that D.J.'s retinal hemorrhages were acute, and the subdural collection could be consistent with minor trauma, but not the retinal hemorrhaging.

Dr. Medina further stated that during his evaluation D.J.'s parents reported that he had similar episodes two weeks prior to being admitted to St. Peter's Hospital occurring over a period

from February 3rd through February 10th, 2017. Dr. Medina stated all of the episodes described to her by his parent's occurred when D.J.'s father was the primary caregiver. The first episode[37] on February 3rd was the first time D.J. became unresponsive during a diaper change. His father told Dr. Medina that he blew air into D.J.'s mouth, called D.J.'s mom, and then EMS. When EMS arrived D.J. was better so his parents took him to his pediatrician. The pediatrician suspected D.J. may have had a bout of acid reflux causing D.J. to choke. D.J. was on reflux precautions for two weeks, meaning he was to keep his head elevated to avoid vomiting. His parents reported that he was a little more irritable during those days and vomiting about twice a day. Subsequently, on February 8, 2017, D.J.'s parents reported to Dr. Medina that again while getting a diaper change D.J. went limp. This time the episode resolved after a "blow-by" – oxygen administered to the face and nose – but he was not taken to the hospital.

Dr. Medina attested to reviewing almost all of D.J.'s medical records from birth, to surgical procedures conducted at Children Hospital of Philadelphia (CHOP) and subsequent records at St. Peter's. Dr. Medina testified that D.J. had a very complicated birth history. In March of 2016, D.J. was born extremely premature at 25 weeks in St. Peter's Hospital. He stayed in St. Peter's until May of the same year, and then was transferred to CHOP for his first cardiac surgery for Patent Ductus Arteriosus (PDA) – abnormal openings in the heart. CHOP repaired two PDA's, one in May and the other in July. D.J. was transferred back to St. Peter's in May but stayed in CHOP after his July surgery until sometime in October of 2016. He was then transferred back to St. Peter's from where he was discharged about a week later.

[37] Note that Dr. Medina misstated the date of D.J.'s first episode. In Frye Hearing transcript it reads, in pertinent part, "The first episode on February 10th [. . .]." Transcript of Oral Argument at 85, State of New Jersey v. Darryl Nieves, September 24, 2020.

Dr. Medina testified that the records from CHOP were important to review because D.J.'s mother was concerned that he was being administered an anticoagulant medication during each of his stays there. If that were true, Dr. Medina stated it could have been a contributing cause to the bleeding observed in his brain in February 2017. However, the record from CHOP showed there was no medication administered containing an anticoagulant. When D.J. was discharged for the second time from CHOP in October, he was prescribed mostly diuretic heart medications.

Dr. Medina also attested that from birth D.J. had mild retinopathy – abnormally growing blood vessels in the back of his eye. At six months CHOP reevaluated the retinopathy and he was found to have healthy mature retinas without any abnormalities. In terms of his altered mental state, from birth Dr. Medina testified that D.J. was a healthy baby. For example, there were no concerns of seizure-like activity until these events in February 2017. Prior to his 2017 admission he was never prescribed medication, and again, the EEG showed no clinical evidence of seizure disorder. As it pertained to his altered mental status this was the only relevant finding. Further, the irritability, vomiting, and not being himself, reported by his parents did not present during the three weeks that he was hospitalized in 2017.

On cross-examination, counsel inquired about D.J. being a "pretty healthy" baby. Dr. Medina agreed that premature babies have more medical problems than full-term babies' there can be more neurological problems than full-term babies as their systems have not been fully developed; and agreed the same is true as it pertains to the digestive system – premature babied can have more problems with regurgitation, vomiting and breathing. Dr. Medina agreed that regurgitation and vomiting can lead to obstruction of airways. She also answered affirmatively that the protective reflexes are not as well developed in premature babies as it is in a full-term

babies' causing delayed responses. Dr. Medina also agreed that subdural hematomas occur more often in premature male babies occur than female, and male premature babies are more likely to develop other issues later in their lives, even years later.

Dr. Medina testified that she was not able to review D.J.'s pediatric records. However, she stated that reviewing those records would have been helpful to her diagnosis due to D.J.'s head circumference size. From birth through seven months, D.J. had three neurosonograms: one at two weeks, one month and at three months, then again at six months at CHOP. Neurosonograms are used for imaging of infant brains when born with an open fontanelle to look at the intracranial cavity. The neurosonograms conducted at St. Peter's did not reveal any subdural hemorrhaging. D.J.'s subarachnoid spaces looked normal as did his brain structure. He had been tracking along the 25th percentile on a corrective age chart due to his prematurity.

Nevertheless, CHOP reported his head circumference between the 25th and 50th percentile. D.J.'s head circumference measurements from his pediatrician would have helped to confirm how his head circumference was tracking before and after his stays at CHOP. That is, blood that has remained in the head tends to enlarge the head just as other abnormalities in the brain may. So, D.J.'s pediatric chart could have helped Dr. Medina to assess the accuracy of CHOP's measurement. Still, the ultrasound conducted at CHOP reported normal, and since Dr. Medina did not receive his pediatric records, she could only make note that from his discharge from CHOP his head circumference was larger. She testified that receiving his pediatric file would not have changed her ultimate diagnosis.

On cross-examination Dr. Medina attested that she never took D.J.'s head-circumference herself but relied on St. Peter's previous recordings and the records from CHOP provided to her

by DCC&P. Dr. Medina said she tried several times to get D.J.'s pediatric medical records but could not get a hold of them due to HIPPA. However, she answered affirmatively that she never asked the prosecutor's office about trying to obtain those records, even though she qualified the records as being of great importance. Dr. Medina testified that she did not know who oversaw the case, even though she later attested to meeting with the assistant prosecutor at the time, Vanessa Craveiro.

Dr. Medina further testified that her ultimate diagnosis of AHT, with or without impact, was based on all the history she reviewed. On cross-examination, Dr. Medina confirmed that with impact would mean D.J. was shaken and hit against something. She also acknowledged that D.J. had no bruises anywhere on his body or face, nor any broken bones or ribs. The doctor agreed with defense that there was no indication that D.J. was hit against anything.

When Dr. Medina spoke to D.J.'s parents, they denied any history of accidental trauma. Nevertheless, Dr. Medina noted D.J. presented to the hospital with an altered mental status, subdural, and retinal hemorrhages in a severe and usual pattern associated with AHT. Her diagnosis was made after all the subspecialist's examined D.J. and provided their diagnosis. There was no other explanation for his presentation. The presence of D.J's specific findings were not accounted for by a metabolic disorder, an accident, or any intracranial pressure. Dr. Medina attested that everything else was ruled out by the treating providers.

On cross-examination, defense counsel pointed out that in the medical report Dr. Medina wrote for D.J. she noted that the retinal hemorrhages and subdural bleeding he suffered were not the result of seizures, CPR, vaccinations, coughing, or acid reflux, to which Dr. Medina agreed. Defense counsel next states that Dr. Medina did not cite to anything in making those conclusions,

to which Dr. Medina also agrees, but says that there are no studies with seizures or CPR that have shown the pattern of severe retinal hemorrhages she described. However, the defense notes that she did not write that in her report, nor is there anything cited about the conclusions she came to.

Defense counsel continued this line of questioning, noting that in Dr. Medina's report she wrote that tearing of the bridging vein in D.J.'s brain caused his subdural hematomas and asked what study shows that that a tear in the bridging vein causes subdural hematomas? Dr. Medina answered that there is no study. She stated that the assumption is, for conditions such as BESS, that the increased diameter of the subarachnoid space places tension on the bridging veins and causes them to rupture on the dural end of the membrane. Dr. Medina affirmed that there is no known amount of force necessary to tear the bridging veins – that is there is no known injury thresholds for infants.

Lastly, Dr. Medina was asked why she ruled out certain injuries in her report, such as seizure and hematological issues, but never indicated that BESS was considered? Dr. Medina was insistent that it was considered. She stated that she referred to BESS in her report where she wrote D.J.'s extra-axial spaces were normal – Dr. Medina testified that extra-axial space refers to BESS. Defense counsel asked why the doctor did not write that in her report as an alternative explanation, for which Dr. Medina replied that it did not apply to D.J. Defense probes Dr. Medina further, asking, "[b]ut you don't write that, do you?" Dr. Medina responded, "[w]hy do I have to write it if he doesn't have it?"

On redirect, the State noted that it asked Dr. Medina specifically about the extra-axial spaces, and whether it was felt to be enlarged by the radiologists that read images or scans. Dr.

Medina responded that neither she nor the radiologist had access to this record of D.J.'s so it was not included as part of her review and comparison. She further testified that she wrote in her report that if there is any information not seen to contact her if that information would clarify anything about D.J. or his record, so that the team can go back to review. Dr. Medina was further asked why BESS does not apply to D.J.'s case to which she testified BESS was not brought up on the case. Dr. Medina stated on the record that BESS is not indicated with retinal hemorrhages in the pattern presented with, not is it associated with altered mental state.

II. Dr. Joseph Scheller, MD

Dr. Joseph Scheller is a child neurologist who is currently employed in private practice in Baltimore, Maryland, after serving as a staff neurologist at various hospitals from 1987-2012, with the most recent being Children's National Medical Center. Having graduated from medical school at the University of Illinois in Chicago, he completed his residency in pediatrics at the Children's Hospital in Detroit, Michigan, followed by fellowships in neurology at University Hospital in San Diego, California, in epidemiology at the National Institute of Neurological Disorders and Strokes, National Institutes of Health, and neuroimaging from Winchester Medical Center. Dr. Scheller is certified by the American Board of Pediatrics in pediatrics, by the American Board of Psychiatry and Neurology in child neurology, and by the United Council for Neurological Subspecialties in neuroimaging. Additionally, he was previously certified in electrophysiology. Dr. Scheller has been admitted as an expert in various courts and in various states. With over thirty-eight (38) years of experience in pediatrics and neurology, and over the objection by the State as to neuroimaging, the Court found Dr. Scheller to be a qualified expert in the field of pediatric neurology and neuroimaging and testified on behalf of the defense.

On direct examination, Dr. Scheller attested that he has studied and reviewed SBS/AHT cases for about 20 years. He stated he is aware of the modern debate and historical development of AHT. He testified that Child abuse experts like Dr. Medina diagnose AHT when a suspicion of abuse arises by a referring doctor. Dr. Scheller testified that the child abuse expert diagnoses AHT based on symptoms and findings that have no other explanation. As an example, he attested that if a child presents with a skull fracture and nobody has an explanation for it, a child abuse doctor may diagnose AHT.

Dr. Scheller testified that the public is educated about SBS/AHT through websites such as the American Academy of Pediatrics and CDC websites. He also attested to a website devoted to shaking - "dontshake.org." He mentioned that many states require by law new mothers to watch videos about the dangers of shaking a child because it can cause a tremendous amount of harm. However, Dr. Scheller attested that medical and scientific understandings change over time. He opined that every couple of years something very dramatic is learned about a very common disease that medical professionals had no idea they did not fully understand.

For example, Dr. Scheller stated on the record that when he finished medical school in 1982, he was sure people got ulcers because of stress. However, later in the 1980s, an Australian doctor wrote a paper that stated ulcers may be caused by bacterium. That paper was ridiculed by doctors, but in the mid-1990's after continued studies that doctor was able to change the medical perception through his studied that ulcers are caused by bacteria and not stress. He later received a Nobel Prize in medicine for having accurately found the true cause of ulcers.

Next, Dr. Scheller testified about the history of SBS/AHT by laying the foundation for his knowledge. Dr. Scheller stated on record that every pediatrician learns about the history of AHT,

as well as pediatric neurologists because it involves traumatic brain injury. Dr. Scheller stated that in 1971, Dr. Guthkelch, a neurosurgeon[38] encountered a problem where a group of newborns – infants in their first few months of life – were found to have subdural hematomas. At that time, it was known that subdural hematomas come from impact injury to the head, such as when a child falls off their skateboard and hits their head, but there was no evidence of impact injury in these infants. So, Dr. Guthkelch proposed perhaps subdural hematomas came from violent shaking. That is, if a parent or caretaker violently shakes a two-to-six-month-old, perhaps that in addition to impact injury, intense shaking can cause subdural hematomas as well.

Dr. Scheller next attested to Dr. Caffey's study in 1974 who recognized that there were abused children going undiagnosed by pediatricians. He was presented with several cases of what he thought was shaken whiplash syndrome - children shaken in such a way that they presented with subdural hematomas and neck injury from whiplash. He wrote his 1974 paper on children that he believed were shaken because they had several injuries including subdural hematomas and retinal hemorrhages. However, he only suspected that they were shaken because they did not have evidence of impact to the head, which is the number one cause of an acute subdural hematoma.

Dr. Scheller went on to explain that Dr. Caffey coined the term triad – loss of consciousness or alteration of consciousness; an acute, subdural hematoma; and retinal hemorrhages. Dr. Scheller testified that the idea of SBS was popularized by Dr. Caffey and accepted as true. Since then, pediatricians in the United States have been taught that SBS is just

[38] A neurosurgeon is a physician who specializes in the diagnosis and surgical treatment of disorders of the central and peripheral nervous system including congenital anomalies, trauma, tumors, vascular disorders, infections of the brain or spine, stroke, or degenerative diseases of the spine. See, https://www.urmc.rochester.edu/highland/departments-centers/neurosurgery/what-is-a-neurosurgeon.aspx (last visited Jul. 26, 2021).

a known fact. If one violently shakes young infants, one can produce three characteristics: a loss of consciousness or alternation, a subdural hematoma, and retinal hemorrhages. However, nearly two decades later, his study was criticized because the children in the study presented with all sorts of injuries, and he did not know what actually happened to them. Critics said he drew a conclusion based on an assumption, not really knowing that the assumption was true.

Dr. Scheller next testified about Dr. Ommaya's whiplash study conducted on monkey's where many of the monkeys suffered whiplash injury with impact. He attested that during the autopsy of the monkey's that died, small, symmetrical subdural hematomas were documented, however none of the monkey's sustained the triad.

Dr. Scheller was next asked by defense counsel how he would attempt to prove that shaking alone could cause the trial, had he been a doctor in the 1970's. Dr. Scheller responded that there was and still is only three ways to prove the triad. First would be to find an animal model that is legal to use that could be shaken and try to produce those same findings. Second would be to produce a baby crash test dummy model that could be shaken violently and measure the forces that are going on inside the infant's head and neck. The final way would be to find witnesses who could attest to someone violently shaking a baby or in modern times catch them on video to be able to examine if there is subdural hematoma, retinal hemorrhages, and a loss of consciousness. Dr. Scheller testified that one of the above three methods would all be acceptable to confirm the theory of SBS exists.

When asked, Dr. Scheller testified that biomechanical studies are ways to measure forces. For example, it is known that seatbelts work because an average size crash test dummy was used to crash into a wall to observe exactly what happened on impact. That is, studies examined where

the body goes, what if any bones were hit and where the stress and force come from. Dr. Scheller explained using a crash test dummy measures how much force is inside and outside whereas with an animal model it is more about what happens to the brain when something causes a certain amount of force. These biomechanical models can be used to measure any type of trauma or impact.

Dr. Scheller continued on the record that the first biomechanical study of shaking alone was done in 1987 by a neurosurgeon named Dr. Duhaime. By that time, pediatricians had been diagnosing SBS for about 7-10 years. Using a model that she created, Dr. Duhaime could not generate forces in the test dummy's head that were powerful enough to create a subdural hematoma. Dr. Scheller attested that since then, there have been other similar studies conducted that have not been able to produce forces great enough to cause subdural hematoma with shaking alone. However, he also attested that there is no biomechanical study that positively shows shaking can cause a subdural hematoma. SBS has not been proven by using a crash test dummy baby or animal models.

Dr. Scheller testified that the idea of shaking a baby and causing harm is not difficult to conceive. The average baby at birth is about seven pounds, which on its own suggests that violent shaking by an adult would cause an infant harm. In contrast, the average adult weights over 100 pounds, making it difficult to surmise that violent shaking could cause them serious harm. As such, injury from shaking depends on the size of the person performing the action. While Dr. Scheller attested that he does not know what happens when an average adult violently shakes an infant 6 months or younger, he opined it cannot be a good thing. Dr. Scheller testified that no

one knows for sure what happens because there are no reports of witnessed cases where subdural hematomas, retinal hemorrhages or neck injury have been identified.

Dr. Scheller, attested that SBS was widely accepted from about the late 1970's through the 2000's but today there is a lot more discussion, criticism, and analysis about the validity of the diagnosis due to the lack of scientific data. He stated that for almost any other disease or medical problem, there is quite good scientific data, but for AHT the scientific data is sorely lacking. Dr Scheller acknowledged that there is growing controversy within the medical community about whether shaking alone can cause the triad

As it pertains to video recordings of shaking events, Dr. Scheller testified that there are about twenty events that he is aware of caught on video and either published in a newspaper or uploaded on to a social media website such as YouTube. He stated that of the recorded shakings none of the children developed subdural hematomas, none developed retinal hemorrhages, and none developed seizures. Dr. Scheller affirmed that there are no cases of children who have died, nor are there any objectively confirmed cases of shaking that resulted in the triad as of 2020. To his knowledge, there has not been any reported cases in the world.

Dr. Scheller also attested that there is a difference between a confession and medical history. Medical history is some piece of information freely given by a patient or caregiver of a patient when asked what brings them to the see doctor. Whereas situations and backgrounds of confessions are different. Confessions are not necessarily freely given the way someone may give their medical history; there may be a tremendous amount of pressure, coercion, and inaccuracies present during a confession. Further, Dr. Scheller stated that a confession is not medical evidence

because it is information presented to non-doctors about events and circumstances that are not necessarily medical history.

Subsequently, Dr. Scheller testified about circular reasoning. He stated that circular reasoning is the idea that what one started with becomes the conclusion. Rather than concluding based on the facts that become present, the conclusion is based on the original idea itself. To illustrate, Dr. Scheller used tattoos as an example. He explained that he sometimes goes into prisons to evaluate patients who have neurological problems, and he learned from his experience that criminals often have tattoos. With this knowledge in mind, he could go out into the world and see someone on the street that has a tattoo, and then assume that person is a criminal because the criminals in prison he has worked with also have tattoos. Dr. Scheller testified that this is circular reasoning – a person sees something in a certain environment that is bad and assumes that any time they see the same thing in a different environment that it is also something bad. He said he would not trust a medical study that relied on circular reasoning.

Dr. Scheller further testified that he agrees with the criticism that the vast majority of papers that draw conclusions regarding what is known about SBS/AHT are tainted by circular reasoning. That is because, when a patient is found with retinal hemorrhages doctor's immediately start looking for other evidence of abuse. When other evidence of abuse is discovered, doctors validate the theory that retinal hemorrhages are associated with abuse. According to Dr. Scheller's testimony, that is not necessarily true. The presence of retinal hemorrhages triggered the doctor to look for abuse as opposed to naught.

Similarly, Dr. Scheller testified that the study conducted by Matthieu Vinchon of confessions uses circular reasoning. In his conclusion, Vinchon concluded that severe retinal

hemorrhages are always or almost always connected with the conclusion of abusive head trauma. Dr. Scheller explained that Vinchon was pursuing patients, in part, to look for abuse in cases where he had found retinal hemorrhages, but if one finds the retinal hemorrhages, they cannot conclude that the retinal hemorrhages point to something else. But, Vinchon concluded based on what he started with rather than starting with an open mind that perhaps anything could cause retinal hemorrhages.

Dr. Scheller continued his testimony explaining diagnosing patients. He stated the gold standard for diagnosing patients is conducting numerous tests to make a diagnosis based on a positive result(s). He suggested testing before and after a diagnosis is made would be the best way to confirm a diagnosis is correct. For instance, if a patient is tested for COVID-19 and there is evidence of the virus in their nose, then a couple of months later there is evidence that s/he has the antibody, that would be the gold standard for proving they had COVID.

Dr. Scheller attested that there is no gold standard for AHT and that AHT as a diagnosis is up for debate. Disease or illness such as diabetes, high blood pressure, cardiac arrest, or ulcerative colitis are all medical diagnoses. Abusive Head Trauma is much vaguer than that, and so there is discussion about whether it is a medical diagnosis or not amongst child abuse experts. Dr. Scheller further testified that an article written by Dr. Geoffrey D. Debelle[39] together with doctors on the Child Protection Committee of the Royal College of Pediatrics in England opined that there is no gold standard for diagnosing AHT.

[39] Geoffrey David Debelle, et. al., Abusive head trauma and the triad: a critique on behalf of RCPCH of 'Traumatic shaking: the role of the triad in medical investigations of suspected traumatic shaking', Archives of disease in childhood, 103(6), 606–610 (2018).

Thereafter, Dr. Scheller testified to certain symptoms and their relationship to AHT. He explained that subdural and retinal hemorrhages can be symptoms of AHT but if there is no subdural or retinal hemorrhage a child may still be diagnosed with AHT. The same is true with seizures, bruising, broken ribs or bones and neck injuries, along with the absence of the injury – a child may still be diagnosed with AHT.

Dr. Scheller next testified to defenses exhibit marked D-2 which was the report he wrote dated September 6, 2019. He attested to reviewing D.J.'s birth and nursery records, pediatric visits, the hospitalization visit at St. Peters in February of 2017, and all the radiology images - x-rays, ultrasound, CAT, and MRI scans. In his report he used a timeline of what happened to D.J. medically and provided his professional opinion based on the timing and records. Dr. Scheller concluded, contrary to Dr. Medina[40], that there was no evidence D.J. was a victim of abuse.

Dr. Scheller testified as to D.J.'s MRIs, submitted to the court by defense counsel. While there were 290 images taken and properly submitted as evidence, Dr. Scheller did not go through each image separately. He identified certain slides to use as pictorial images for his explanation, describing what he believed to be hygroma[41]. Dr. Scheller explained a hygroma as a fluid collection in the body that the body does not know how to get rid of and so it collects in a space between the brain and the skull within the dura and the arachnoid. This fluid does not belong there, and it is caused by minor trauma. Additionally, Dr. Scheller noted that hygromas are a common finding in premature babies and ex-premature.

[40] Dr. Medina concluded D.J. was a victim of abusive head trauma with or without impact.

[41] Dr. Scheller testified that there are other names used for hygroma such as subdural effusion or subdural collection but it describes the same thing – a fluid collection in the body that the body does not know how to get rid of and collects in this space.

Dr. Scheller testified that a hygroma can be detected in two ways: one way is by noting that the head circumference grew too fast. Normally, when measuring the head circumference doctors are measuring the brain, skull, and scalp but when there is a hygroma that measurement also includes the hygroma. Another way would be if the fluid can see be seen on an ultrasound to determine if there is too much fluid between the brain and the inside of the skull. To diagnose it there would need to be a picture like a sonogram or a CAT scan.

Dr. Scheller believes D.J.'s prematurity is what caused the hygroma found on his MRI. According to Dr. Scheller, symptoms of the type of subdural hygroma D.J. presented with can range from a large head, poor feeding, and poor weight gain. He also testified that sometimes it can cause seizure and delay in development. Dr. Scheller reminded the court that D.J. was born only 600 grams at birth.

Furthermore, Dr. Scheller testified that within the hygroma there was a blood clot, though he noted it not large and was not actually bleeding. Since there was no evidence that D.J. had trauma near its location, i.e.: the brain was not swollen or bleeding, and it is within a much larger collection, he concluded that the blood clot had been sitting there for a period of time.

Dr. Scheller next testified about bridging veins. According to his testimony, bridging veins are large veins usually found near the top of the brain that collect blood to bring it back to larger blood vessels in order to deliver it to the heart. If bridging veins rupture, a large blood clot will usually develop. Dr. Scheller testified that the blood clot found within the hygroma on D.J.'s MRI was a sliver of the size of a blood clot found when a bridging vein ruptures.

As such, Dr. Scheller testified that he diagnosed D.J. with a subdural hygroma. He believes D.J. had a seizure on or around February 10, 2017 which he testified "certainly" could have been

caused by the hygroma. He attested that such a fluid collection can cause a neurological symptom such as a seizure because it is "squeezing" the brain, which causes irradiation. Dr. Scheller explained that a seizure is an electrical disturbance caused by anything that might irritate the brain such as from squeezing it or blood sugar that is too low.

Regarding retinal hemorrhages, Dr. Scheller testified that the retina has arteries and veins that can be seen through the pupil. A retinal hemorrhage is one or more drops of blood next to a retinal vein. Retinal hemorrhages occur when there is a problem in the circulation of the brain affecting the adjacent blood flow in the eye causing a backup of blood flow that can cause a retinal hemorrhage. Two common neurologic conditions that can cause retinal hemorrhages are aneurisms[42] and a subdural hygroma.

As to multilayered retinal hemorrhages, Dr. Scheller testified that bilateral multilayer retinal hemorrhages present in at least two of the three different layers within the retina of both eyes. When there are over 20 retinal hemorrhages identified with the retina, ophthalmologists identify it as too numerous to count. Retinal hemorrhages are considered severe when they are too numerous to count, the hemorrhages go into the periphery, and it is multilayered. Historically, when a patient presented with retinal hemorrhages it signified that there was a vascular problem -- something wrong with the blood flow or the blood vessels in or around the brain. A subdural hygroma could lead to increased pressure and retinal hemorrhages.

Dr. Scheller then addressed attested the vitreoretinal traction hypothesis. That is a theory about what shaking might do to the brain and eyeball. The idea is there that if you take an eyeball and you shake it violently, gel will tear in the retina and cause bleeding. So, the theory is similar

[42] Dr. Scheller testified that an aneurism is a leakage of blood or anything that causes too much pressure inside the brain, such as a tumor or stroke.

to shaking a baby violently in that violent shaking will cause a retinal hemorrhage from the gel pulling against the inside of the eye. However, Dr. Scheller testified that the hypothesis is difficult to understand scientifically because it has not been proven and even further, it is not possible to shake the eye separate from the head.

Next, Counsel gave Dr. Scheller two documents to consider. Dr. Scheller described the first document, labeled D-4, as a study about shaking abnormalities that are found in ovine, which is a lamb model. In this study, they physically shook baby lambs. Dr. Scheller authored this study with a Dr. Finnie. Dr. Finnie also authored document D-5, the second document associated with D-4 that Counsel asks Dr. Scheller to consider.

Transitioning back to D-4, Counsel asked Dr. Scheller to describe that study. In this study, they shook lambs, and were looking to see whether this caused retinal hemorrhages. The study did not find bilateral multilayer retinal hemorrhages. While some of the lambs died, they did not have multilayered retinal hemorrhages.

When asked, Dr. Scheller described the conditions that cause retinal hemorrhages. Dr. Scheller explains that, at birth, the number one condition that causes retinal hemorrhage is being born normal. Defense counsel followed up by asking whether there are there any studies about retinal hemorrhages in birth? Dr. Scheller replies in the affirmative: that there are a number of them and they all pretty much find that in perfectly normal newborns, one-fifth to one-third of them have retinal hemorrhages.

Counsel asks Dr. Scheller about a study performed by Dr. Callaway in 2016 on retinal and optic nerve hemorrhages in newborn infants. This study, entitled “Retinal and Optic Nerve Hemorrhages in the Newborn Infant” is labeled document D-6. In this study, Dr. Scheller

explained, researchers looked at more than looked at more than 200 perfectly normal newborns shortly after they were born to examine their eyes and see if they did have retinal hemorrhages. The results of this study displayed that about 20 percent of these children had retinal hemorrhages. Out of that 20 percent, about 70 percent had multilayer retinal hemorrhages.

Dr. Scheller explained that babies get retinal hemorrhages at birth because there is a circulation problem at the brain as babies are leaving the birth canal; the head is being squeezed very dramatically, drastically changing the circulation. Counsel then asked Dr. Scheller whether he authored any papers on retinal hemorrhages appearing in children with subdural hygromas, to which he replied that he has. Defense offered this study, entitled Infantile Retinal Hemorrhages and the Absence of Brain and Bodily Injury, into evidence, labeled as document D-7. This paper was published in the Pediatric Journal of Sweden[43] and is on retinal hemorrhages appearing in children with subdural hygromas introduced. This study identified infants who had multilayer retinal hemorrhages but no evidence existed that they had been injured, nor did they present with brain injury. Dr. Scheller testified that his paper raised the questioned of whether it takes an act of violence to create multilayer retinal hemorrhages.

Dr. Scheller attested that D.J. did have multilayer retinal hemorrhages in both eyes per the ophthalmologist's report from February 15. Dr. Scheller believes the accumulation of too much fluid and too much pressure in between the brain and the inside of his skull. He testified that children who are abused often have indications that they have been abused, e.g.: fractured bones, neck injury, bruises, internal organ injuries. D.J. did not have any of that. While neck injury can be detected on an MRI, there was no dedicated neck MRI done. What D.J. did have was a

[43] Joseph Scheller, Infantile retinal haemorrhages [sic] in the absence of brain and bodily injury, *Acta paediatrica (Oslo, Norway: 1992)*, *106*(12), 1902–1904 (2017).

very small acute subdural hematoma, which in theory would be an indication of a traumatic event however there was no evidence of trauma. In his medical opinion, to a reasonable degree of scientific certainty, D.J. was not the victim of abusive head trauma. He believes D.J. has another condition that mimics abusive head trauma which he does not believe Dr. Medina considered.

III. Julie A. Mack, MD

Dr. Julie Mack, M.D., is an Assistant Professor of Radiology at the Penn State College of Medicine at Penn State Milton S. Hershey Medical Center, in Hershey, Pennsylvania, where she also serves as Chief of the Division of Breast Imaging. Having attended Harvard University Medical School in Boston Massachusetts, she completed her residency in Diagnostic Radiology at the Baylor University Medical Center in Dallas Texas, and her fellowship in Pediatric Radiology at the Children's Medical Center in Dallas Texas. She is board certified by the American Board of Radiologists in Diagnostic Radiology with added certification in Pediatric Radiology. She has over twenty-five (25) years of experience working in the field of radiology in various hospitals and as a professor of Radiology for two (2) universities, which include her current tenure with Penn State University. Dr. Mack testified on behalf of the defense and was qualified as an expert in the field of radiology and pediatric radiology.

Julie Mack, M.D. appeared in court as an expert witness for the defense. Having graduated from Harvard Medical School in 1990, Dr. Mack is currently licensed to practice medicine in Pennsylvania and is board certified by the American Board of Radiology. Following graduation, Dr. Mack did her residency at Baylor University Hospital where she first began her training in medical imaging, known as radiology. Dr. Mack practices in radiology at Penn State Hershey Medical Center, specifically in the breast imaging division, where she interprets imaging studies,

discusses results with patients, performs tests and biopsies, and teaches. Specifically, Dr. Mack is the Division Director of Breast Imaging. While Dr. Mack does not regularly practice in pediatric radiology, she maintains a Certificate of Added Qualifications in pediatric radiology. This an elective certification, which requires yearly maintenance. Additionally, Dr. Mack has is published in the field of pediatric radiology, has presented at conferences concerning pathology and radiology, and researched and written about abusive head trauma and shaken baby syndrome as it relates to radiology. Dr. Mack has experience testifying as an expert witness in criminal court, which she estimates to be upwards of 35 times. More recently, Dr. Mack has testified as an expert for defense counsel, but due to her prior work in Lancaster as the pediatric radiologist on staff, she would occasionally testify for Children and Youth (what New Jersey would call DCCP) in Civil Court. Considering this evidence, the Court accepted Dr. Mack as an expert in the field of radiology and pediatric radiology.

In concert with her testimony, Dr. Mack presented from a power point slide show, which contained D.J.'s imaging, as well as images depicting general anatomy of the brain. Dr. Mack first explained dural anatomy in reference to a pictorial drawing of the brain, testifying that dural anatomy is a description of a structure that lives next to the skull, around the brain. Next, Dr. Mack identified the bridging vein in the pictorial drawing. The bridging vein is a vein that travels from the surface of the brain up through the subarachnoid space, and into the dural sinus. Eventually, the dural sinus gives the blood back to the heart. In sum, the importance of the dural sinus and bridging veins is that they are the exit zone for the last portion of blood that enters the skull.

Adhered to the dura is the arachnoid barrier membrane. They are cell to cell interfaces, so no space exists until one is created by the collection. The subarachnoid space is filled with cerebral spinal fluid, which you will see in the dura. The pia is the membrane closest to the brain. As demonstrated in the image, Dr. Mack stressed that the bridging veins are large. When you look at an autopsy, they are visible, and they carry a lot of blood.

Dr. Mack moved on to the next slide (Slide 5), which depicted how the bridging veins can be stretched at autopsy if you are careful and identify them. Normal bridging veins are strong. Moving on to Slide 6, Dr. Mack explained how for bridging veins to truly rupture, a substantial amount of force is required. On Slide 7, a bridging vein rupture is depicted. Bridging vein ruptures are true surgical emergencies. If the patient is normal and there is true bridging vein rupture, Dr. Mack asserts, then you can certainly ascertain that there was trauma. Albeit you cannot determine how much trauma, but you can surmise that trauma on some level occurred to achieve this result.

Using Slide 8 as a reference, Dr. Mack clarified certain terminology. “Subdurals” is used to describe anything that occurs that disrupts the connection between the arachnoid and dura, be it fluid or old blood or new blood. The word hemorrhage is sometimes used as a catch all, but when looking at the data, it is important to discern how much of the liquid that you see hemorrhage vs. how much is fluid.

Dr. Mack describes how she studied a population of Amish and Mennonite families in Lancaster. There is a condition that occurs in the Amish called glutaric aciduria (GA-1). While D.J. does not have this, it is relevant to the idea that subdurals can occur without trauma. The children

Dr. Mack studied with GA-1 did not have underlying collagen abnormalities or bleeding disorders, rather, they had a metabolic condition that predisposes them to hemorrhages or collections without trauma. Dr. Mack explained that what she once believed during her residency was that subdurals equal trauma. What she ultimately learned throughout her studies, though, was that other non-traumatic events can cause subdural collections.

Returning to Slide 7, Dr. Mack clarifies what bridging vein rupture would look like in an infant's brain. She explained that what the Court was looking at was a documented bridging vein rupture in an infant's brain. The CT scan showed an acute hemorrhage and depicted blood within the brain.

Dr. Mack explained that a subdural collection that occurs without trauma can be due to BESS, or benign enlargement of the subarachnoid space. It is not understood why some children get it and why others do not, but it tends to be limited, only occurring in infants, and usually resolves by a year or so of age. It's more common in males and premature infants. It is sometimes associated with a big head, changes in the eyes like a downward gaze or lethargy. It has a spectrum of presentations, one example being seizures. There is no way to know how much of the population has it that don't develop symptoms.

When asked what she would think of the premise that a child that presented with BESS would have a rupture in the bridging vein with very little trauma, Dr. Mack replied that she would agree that you can get subdural collections in the ESS with every little trauma. She clarified, though, that a rupture would be evidenced by a large volume of blood. It is more likely that stretching could produce some leakage, but not a rupture.

Next, referring to Slide 11, Dr. Mack described the dural plexus. The dural plexus are the capillaries that invest the dura. They are much more diverse in babies than they are in adults, and if they bleed, the result of that bleeding can be subdural hemorrhage. On Slide 12, Dr. Mack continued her explanation. The bridging vein is the strong vein, whereas the plexus can bleed without impact or trauma, unlike a bridging vein. It is not known for certain why this can happen, as it is not even understood why these vessels exist or what function they perform. One explanation of why you can get fluid or bleeding without trauma is meningitis, as it affects the pia and the arachnoid and the space around it. The response of the dura in some cases is to produce fluid. The arachnoid and the pia, which belong to the space called the protective brain barrier, maintain a very unique equilibrium for the brain to function well. A little bit of blood in this space and there may be trouble, whereas the dura could bleed, and you may not have any symptoms. Most newborns with subdural bleeding do not present with symptoms. Additionally, you can have fluid in the dural space, and you would not know it.

Dr. Mack explained that the dural space is non brain space. Rather, it is actually part of the systemic circulation. When asked why it would be important to look for fluid in a patient exhibiting subdural hemorrhages, Dr. Mack stressed that it is important to not inadvertently call subdural fluid hemorrhage, because it is not. Second, when you do have remote hemorrhage in the dura, over a period of weeks to months, you can develop fluid as a result of your body trying to heal the two compartments. Dr. Mack explained that re-bleeds can also factor in, which is when the repair response in the dura is to produce neomembrane. Within the neomembrane are increased vessels, and these can bleed as well.

Next, Dr. Mack was asked what macrocephaly was. Dr. Mack explained that within the premature population, you can have expanded fluid spaces around the brain if you have a large head. This may be because the premature brain has some atrophy associated with it just from being born early. So, macrocephaly, or a large head, can be associated with BESS, but is not a requirement.

Dr. Mack also testified about the scientific method. The scientific method includes observation, investigation, and then drawing a hypothesis using experiments. If the testing fails to confirm your hypothesis, you then modify your hypothesis and try again. In relation to her practice, Dr. Mack states that confirmatory tests are important. For instance, you would not treat for breast cancer without doing a biopsy and having that confirmation test.

Dr. Mack was then asked whether there was a confirmatory test for abusive head trauma, or shaken baby syndrome. Dr. Mack said no. The confirmatory test, she suggested, would be the courts, since abuse is a crime. There is no test you can order that confirms intent. Abusive head trauma is a medical code. This is a billing code for a medical diagnosis. It does not mean that it is the conclusion. When considering the statement that here is a 96 percent accuracy rate of retinal hemorrhages in diagnosed abusive head trauma, Dr. Mack said this is an incorrect way to measure. What should be considered here is positive predictive value, which compares the true positives to the false positives. This should never be above 50%, or you're missing false positives.

Next, counsel asked Dr. Mack whether if an E.R. doctor who sees a subdural hemorrhage in an infant on an imagine should report this as a concern for abuse. Dr. Mack says that it depends whether they are a mandated reporter. Most physicians are mandated reporters, and anything

that reaches the threshold of suspicion should be documented or they should follow whatever protocol is given by DCP&P. Dr. Mack described what she would do in the setting of the E.R. after seeing images she found suspicious. She said that she would call the E.R. physician who caring for the patient and let them know that there is subdural hemorrhage. The E.R. physician would have to decide if the history provided by the parents was sufficient so that it doesn't reach their threshold of suspicion. The threshold of suspicion is a low bar and is different for each physician. Radiologists rarely report directly to state agencies, but their duty as mandated reporters usually involve notifying the physician who ordered the test of what they see. When it comes to a child's safety, Dr. Mack states that you should presume the worst possible scenario to keep them safe. You want to make sure you do not miss something. Considering this, Dr. Mack agreed that it is appropriate to investigate any possible concern that abuse caused an injury like a subdural hemorrhage.

When asked about retinal hemorrhages, Dr. Mack explained that when a subdural hemorrhage appears cause unknown, the next step is to look for retinal hemorrhage. At that point, the children are referred to the state agency for investigation. If there is a child abuse pediatrics program, they are called in to help with the investigation. From a radiological standpoint, Dr. Mack stated that the child abuse pediatrics program should confer with the radiologist and review the images. Counsel asked Dr. Mack whether that, as a radiologist, she determines that injuries she sees are a result of trauma. Dr. Mack answered that while you can see evidence of trauma on scans, you cannot tell for sure whether it is intentional trauma or not. Subdural hemorrhage can reflect trauma but can also occur without trauma. A telltale trauma

signature of an impact injury on a scan would be a fracture or soft tissue swelling that is correlated with scalp hemorrhage that you can see bleeding under the skin.

In cases where parents deny any trauma, and Dr. Mack reviews the imaging, she can ascertain that there is evidence of trauma in the images, and she can flesh out a broad idea of how old the trauma is. Dr. Mack explains, though, that she cannot find inflicted trauma in the injuries because inflicted trauma deals with intent. She can infer possible inflicted trauma, but she cannot make a definitive diagnosis. In the context of court, as an expert, Dr. Mack consults with attorneys about what the imaging shows. One such image would be a neurosonogram. A neurosonogram is done on an infant because they have a soft spot on their head.

Dr. Mack was asked to consult on a finding of abusive head trauma related to D.J. and write a report about her findings. In creating her report, Dr. Mack reviewed the ultrasound that was performed when he was admitted for his ventricular septal defect (VSD) comparison in July. VSD is a heart defect, which D.J. had repaired. She also reviewed the MRI that was performed when he came to the hospital unresponsive, due to a suspected seizure, as well as additional ultrasounds provided to her by counsel that were performed through D.J.'s life. She also reviewed a sonogram performed 7/22. Dr. Mack always begins by looking at the imaging. She walked the Court through the medical imaging she reviewed. Dr. Mack first shows the court an information page which is provided by the technologist who did the scan, which identifies it as a portable ultrasound on a four-month-old male. The reason for the exam as indicated on the information sheet was dropping hematcrit, HCT and platelet NP (Dr. Mack told the court she did not know what NP meant). This exam was done on July 22, after D.J. had surgery on July 20.

Next, Dr. Mack turned to the image itself. She explained that what the image depicted was a measurement of the space between the brain and the dura, which is pressure in the subarachnoid space. Dr. Mack explained the significance on this, stating that, while it is normal for fluid to exist in the subarachnoid space, the distance between the brain and the dura is usually not four millimeters. Four millimeters indicates that expansion has occurred. In D.J.'s ultrasound the distance is 10 mm, which shows that his subarachnoid space was bigger than usual at the time. But this issue would generally not need to be treated, as it is benign. He did not have any observed symptoms to his brain, and the treatment (putting a tube in a baby's brain) would be worse than the injury.

Discussing the next set of sonograms, Dr. Mack pointed out the progression between images. Shortly after birth, D.J.'s brain appeared average, with a distance of 2.5 mm between the dura and the brain. In April, the next image shows D. J's brain is beginning to look more developed, and while the space between the dura and the brain is a bit enlarged, it is still within the average range. By June, however, the space has reached about 7 mm, which shows progressive growth of that space. Some of this may be attributed to the fact that D.J. was born prematurely. In the next set of images, captured from an MRI performed February 2017, Dr. Mack points out some misplaced fluid. She states that while most of it is fluid, some of it is blood.

Counsel asked Dr. Mack if you can diagnose subdural hemorrhages from that scan. Dr. Mack explained that it depends on how you define hemorrhage. Because there is a little bit of blood, you may be able to call it a hemorrhage. But it is not equal to the severity of a hemorrhage that would be caused by acute bridging vein rupture. Dr. Mack then explored some of the possible causes of the fluid and blood seen in D.J.'s brain. Dr. Mack says that she does not see

any direct trauma in the images. There is no soft tissue swelling, and soft tissue swelling is almost always present with an acute skull fracture. There is also no abnormality in the brain itself.

Dr. Mack summarizes her findings, reiterating that there was data that showed that the subarachnoid space was slowly expanding. When D.J. was hospitalized for his heart surgery, the subarachnoid space was up to 10 mm. Dr. Mack called this a benign expansion of the subarachnoid space. She believes the evidence supports this finding because there is literature to support that this association can occur, as well as the fact that you cannot see any injury or soft tissue swelling in the brain. Further, what is present is mostly fluid. This, Dr. Mack says, is what Benign External Hydrocephalus (BEH) looks like. This condition is characterized by subdural fluid collections in the context of enlarged subarachnoid spaces. The associated symptoms include seizures, lethargy, and loss of appetite. Although D.J. presented with seizures, the seizures were not ongoing.

When asked about D.J.'s diagnosis of retinal hemorrhaging, Dr. Mack stated that it does not change the data that exists: that he had enlarged subarachnoid spaces, and there were some fluid collections, not just hemorrhage. Retinal hemorrhaging is associated with BEH. She discusses an article by Dr. Piatt, entitled "A Pitfall in the Diagnosis of Child Abuse External Hydrocephalus, Subdural Hematoma and Retinal Hemorrhages." This article followed the case of a child that, while being bounced up and down by his parent, fell backwards and got injured. This child had retinal hemorrhaging. There was a social services investigation, the parent passed a lie detector test, and no evidence of abuse was found. Dr. Piatt's article challenges the sticking point that retinal hemorrhages are directly associated with abuse. Rather, the article emphasizes the importance of being careful not to jump to conclusions of abuse, because the child had BEH,

suffered a minor trauma, and developed subdural collections and seizures. This article argues the notion that you can no longer make the claim that retinal hemorrhages are specific to abuse.

Dr. Mack stated that if a pediatrician presented to her scans such as D.J.'s case, and claimed that retinal hemorrhages meant abuse, she would caution that you cannot ignore the data, which is no brain injury, enlarging subarachnoid space over time, and fluid collection. You cannot immediately assume abuse and ignore the data on the imaging and sequence of films. At this point, the defense ended their examination, and Dr. Mack was subject to the State's cross.

On cross, it was established that Dr. Mack has never conducted a forensic child abuse evaluation, nor treated a patient. Additionally, Dr. Mack has no subspecialty or board certification in child abuse. Her entire career is radiology based. She works at Hershey three and a half days a week, and that time is spent working on cases involving breast disease and intervention. Very rarely do those cases involve infants.

When challenged regarding D.J.'s imaging, Dr. Mack stated that she had no problem with D.J.'s initial phase being reported as a potential abuse case. She agreed with the State that abusive head trauma is a generally accepted term in the medical community. She also agreed that shaking and infant would be very dangerous. It was established that Dr. Mack relied on Dr. Medina's outline of the facts as well as D.J.'s imaging in creating her report. When questioned as to whether she believed it would be better if she reviewed D.J.'s medical history herself, Dr. Mack stated that for the question that she was asked, she believed Dr. Medina's recitation and the imaging to be sufficient enough to reach her conclusion. She also did not have access to any of D.J.'s radiologists as their findings are protected under HIPAA rules. Dr. Mack did not know their findings or whether they were different from her own.

Next, Counsel asked if it was Dr. Mack's opinion that she cannot discern from the February 13th image whether the trauma was accidental or inflicted. Dr. Mack confirmed this. When challenged on her view of bridging vein rupture, Dr. Mack stated that she does not believe there has been good evidence that shaking can cause bridging vein rupture. Although there is literature that makes the presumption that it does, those experiments were performed on animals. In essence, the theory that isolated shaking without impact can generate the type of force necessary to rupture the bridging vein rupture remains a theory.

Dr. Mack agreed with counsel that a radiologist cannot diagnosis child abuse; that would be left to a child abuse pediatric team should the hospital have one. She acknowledged that a opinions from all different subspecialists were used to create Dr. Medina's report, but that she did not speak to Dr. Medina regarding this. They also did not speak about their difference of opinions on the cause of D.J.'s brain abnormalities.

Counsel began to question Dr. Mack about differential diagnoses. A differential diagnosis is a diagnosis that allows you to rule out all other causes. Dr. Mack clarified that unknown is a potential diagnosis, but generally, you should start to exclude possibilities based on testing. Counsel delved deeper, asking Dr. Mack whether there are specific types of retinal hemorrhages associated with abusive head trauma. Dr. Mack stated that this is correct, but that there is literature on both sides of this opinion. Counsel challenged Dr. Mack, contending that the specific types of retinal hemorrhages being associated with abusive head trauma is a widely accepted theory in the ophthalmological community. Dr. Mack countered, stating that she does not believe this is a widely accepted opinion. She clarified that the retinal hemorrhaging has no impact on what the imaging data shows. Counsel moved on to discussing other points in Dr.

Mack's report. Discussing BESS, Counsel contended that the scans prior to February 13th were normal. Dr. Mack disagreed, stating that the subarachnoid space slowly enlarged over time, so she would not call this normal, but stated that they could reasonably be characterized as what can be seen among infants. It is a finding that is untreated. Counsel again asked whether the tests prior to the February 13th test were normal. Dr. Mack conceded, stating that they were normal, but normal considering that the images were limited.

On redirect, Defense counsel asked Dr. Mack about her acknowledgment to the State that abusive head trauma can cause injury to infants and asked whether she accepts this as a diagnosis. Dr. Mack replied that abusive head trauma exists as a medical diagnosis and that she accepts the general proposition that abusive head trauma exists. Defense clarified further, asking whether Dr. Mack agrees with the premise that shaking alone can cause the injuries that she saw outlined in Dr. Medina's report. Dr. Mack said that this is a highly controversial issue in the medical community and said that it was her opinion that you could not use these images to conclusively tell whether abuse exists. Defense asked Dr. Mack whether she would consider what she did a thorough diagnostic report. Dr. Mack stated that it was not one, not in the context of radiology. When asked, Dr. Mack said that it was appropriate to examine these neurosonograms considered in relationship to the MRI that was done in February of 2017. As this is data, they want to evaluate what has happened over time and how they got to this point. The Defense ended their examination of this witness.

During the recross examination, the State challenged Dr. Mack, asking whether she agrees that shaking can cause injury to an infant. Dr. Mack vehemently agreed, saying that shaking can be dangerous to a baby. The State then raised the proposition that had Dr. Medina consulted

with other radiologists, would that make Dr. Medina's assessment more thorough. The Defense objected to this question, and the Court clarified a few things with Dr. Mack. Dr. Mack stated that her assessment was confined to the four corners of Dr. Medina's report, and that she did not know what Dr. Medina left out or why. The Court asked Dr. Mack whether she had only been contacted by defense attorneys, to which Dr. Mack replied this was incorrect. She clarified that she had only been contacted defense since 2009 when she published her aforementioned paper. The Court asked Dr. Mack whether she had ever provided an opinion contrary to the interests of the defense attorneys who have reached out to her, to which she replied yes. She said that she could not break it down percentage wise but she has been consulted close to 400 times, and has testified in criminal trials around 34-36 times. When asked by the Court whether she'd agree with the statement that the diagnosis lies in the eye of the holder, Dr. Mack agreed. She said that each professional that looks at the data will make their own assessment. There is no test to confirm the diagnosis of abusive head trauma.

IV. Chris Alen Van Ee, PhD

On October 13, 2020, defense called Dr. Chris Alan Van Ee as an expert witness. Dr. Van Ee, PhD, is the principal engineer for Design Research Engineering, in Novi, Michigan, where he focuses on impact biomechanics and mechanical engineering. Having graduated from Dordt College in Northwest Iowa with a degree in mechanical engineering, he attended graduate school Duke University in North Caroline where he graduated with a Ph.D. in biomedical engineering. After obtaining his Ph.D., he moved on to work at the University of Michigan Transportation Research Institute. There, he continued his work in impact biomechanics as well as his research on hip and neck injuries and injuries to pregnant mothers and their unborn babies to try to figure

out what is the best kind of seat belt for a pregnant person so that you decrease the chance of them sustaining injury to themselves or their baby in the crash. Additionally, he also studied aorta injury, which is the second leading cause of death by car accident, behind head injury. He has qualified to testify as an expert in the field of biomechanics relating to abusive head trauma or shaken baby syndrome nearly a hundred times in more than ten (10) states. He is a prolific publisher of peer-reviewed studies in the field of biomechanics, which he describes as the application of mechanical principles to biological structures. He has specifically focused on impact biomechanics which he describes as the study of the human body and how it responds to forces or accelerations when they impact the body or when the body is moved and how those forces and accelerations translate into physical loading and property of the tissues of the body and how they become injured. He was qualified to testify as an expert in biomechanics on behalf of the defense.

Dr. Van Ee works at a company called Design Research Engineering, located in Novi, Michigan, as an engineer. Design Research Engineering is a consulting company. Specifically, he focuses on orthopedic impact biomechanics and mechanical engineering. Elaborating further, Van Ee defined biomechanics as the application of mechanical principles to biological structures. Orthopedic biomechanics considers the applications as they relate to orthopedics. For example, the types of screws or the types of material that implants should be made from. Van Ee explains that while he has experience in that, primarily what he focuses on is impact biomechanics, or the study of the human body and how it responds to forces and how those forces translate into physical loading and property of the tissues of the body and how they become injured.

It is comprised of multiple engineers and naval architects. Their clients mainly consist of attorneys who call for questions such as these as well as well as industries. Van Ee stated that he has consulted with clients from the Air Force Jags to Innocence Clinics, as well as criminal attorneys, prosecutors, and different attorneys relating to plaintiff or defense cases. He also has consulted for attorneys that work for companies who deal with patent litigation or marketing claims.

Van Ee is not a medical doctor. He explains that what he does is different because he does not work in a hospital or treat patients. Rather, Van Ee's work involves understanding the mechanics of how an injury takes place and then evaluating the designs or forensic history that is given determining whether this accounts for what is present.

Van Ee also is an adjunct professor at Wayne state University, where he taught graduate level courses in biomechanics. He is a reviewer for multiple journels, being "Journal of Biomechanics" and "Annals of Biomedical Engineering." He also works with the Society of Automotive Engineers as an associate editor for one of their journals, as well as with the U.S. Army researching injuries that occur to war fighters in the field and how they can be best protected.

When asked how often he consults on "Shaken Baby Syndrome," Van Ee replied that he believes that it comprises about a third of his testimony in court. He estimates that he has testified as an expert on shaken baby syndrome upwards of 80 times. When he began his training at Duke, Van Ee was trained specifically in orthopedic biomechanics classes about how tissues change through maturation, considering how your tissues begin as an infant and what happens to them by the time you are elderly. He also researched how air bag injuries differentiated

between children and adults. Further, he studied the properties of the infant head, in terms of impact, and what accelerations are measured when it comes in contact with a hard surface, and then compared that to the crash test dummies that they used to represent children. Van Ee has also done additional work developing a risk curve for skull fracture for infants based on crash dummy responses. This study is peer reviewed and published in 2009. Considering these qualifications, Defense offered Van Ee as an expert to the Court.

On voir dire cross, the State asked Van Ee what number of cases dealt with scenarios of shaking alone. Van Ee stated that he cannot put a number to it because in these cases, you do not know what happened. While in some cases the trauma is clear, in other cases, like D.J.'s, it is not clear whether the child was shaken or not. Van Ee clarified that if the prosecution meant allegations of shaking without impact, that is less common. The State asked how many of those cases dealt with short falls, to which Van Ee estimated about 70%. The Court asked for further clarification, and ultimately, Van Ee agreed with the Court's characterization of the cases that Van Ee has testified for as cases where you do not know if there was any shaking, but defense counsel characterized it as a shaken baby case. The Court then qualified Van Ee as an expert witness in biomechanics.

Beginning the direct examination, Defense counsel asked Van Ee to again explain biomechanics. Van Ee explained that, as it relates to this case, impact biomechanics looks at the human body to understand what the forces or accelerations are that gave rise to a specific injury. The forensic aspect of that is looking at whether the specific injury can be identified as trauma and what acts are compatible with producing that. Van Ee was next asked about the premise of angular acceleration being a cause of intracranial injury. Van Ee explained that this was

hypothesized by Dr. Holbourn from the UK in the 1940's. Dr. Holbourn believed that angular acceleration, how quickly the spin of something changes, could give rise to things like subdural hematoma and intracranial hemorrhage.

Van Ee continued. He explained that G's are linear acceleration. This is acceleration along a line and how quickly you come to a stop or accelerate out if you are already stopped. Angular acceleration is the spin of something. The idea is that the brain must accelerate due to changes in the skull motion and as you move to the outside of the brain, those forces get larger to stay with the skull. Angular accelerations can cause concussion and subdural bleeding, and in some cases diffuse axonal injuries or break and stretch the nerves in the brain.

Counsel next asked Van Ee how abusive head trauma relates to biomechanics. Van Ee explains that biomechanics is a way of looking at that topic. Shaken baby syndrome is a hypothesis that suggests that if you take a child and hold them by the torso and shake them, the head goes back and forth, and it is speculated that this creates these angular accelerations of the head that are sufficient to rip bridging veins and cause injury to the child. Biomechanics considers what these angular accelerations are and whether they are consistent with what researchers know causes injury in similar events. When asked about a test for Shaken Baby Syndrome, Van Ee states that there is no perfect test.

Discussing the differences between pediatric anatomy and adult anatomy from a biomechanical perspective, Van Ee said that what should be considered in children rather than adults is the weakness of their necks. Infants have very heavy heads which represent a large portion of their body. Adult's head represents less than 10% of their total body weight. Other aspects that are also important is the thinness of an infant's skull, as well as the different

properties of the brain and other tissues. This affects their tolerance to injury because they have an overall weaker structure.

Van Ee was next asked about the "Ommaya study." These were studies done in the late 60's where primates were strapped to a chair and then accelerated so that their heads snapped back in forth in a very extreme whiplash motion. Some of these primates suffered subdural hemorrhages and neck injuries as a result. Ommaya surmised that this supported the idea of that shaking could cause injuries to children. Dr. John Caffey supported this idea. This study involved a force of 30-mph crash, which is not a force that a human can generate through shaking.

Van Ee stated that you would rarely ever see subdural hematomas generated by a 5-10 G incident, which would be comparable to the force that a human could generate. Though, Van Ee made clear that there is always an exception to the rule. Here, it would be if the person experiencing the force was particularly vulnerable. For instance, there have been people that have rode roller coasters and sustained a subdural hematoma, but it is very rare that those types of exposures would cause a traumatic injury. Van Ee then presented his personal report on the subject. Counsel, referring to page 4 of his report, asked what Van Ee meant when he said that the hypothesis that shaking is "likely to result in injurious angular acceleration/deceleration resulting in direct damage to bridging veins and diffuse axonal injury will simultaneously not injuring the neck or torso cannot be scientifically supported." Van Ee explained that, as the infant neck is very vulnerable to injury, that would be the first place to look for injury from a biomechanical standpoint when an infant has been under that type of motion. The idea that you can create a subdural hemorrhage by ripping a bridging vein for a normal healthy child without injuring the neck is not supported by data, because the angular accelerations that are created in

shaking are less than what is seen in even a one-foot fall. When considering whether the physical situation and the medical findings match, Van Ee states that biomechanics says that if you start shaking a child like that, the neck should be where injuries would start.

Van Ee goes on to explain that they have looked at cases where there are witnesses or where the incident has been caught on video. These cases can give a good idea on what types of impacts result in subdural hematoma, as well as what types of impacts result in neck injury. You can also do tests with human cadavers or animals and do computer models. When you are doing tests with cadavers or animals, you can use a test device that allows you to attempt to test certain hypotheses, i.e., what types of head accelerations occur when the head is impacted a certain way.

Next, Counsel asked Van Ee to discuss the "Prange" study. Outlining the study for the Court, Van Ee explains that this is a study done at the University of Pennsylvania, published in 2003 in the Journal of Neurosurgery. In this study, the authors developed a test device that represented the weight and relative size of a one-and-a-half-month-old infant. They took this test device and had people shake it, slam it, and drop it onto varying surfaces. The point of this study was to gain understanding on the head acceleration under these circumstances. They also varied the study and looked at properties of the neck, as well as skull stiffness, and determined that these are big factors.

Using a Powerpoint graph, Van Ee explained the variables as they appear on the graph and what they represent. Summarizing the findings as relevant to this case, the researchers determined that they still did not have any data that points to shaking giving rise to the injuries that have been associated with it, and that the term shaking should not be used in legal settings.

There was no biomechanical basis to support this idea. Counsel asked how these findings would be applied to a larger infant. Van Ee replied that the heavier the child is, the harder the child is to shake. So, less overall head acceleration is created. Additionally, less angular velocity and angular acceleration is created when shaking a child in the range of 17 lbs.

Counsel then moved on, asking Van Ee to explain for the Court the "Jenny" study. Van Ee stated that this was a more recent study performed in the early 2000's. In this study, the researchers used crash dummies that were made in Japan. This crash dummy represented the fifth percentile newborn of the Japanese population, meaning that it weighed around 5 lbs. They shook this crash dummy, which was intended to represent a very small baby, and could not reach the thresholds associated with diffuse axonal injury thresholds and alluded to not being able to reach subdural hemorrhage thresholds. In this study, the researchers also considered falls and found them to create much greater accelerations than during a shake.

Turning to Van Ee's personal studies on shaken baby syndrome and abusive head trauma, Van Ee explained the findings of his study. It is not that shaking does not cause injuries in some other way that is not yet understood, rather, if it is head acceleration as it has been hypothesized, then things that are more severe than shaking should cause injury as well. In everyday life, there are car crashes where children do not have injuries and one foot falls onto linoleum where kids do not have injuries. Discussing shaking alone vs. shaking with impact, Van Ee said that he hardly sees allegations of shaking alone. Van Ee again reiterates that the evidence base is weak to associate shaking alone with the injuries that are associated with it. Impact can certainly cause those injuries, though. For instance, if you examine the autopsy of a child who died because of child abuse, signs of impact may appear that were not able to be appreciated prior to autopsy.

These injuries would be a subtle skull fracture or bleeding, subgalea bleeding of the scalp and swelling of the scalp.

Counsel asked Van Ee whether a study exists that supports a position that shaking alone can cause the injuries associated with shaken baby syndrome. Van Ee stated that he has not seen a biomechanical study that says definitively that shaking does cause the associated injuries. When asked, Van Ee also said that he has never seen a study done with dummies or with animals that have shown subdural hematomas and retinal hemorrhages occur from shaking. There are some video instances of shaking that have been caught on nanny cams or surveillance cameras, but none which Van Ee knows of that had injury that was reflective of what is associated with shaken baby syndrome. Regarding this case, Van Ee has no diagnosis to offer. Defense indicated that they had no further questions, ending their direct examination.

On Cross, the State began with clarifying questions. Van Ee is not a doctor, he has no medical degrees, and he does not diagnose or treat patients in his line of works. He has never been taught what a forensic examination for child abuse entails, nor was he trained to diagnosis a child with abusive head trauma. He has never conducted an examination for child abuse or been consulted when one of those exams was conducted. He has never medically examined an infant.

Discussing Van Ee's report, the State asked whether he was saying that shaking *can* cause injuries. Van Ee said that shaking absolutely can cause injuries. The question, he says, is whether you can get the subdural, the encephalopathy and the retinal hemorrhaging without any other findings from shaking. Right now, there is not a mechanistic explanation that allows one to go from shaking to those injuries.

The State asked about the specifics of the child abuse pediatrician examination. Van Ee again states that he is not a doctor and does not know exactly how they operate. The State begins a line of questioning as to Van Ee's familiarity with the testimony of the prior expert witnesses. Van Ee reviewed the transcripts that he received to see what they said about biomechanics and how it related to this understanding of shaken baby syndrome, though he did not review any of the medical records. He was not influenced by any of those prior testimonies, though, because his testimony is not case specific. At the behest of the Court, Van Ee discussed the findings the "Lynoe" study published in 2017. Essentially, the passage read aloud conveyed that the study concluded that there was insufficient scientific evidence to associate the triad of injuries with traumatic shaking. Van Ee's interpretation of this is that even if a child does have these injuries, you can not absolutely say that shaking is the cause.

The State challenged Van Ee's prior testimony about bridging veins and whiplash, suggesting that violent and repeated shaking should cause more movement of the head than a single whiplash event, as depicted in the Ommaya study. Van Ee explains that the key consideration is the level of acceleration. When asked, Van Ee agreed that he does not dispute that abusive head trauma is a valid diagnosis in the medical community. When asked whether he disputes the idea that shaking alone as the mechanism of injury is widely accepted in the medical community, Van Ee stated that it depends on the medical community being referenced.

Referencing the Duhaime study, the State asked Van Ee whether the conclusion of that study was that shaken baby syndrome in its most severe form is not usually associated with shaking alone. Then, moving on to the Cory study, the State asked whether that study was able to show that the forces generated by shaking of a child can exceed the minimum forces needed

to cause injury. Van Ee stated that the situation that Cory and his colleagues studied was unique, they used a unique testing device that shows where the chin hits the head, and the back of the head hits the spine. This is generating a factor of 10 g's greater than the force that Duhaime studied. It is an impact. It was found that during these impacts, they were able to reach the threshold for concussion, but even so, these impacts were not able to reach the levels of subdural or diffuse axonal injury.

The State moved on to challenge biomechanics, asking Van Ee if what he is saying is that in the biomedical community, the science isn't there. Van Ee replied that within the biomedical community, shaken baby syndrome is a subject that is consistently written about as being controversial. There is no answer to say exactly how an injury occurs. Van Ee clarifies again that violent shaking of an infant may cause serious injury or even death. But regarding the question of whether shaking can be associated with those triad of injuries, the answer is unclear.

Challenging Van Ee's prior statements, the State inquires why Van Ee feels that someone admitting that they shook a child and looking at the injuries sustained from that is less reliable than using a fake baby and shaking it and testing if that fake baby is going to have injuries. Further, the State pointed out the limitations of using these test devices, being that they do not have blood flowing through them and the neck is made of rubber or hinges. Van Ee conceded that these test devices cannot mimic the neck of an infant, specifically in Prange's study. The State pushes more, asking whether Van Ee agrees that using these test devices causes issues with the accuracy of the studies. Van Ee says that there could be inaccuracies in any study. Summarizing his position, Van Ee stressed that he was not testifying that shaking absolutely cannot cause these injuries. Rather, he is examining the question from his field, and he would

agree with the State that he as a biomechanical engineer cannot positively rule out shaking as a cause of these types of injuries. The State had no further questions for the witness, and Defense had no redirect.

The Court then questioned Van Ee, asking whether any of his study involves examining the weaknesses or strengths of living tissue. Van Ee stated that is ultimately what he is trying to reach in every study. Addressing the Court's concerns over the fact that every presented study involves animals rather than human, making it hard to reach conclusions about human infants, Van Ee agrees that this cannot bridge the entire gap. The Court asked Van Ee whether the sample of the videos of people shaking babies is enough to draw any conclusions from it. Van Ee stated that case study data can be misleading as it is situational and unique.

Asking a follow up question, the State asks whether in the nanny cam cases that Van Ee is referencing he knew what kind of examination the infants underwent, like whether they went to a child abuse pediatrician. Van Ee stated that he cannot say exactly what was done. Questioning of this witness was then concluded.

STATE'S ARGUMENT

The State argues that Dr. Medina's testimony and diagnosis is reliable and admissible as AHT is generally accepted in the medical community as a valid diagnosis, both domestically and internationally. In addition, the State maintains that the diagnostic methodology used by child abuse pediatricians for AHT is also widely accepted within the medical community.

While the State acknowledges that there is controversy surrounding the diagnosis of AHT, it maintains such debate does not negate its general acceptability and asserts, per Dr. Medina's testimony, that "the controversy is primarily limited to the biomechanical field where the studies

conducted on the topic have resulted in diverse conclusions and lack their own consensus on the controversy." St. Br. at 6, Nov. 5, 2020.

Furthermore, the State challenges the defense's experts' opinions as speculative and not reliable as none of them used the method for diagnosing AHT to reach their conclusions. In addition, the State contends that none of the experts for the defendant contacted the parent's or doctors involved in this matter, and only one expert, Dr. Scheller, reviewed all the files for D.N. in order to formulate his opinions and conclusions.

DEFENDANT'S ARGUMENT

The crux of the defense's argument is captured within the "preliminary statement" of the brief they filed in support of their motion. They assert that diagnoses of AHT have been seriously undermined over the past two (2) decades by multiple studies showing that adult humans cannot produce the requisite physical force necessary to produce the symptoms associated with AHT. With the State alleging in this case that the defendant is criminally liable for causing the injuries to D.N., injuries symptomatic of an AHT diagnosis, with no other evidence that the defendant inflicted any force or abuse upon D.N., the unreliability of the "science" behind a AHT diagnosis is insufficient to warrant implicating the defendant in any abusive conduct towards D.N. The defense requests a *Frye* hearing to determine the medical and scientific reliability of AHT and whether it should be admissible as evidence in this criminal trial. The defense posits that a diagnosis of AHT is not reliable because it is based on unsound studies which have never been validated, and in the field of biomechanics the reliability of those studies has been called into question because no biomechanical study has validated the hypothesis that shaking a child can cause the triad of symptoms associated with AHT.

In the end, the defendant argues that the State has failed to clearly establish that Dr. Medina offered a reliable opinion. The defense proffers that because D.N. has a complex medical history, Dr. Medina should have considered an alternate diagnosis, specifically, benign enlargement of the subarachnoid spaces or BESS—an anatomical condition in which fluid collects in the skull and causes "a few millimeters" of growth in the subdural spaces. Symptoms associated with BESS are like the symptoms associated with the triad in AHT. However, the defense states Dr. Medina did not note ruling out BESS in her final written report and only mentioned BESS as a possible diagnosis on cross-examination.

LEGAL PARAMETERS

Our criminal jurisprudence rests upon three (3) fundamental principles: (1) in criminal prosecutions, the State has the burden to prove each element of an offense charged beyond a reasonable doubt, (2) that burden never shifts to the defendant, and (3) a defendant has no obligation to prove his innocence nor offer any proof related to his innocence. *N.J.S.A.* 2C:1-13a. *State v. Bailey*, 231 N.J. 474, 483-484 (2018); *State v. Cotto*, 182 N.J. 316, 326-327 (2005); *In re Winship*, 397 U.S. 358, 364 (1970). Criminal cases routinely take the form of witness' testifying on behalf of the State only as to facts known by them. However, where a witness is versed in some special knowledge, skill, experience or training which is acknowledged as material to a case and not possessed by the ordinary juror, and that specialized knowledge "will assist the trier of fact to understand the evidence or determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education may testify thereto in the form of opinion or otherwise." *N.J.R.E.* 702.

New Jersey Rules of Evidence 702 governs the admissibility of expert testimony. *State v. Harvey*, 151 N.J. 117, 169 (1997). The burden is on the proponent to demonstrate the expert testimony as generally acceptable scientific evidence. *State v. Kelly*, 97 N.J. 178, 208-209 (1984). "[P]roving general acceptance 'entails the strict application of the scientific method, which requires an extraordinarily high level of proof based on prolonged, controlled, consistent, and validated experience.'" *State v. Harvey*, 151 N.J. 117, 171 (1997) (quoting *Rubanick v. Witco Chem. Corp.*, 125 N.J. 421, 436 (1991)). To be admissible at trial as expert testimony, three (3) basic requirements must be satisfied: (1) the intended testimony must concern a subject matter that is beyond the knowledge of the average juror; (2) the subject of the testimony must be at a state of the art such that an expert's testimony could be sufficiently reliable; and (3) the witness must have sufficient expertise to explain the intended testimony. *Id*. (quoting *State v. Kelly*, 97 N.J. 178, 208 (1984); *N.J.R.E.* 702, 1991 Supreme Court Committee Comment). The law requires that for expert testimony to be admissible the discipline, methodology, or premises relied upon must be sufficiently reliable. For scientific expert testimony, the technique or mode of analysis will only be deemed acceptable if it has "a sufficient scientific basis to produce uniform and reasonably reliable results so as to contribute materially to the ascertainment of the truth." *State v. Torres*, 183 N.J. 554, 568-570 (N.J. 2005). General acceptance need not be unanimous acceptance, but rather that the "scientific technique or procedure be accepted as scientifically reliable, not that it produce results which are beyond all legitimate doubt." *Magaw v. Middletown Bd. of Educ.*, 323 N.J. Super. 1, 14-15 (N.J. Super. Ct. App. Div. 1999).

Although the Supreme Court of the United States and Federal Rules of evidence have relaxed the standard for admissibility of the scientific reliability of expert testimony, New Jersey

continues to apply, in criminal cases, the *Frye* test for determining such reliability. *State v. Harvey*, 151 N.J. 117, 169-170 (1997). Under the *Frye,* "[. . .] 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." *Frye v. United States*, 293 F. 1013, 1014 (D.C. Cir. 1923).

As the test, then, requires the demonstration of "general acceptance" among those within the relevant profession, it can be demonstrated in three ways: (1) by expert testimony as to the general acceptance, among those in the profession, of the premises on which the proffered expert witness based his or her analysis; (2) by authoritative scientific and legal writings indicating that the scientific community accepts the premises underlying the proffered testimony; and (3) by judicial opinions that indicate the expert's premises have gained general acceptance. *State v. Harvey*, 151 N.J. 117, 170 (1997); *State v. Moore*, 188 N.J. 182, 206 (2006) (citing *Rubanick, supra*, 125 N.J. at 432 (1991)) (quoting *Windmere, Inc. v. Int'l Ins. Co.*, 105 N.J. 373, 379 (1987)). "Such reliability, however, does not depend upon unanimous belief or universal agreement within the scientific community as to the acceptability of the subject-matter." *State v. Tate*, 102 N.J. 64, 83 (1986). However, a "moderate" degree of acceptance is apparently not sufficient. *Tonsberg v. VIP Coach Lines, Inc.*, 216 N.J. Super. 522, 526-527 (App. Div. 1987). In criminal prosecutions, conditions of admissibility must be "clearly established." *Windmere, Inc. v. International Ins. Co.*, 105 N.J. at 378. In evaluating the admissibility of scientific evidence introduced by the State in criminal cases, it is important to recognize that a high degree of reliability is necessary where the freedom, or even the life, of an individual is at stake. *State v. Cary*, 99 N.J. Super. 323, 333 (Law Div. 1968), *State v. Doriguzzi*, 334 N.J. Super. 530, 540 (App. Div. 2000).

In the present case, the experts who testified were deemed qualified within their respective fields and found to have sufficient expertise to explain their intended testimony. They each brought years of experience, observation, and study to the assessment of AHT as a routine diagnosis. Each expert based their opinions on authoritative, scientific literature had been published and/or peer reviewed. Furthermore, there were several reliable studies conducted and submitted to the Court in support of the testimony given by each expert witness, including their own published articles. In the end, the studies provided for review were of great assistance to the Court's attempt to understand the origin of AHT and the issues surrounding this diagnosis.

There is no doubt that a diagnosis of AHT and the "triad" of symptoms (i.e., bleeding in the brain, bleeding in the eyes, and neurological impairment) associated with it is a subject matter that must be deemed outside of the knowledge of the average juror. As per Dr. Medina's testimony, a diagnosis of AHT involves a finding of the triad along with a comprehensive evaluation conducted of the child's medical history, the physical findings at the time the child was examined, laboratory and imaging testing, and consultation with multiple subspecialists within the field of pediatrics and trauma. This, then, necessarily requires expert testimony to explain how an AHT diagnosis could be concluded without actual evidence of child abuse.

What this court has gathered from a review of the literature and testimony provided is that physical examinations are most useful to medical treatment providers because they use the symptoms presented by a patient, combined with a patient history, to run medical tests to then enable them to develop a diagnosis for the cause of a patient's illness or infirmity. Essentially, making a diagnosis is about eliminating possibilities through testing, and a valid diagnosis can improve the effectiveness of treatments and avoid long-term complications for the infected

patient. It can also lead to a greater understanding of the medical issue presented and provide the best opportunity for a positive health outcome because clinical decision making will be tailored to a correct understanding of the patient's health problem through testing.

What is also clear from the literature and testimony is that AHT has never been medically nor scientifically validated as a diagnosis because it has never been developed through scientific/medical techniques or procedures which, in turn, would make it a diagnosis that is scientifically or medically reliable. What has been provided, especially through Dr. Medina's testimony, is that AHT is more conjecture than a diagnosis because it is an option embraced once a diagnostician runs out of diagnostic options. No test could be cited by Dr. Medina, nor referenced within any of the literature, that could support a finding that humans can produce the requisite physical force necessary to produce the symptoms in an infant associated with AHT. Providing no evidence that the defendant inflicted any trauma upon the victim in this case, AHT is a flawed diagnosis because it originates from a theory based upon speculation and extrapolation instead of being anchored in facts developed through reliable testing. There is no proof provided that AHT is, in fact, a valid diagnosis explaining an inflicted trauma which causes a pathology. Instead, what the literature and testimony have clearly shown is that AHT is an assumption packaged as a medical diagnosis, unsupported by any medical or scientific testing, based upon scaled down versions of testing done on monkeys, wooden dolls, or other anthropomorphic surrogates, and which is proffered in cases like this one as proof beyond a reasonable doubt as to the cause of the infant's injuries. Again, there is no support for allowing this to stand since no study has ever validated the hypothesis that shaking a child can cause the triad of symptoms associated with AHT. For purposes of use within a criminal courtroom to prove

causation, AHT can be highly prejudicial and far less probative given that this diagnosis is akin to "junk science" in that it is testimony presented both inaccurately and misleadingly as scientific or medical evidence when it has little to no connection to scientific or medical testing, especially when no one has ever tested the capacity of an individual to shake a baby in an effort to cause the triad of symptoms defining AHT. Human babies are very different from the monkeys, wooden dolls, or other anthropomorphic surrogates utilized in the studies referenced and reviewed concerning the effects of force and impact. As a result, and as testified by Dr. Medina on behalf of the State, we do not know nor will we likely ever know what is the minimum force necessary to cause subdural hematomas or any of the other triad symptoms making up AHT as there is no scientific technique or procedure to confirm AHT a reliable diagnosis. That technique or procedure is mot necessary because it is "the **thing** (*emphasis added*) from which the deduction [i.e., the diagnosis] is made" and is what must be deemed "sufficiently established" in order for expert or medically testimony to be admissible as reliable testimony under *Harvey*[44] and *Frye*.

The testimony of the experts coupled with the literature reviewed make clear that testing or experiments are the means of proving the validity of a particular hypothesis or diagnosis. The process seems to begin with an idea about a particular outcome which is then subjected to rigorous testing and peer review. Both then transform this hypothesis into an informed opinion based on the hard data resulting from testing. Under this rubric, presumptions are separated from knowledge by the degree to which an idea is tested since testing becomes the arbiter of facts and/or conclusions reached. Unlike a medical diagnosis concerning an injury to an individual via physical evaluations by medical personnel, AHT is a diagnosis which is not the result

[44] State v. Harvey, 151 N.J. 117, 169-170 (1997); Frye v. United States, 293 F.1013, 1014 (D.C. Cir. 1923)

of physical evaluations.

This trial court is not so presumptuous so as to believe it can influence or critique an entire medical profession into change as it relates to AHT. But the literature and testimony provided, especially that of the State's witness Dr. Medina, make clear that infant brains have never been evaluated for causation of brain injury because there is nothing that can simulate an infant brain. While the Center for Disease Control has defined AHT as an inflicted injury of the skull or intracranial contents in an infant or a child under five (5) years of age caused by violent shaking, blunt head impact of a combination of the two, Dr. Medina testified that a diagnosis of AHT is never made on a clinical finding in the manner that all other diagnoses are. It is made by way of a process of elimination involving medical testing to assess and/or eliminate possible causes of the triad of injuries associated with AHT, and when all testing runs its course without positive results as to causation, diagnosticians are left with AHT as a final option.

AHT as a diagnosis was devised from studies concerning the injury thresholds for intracranial injury beginning with the Ommaya study in 1968 on monkeys. Having established what forces are required to generate a concussion or a brain injury in a monkey, studies conducted after the Ommaya study used different animal models, computerized models, and various anthropomorphic devices (similar to crash test dummies) in an attempt to determine the injury threshold (i.e., force) necessary to generate intracranial in those test surrogates, all in their efforts to determine the injury threshold for intracranial injury in infants. What the testimony and literature have provided is that the conclusions from all studies are so diverse that no consensus can be reached concerning the injury threshold for intracranial injury in infants. This is because the scaling down of test results for intracranial trauma for primates, established in the

Ommaya study, to adult human brains have not been validated, nor has the attempt to scale down those results infant brains been validated. An infant brain is significantly different from an adult brain and so, as testified by Dr. Medina, no one really knows the injury thresholds required to cause injury to the infant brain, given how different it is from any other models tested. As a result, as no model can accurately simulate an infant's brain doctors are left with scaling down results of the prior tests on monkeys, crash test dummies and wooden dolls to make assumptions about the force necessary to cause brain injury to an infant.

As has already been outlined, criminal defendants are entitled to a presumption of innocence as to all charges unless and until the State proves their guilt beyond a reasonable doubt. *Delo v. Lashley*, 507 U.S. 272, 278 (1993); *In re Winship*, 397 U.S. 358 (1970); *State v. Hill*, 199 N.J. 545, 558-59 (2009); *N.J.S.A.* 2C:1-13. They also have the right to a fair trial before an impartial jury, with their guilt or innocence determined solely upon competent evidence deemed admissible at trial. *State v. Artwell*, 177 N.J. 526, 533-34 (2003). Trial courts may make such rulings as they deem necessary to protect those rights. *See State v. Kuchera*, 198 N.J. 482, 494-502 (2009) (addressing the issue of a prosecution witness appearing in restraints and prison garb); *Artwell, supra*, 177 N.J. at 534-39 (addressing the issue of a defense witness appearing in handcuffs and prison clothing); *State v. Maisonet*, 166 N.J. 9, 16-23, 763 A.2d 1254 (2001) (addressing the issue of a defendant appearing in dirty and unkempt state due to denial of basic necessities in jail). Trial judges must also control the courtroom "and prevent conduct which may improperly impact on the trial process." *State v. Castoran*, 325 N.J. Super. 280, 285, 739 A.2d 97 (App. Div. 1999) (defendant wearing t-shirt that was testimonial in nature), *certif. denied*, [*12] 163 N.J. 78, 747 A.2d 286 (2000). The court's rulings on such matters are important

because the presumption of innocence and the integrity of a prosecution cannot be compromised by the introduction of evidence which has no probative value and which is, instead, highly prejudicial. On the strength of its name alone, "***Shaken Baby*** Syndrome/Abusive Head Trauma" evokes a sense of horror that affects the sensibilities of any competent juror, compromising their ability to follow the instructions of court concerning the weighing of evidence fairly and impartially. Thus, AHT cannot become part of a case unless it is coupled with physical evidence that an accused subjected the infant-victim to some impact of physical trauma that would support holding the accused criminally liable. Otherwise, AHT remains exactly what is it…a final option lacking a reliable diagnostic criteria masking as a diagnosis.

Errors in our Criminal Justice process cause harm to society and those involved. We set our efforts in a criminal trial towards examining whether guilt is established beyond a reasonable doubt. We utilize various measures to ensure the requirements of Due Process are met in the form of pretrial motions and the *voir dire* developed for jury selection. To justify the admission of testimony concerning AHT as reliable forensic evidence of causation, this diagnosis should originate from disciplined research and testing mechanisms which can be identified and deemed reliable. This is important because the admission of speculative evidence fails to ensure safety from false convictions founded then more on bias and prejudice than certainty of proof. The admissibility of AHT inappropriate because it is an inaccurate and misleading diagnosis because it lacks scientific grounding. There is no "quality assurance" component to this diagnosis because it is a hypothesis based upon extrapolation of data, coupled with a "process of elimination" engaged in by diagnosticians in an effort to reach a "conclusive diagnosis" which, in the end, cannot be treated medically. The accuracy of scientific evidence must be established and not left

premised upon probabilities based upon extrapolation of data but, instead, certainties borne from testing and examination. Otherwise, such evidence would have no staying power. In the end, a hypothesis proffered by a medical professional in a criminal trial has never been considered more important than the testing utilized and identified to determine its certainty. Furthermore, in a criminal trial the State has a heavier burden to meet in establishing guilt "beyond a reasonable doubt" than do doctors hypothesizing to a "reasonable degree of medical certainty." The evidentiary standard for a hypothesis proven to a reasonable degree of medical certainty falls short of the evidentiary standard employed to determine guilty in a criminal trial. The former is defined as "…a standard requiring a showing that the injury was more likely than not caused by a particular stimulus, based on the general consensus of recognized medical thought,"[45] while the latter is defined as "…proof, for example, that leaves you firmly convinced of a defendant's guilt."[46] The danger to be avoided here is influencing jurors through confident and confirmatory responses cloaked in the language of science or medicine, and which are responses provided by witnesses qualified by the court as "experts" who, in the end, testify without being able to identify the testing mechanisms to support their conclusions as reliable because there are none. In this instance, there is also a risk that jurors will receive the word "certainty" within the phrase "to a reasonable degree of medical certainty" as suggesting a high degree of value and reliability concerning AHT as a proven diagnosis for causation.

For the foregoing reasons, testimony concerning AHT cannot be allowed in this case because it is not reliable evidence and is far more prejudicial than probative in value. To allow it

[45] Black's Law Dictionary, Eighth edition. 2004.
[46] State v. Medina, 147 N.J. 43, 61 (1996).

into a case containing a provocative set of facts like the ones we have here would be foolish because doing so would be the perfect recipe for a conviction not borne of a fair and unbiased decision-making process but, instead, one which would compromise the integrity of this prosecution and our criminal justice system. In this case, the State has failed to provide evidence that the defendant inflicted force upon the victim resulting in injuries symptomatic of an AHT diagnosis. They have also failed to prove that the science behind an AHT diagnosis is reliable so that it can be used to by the State to implicate the defendant in abusive conduct and hold him criminally liable for causing the victim's injuries. For the foregoing reasons, the defense motion to bar the admissibility of testimony concerning "Shaken Baby Syndrome/Abusive Head Trauma" is **GRANTED**.

HONORABLE PEDRO J. JIMENEZ, JR., J.S.C.
SUPERIOR COURT OF NEW JERSEY
CRIMINAL DIVISION

ORDER OF THE COURT

State of New Jersey

vs.

DARRYL NIEVES
Defendant

Ind./Acc./Complt. #: 17-06-00785

PROMIS #: 17000837

ATTORNEYS: For the State: Jody Carbone, Esq.

For the Defendant: Danica Rue, Esq., & Caroline Bielak, Esq.

DATE: January 7, 2022

THIS MATTER having been brought before the Court by way of: a defense motion to bar the admission of testimony concerning "Shaken Baby Syndrome/Abusive Head Trauma";

AND THE COURT having considered: the testimony of witnesses, the arguments of counsel, and the briefs filed in support of same;

IT IS HEREBY ORDERED: the defense motion is GRANTED for the reasons contained within the decision to which this Order is attached, and the remarks added by the Court on the record at today's status conference.

P. J. Jimenez Jr.

Honorable Pedro J. Jimenez, Jr., J.S.C.
Superior Court of New Jersey