

Traumatic Brain Injuries in Early Childhood: *Recognizing, Recovering, Supporting*

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Hi. My name is Keely Deidrick. I'm a psychologist at the Thompson Center, working at the University Of Missouri for about nine years, working with kids with brain injuries and other brain-related kinds of developmental issues, and Dr. Eileen Bent is here with us, as well, she's a child psychologist. She's getting additional specialized training in our center for working with kids. We're really excited to be here today.

We're hoping that this will bring some additional awareness to what we think is probably an under-recognized problem for our young children, which is physical injuries to the brain.

As I'm sure you're aware, our brain is an amazing organ.

No matter what you're doing, if you're cleaning the bathroom or making some big decision or learning something new or crying because you've lost a loved one, your brain is involved in that.

It's involved in interpreting what you see, hear, taste, and touch. It's involved with processing the information that you see around you and timing your perceptions to emotional reactions.

And so when we're working with kids who have had a brain injury, there is an injury that occurs on top of all of the development that's going on already. They can start to have difficulties, learning, behavior, personality, particularly if we don't recognize that issue and provide support when we can.

So I think our hope today really is to be able to provide some additional awareness, give kind of a foundation of some beginning knowledge, and our hope is that what you'll do is ask questions today any time you get a chance. Talk with us at lunch. Ask questions throughout the presentation, and then contact us in the future.

We're hoping that we'll be a resource for you so that if you have children in particular that you're worried about or questions that you have as you're learning more that you'll contact us and we'll be glad to access resources for you in those areas. Okay? Good.

This just highlights what Tina was talking about in terms of the multiagency collaboration that we've all been working together on this training, and we received some funding for this training through the Missouri Department of Health and Senior Services through the Missouri Head Start State Collaboration Office, and we're really grateful for that support.

We also want to highlight a lot of the material from this talk was adopted from a prior effort that was a statewide effort towards developing a training for teachers in Missouri on traumatic brain injury. It wasn't early childhood focused. It was broader than that. But it was called understanding students with brain injury, and it was through -- I don't know if you remember when we used to have the center of information in special education in Columbia. It was funneled through that center. Those trainings are not in existence -- anymore, but those materials are.

So really the presentation today has kind of three main sections, if you want to think about it that way.

The first section will include me giving you kind of the background things that you need to understand to be able to understand the impact of traumatic brain injury in children.

The next section is probably more practice for you because it will talk about what are the cognitive and behavioral impacts of a brain injury on young children and what are some strategies that you can use when you're working with kids with a brain injury, and at the end, I'll talk a little bit about what do you do if you have a kid who

hits their head when they're in your care, and what do you do if you have a kid who you suspect may be having trouble because of a brain injury? How do you follow that up?

In order to understand brain injury, we have to understand a little bit about the brain: I'm going to spend some time talking about how the brain is put together, brain anatomy and how brain development happens.

So our brain is made up of millions of neurons. The neurons are the basic information processing pieces in the brain. And they're amazing, because what they do is they take in information. These processes here are called dendrites. They take in information from all over the brain, and they take that information in, and when it gets to the cell body, that cell body has to make a decision about that information. So put that information together and decide what to do with it.

So it has to decide, am I going to send that information on to other neurons or not, and if I'm going to send it on, how strong is my signal going to be and what kind of signal is that going to be. And then that cell sends that information out this long axon and out these terminal branches either to muscles or other organs in your body or to other neurons.

And so neurons can look very different from one another, but they all are characterized by these distinctive processes that allow them to connect with other neurons in very complicated circuits all throughout the brain, and it's those circuits that the work in -- the things we do in our daily life, those are the circuits that cause that to happen, those connections between neurons.

During development, what we see in young children as they're developing is the development of those connections between neurons and the development of those circuits.

So some of those circuits are kind of hard wired, so when you think about infants coming into the world, what are some of those skills that they come in with already that seem to be hard wired.

Breathing.

What else?

Sucking, uh-huh.

What else?

Crying, yeah, crying.

Reflexes.

They can identify shadows and light, right?

So there are some things that are already in there and already programmed in there when infants come into the

world. But then there are other circuits that are developed through experience that experience really shapes how those circuits are created so that the infant's interaction with the world helps them create circuits that allow them to develop and grow.

So when you think about the infant who can't hear sounds when they're born but very quickly becomes to distinguish their mother's voice as a special sound, because that sound is related to food, you know, related to food and comfort and all of those good things, right?

And so that experience helps that baby's brain circuitry develop so that it recognizes its mother's voice.

The other thing that happens that we notice in development is actually the removal of brain senses that aren't working or needed anymore. So some of those early primitive reflexes that babies have that then go away later are a great example of what's called pruning.

Old circuits that aren't working are pruned away.

So all of these circuits and all of these neurons and in addition some other cells that offer nutrition and support to those neurons form your brain, which is this really impressive looking kind of three pound structure, right, that is the consistency of a Jell-O jiggle. Do you make those? It's got a little substance to it, but it kind of jiggles. That's kind of the substance of your brain, not a real tough kind of structure. And then it's kind of crammed into the brain -- or into the skull, and in order to make the most of that space, it has all of these nooks and crannies to increase the surface area of your brain and maximize space.

So you have this structure, and it's in your skull, and it's kind of balanced on the brain stem, so it's kind of like having a soccer ball balanced. It's this big three pound structure on top of this kind of smaller spinal cord. And in that skull, which protects the brain, there is a hole, and through that hole is where the spinal cord goes, right? And right above that is your brain stem, right above where that hole is. Your brain stem is where all the things that keep you alive happen, making sure you breathe and your heart is still beating and your blood pressure stays stable all happens in that brain.

And then in addition to kind of protecting your brain, there are some places where the brain almost kind of rests in some ways on parts of the skull.

The thing to remember, if you have ever looked on the inside of a skull, like in a skeleton or something, there -- is it a smooth surface?

Huh-uh. It's a rough surface with pieces of bone that stick out from it, so it's not a real comfortable place to rest, right? And so this are places like up here underneath the frontal lobes of your brain and down here under what are called the temporal lobes of your brain that the brain is resting close to these rocky looking places in your skull.

And so in addition to the skull protecting your brain, your brain also has a system of membranes that protect it, as well, and that cushion it in kind of a thin layer of fluid. So it's almost kind of floating in this thin layer of fluid. So there is a membrane that's kind of like cellophane, and it covers every nook and cranny can closely to the surface of the brain. That's right here in the pia mater, and then here is the middle of the brain, the arachnoid, kind of a spongy part. Through that spongy part, fluid flows, which is called cerebral spinal fluid and that offers that watery cushion so that the brain is almost floating.

And then the top membrane, the dura mater, is this very thick membrane whose job is to protect intruders from coming into the brain. So you've got this brain kind of floating in this cushion in this bony skull. That fluid that surrounds the brain flows. It has a couple purposes, not just to protect your brain but also nourish it. And so it

flows through the brain in kind of these -- these are called ventricles, but it's a system that almost is like -- if you think about cave systems under the ground, right, those caverns that water flows through, and so the fluid flows around those membranes and also through these ventricles and down into the spinal cord and into the membranes that cover the spinal cord, and it's a fluid that is constantly being produced. Okay?

So the brain is nourished by that fluid, and then it's also nourished by its blood supply. And so the brain has this system of blood vessels that is kind of like a web. It almost looks like fingers, if you look at that, that tries to make sure that every area of the brain receives adequate blood supply so that it can function accurately. Okay? Does that all make sense so far? Just kind of an overview of how the brain is put together.

So when you think about your brain, we often think about it almost like a factory. So you've got a factory, and it has different departments, and each department does its job, right? So there's one department that mixes the wax and then there is another department that molds the crayons, and then there is another department that packages them up and labels them, a department that puts them in the boxes and the shipping department, right? And they each have their job to do. There certainly is some of that that's true for your brain as well.

There are parts of the brain that are specialized for certain operations, certain things that it should do. But then the other thing that's true is that all of those parts of your brain are connected together in complicated ways. So just like in the factory, if the people mixing the wax start to run low on wax, they've got to tell everybody else so they can adjust their production. The same thing is true in the way your brain works.

So let's say you're going to pick up your bottle of water or cup of water in front of you. Think about all of things that are involved in that. First, one part of your brain has to see it, right, and perceive it. That's a cup, okay. Kind of figure out what size it is, what shape it is, what size it is. And then another part of your brain has to use that information to say, hey, hand, reach out and grab that cup and tell you how far you should hold your hand apart, and then when you lift up that cup, another part of your brain is to tell you how heavy is it so you don't end up throwing a cup of water over your head and so you can adjust how your motor movement works. And then you take a drink. So that wouldn't be possible if all of those parts of your brain weren't communicating very rapidly and very closely with one another.

So the function of each part of your brain is important, but those connections are almost more important, and you'll see why when a kid has an injury it's critical to think about that, because a lot of times we can get focused on, well, this kid had this injury to this part of the brain, so he's only going to have problems doing this particular skill, when in actuality, an injury in any part of the brain is also going to disrupt all of those connections, so you might have unintended consequences that you don't expect because of the way those connections are disrupted.

Here is just an example of what we divide the brain up into kind of large areas and think about their function, what that looks like. So the back part, the occipital lobe, anyone fresh on their brain anatomy? We usually think about the occipital lobe as vision, right, vision, processing visual information. And the cerebellum, anyone remember what that is? Can you think what that is focused on? Motion, coordination, balance, yes. And then the temporal lobe? Hearing, visual facial processes. The parietal lobe we usually think of as dealing with sensation.

If you can think back to your undergraduate psychology class where they showed you that strange looking person drawn on that part of your brain where a body is represented, the sensations in our body are represented in that portion of your brain. And then there is the frontal lobe, which is where judgment and reasoning and planning and forethought and impulse control and motor coordination all happen. Okay? So each of those pieces have a specific part to play.

But also, this just kind of gives you an idea of the types of connections that are found in the brain. So some of them are highlighted, but you can kind of see throughout this picture these almost cable-like looking structures, and those are tracks, and those are formed by the axon, remember that long process? Those axons kind of come together to make these cable-like connections.

Those connections can happen in multiple ways. They can connect very distant parts of your brain, so that long blue connection kind of shows you how parts of the back of the brain can be connected to parts of the front and everyone in between. Also adjacent structures can be connected. If you look at that yellow connection there. And then also kind of surface areas of your brain can be connected to more deeper structures if you look at that red kind of connection. So the point of this is just to show you how many different types of connections and how complicating those connections can quickly become.

So what questions do you have just about basic brain anatomy? Any questions about that or things you didn't remember?

What part of the body makes the fluid?

You say there is a fluid in the brain. What part is the one in charge to make that?

It's really made in the membranes. There are specialized cells in those membranes that generate that fluid. So it's not generated by a part of the body like when you think about your blood being generated in your spleen and marrow. It's not really like. That it's really generated by specialized cells in those membranes.

To make sure the brain is lubricated?

Yes, making sure it's lubricated and protected and it also brings nourishment to the brain as well. All right.

Thank you.

Other questions? Okay.

Let's talk briefly about what a brain injury is.

I'm really going to focus did on the educational categorization of traumatic brain injury, because that's probably the most relevant to you when you're thinking about kids in your care. But that educational definitions defined by an acquired injury. So this excludes kids who have had a congenital injury.

So kids who were born with some malformation in their brain, kids with cerebral palsy, kids who had a stroke in utero, kids exposed to alcohol or drugs in utero.

So there are lots of kids who have injuries to their brain but are not included in this definition. Typically what I see, and you may tell me differently, in the educational system, those kids usually end up categorized into other health impaired categories most often or are sometimes categorized in a learning disability category, which doesn't really fit them that well. But sometimes it makes sense in terms of services, et cetera. So this definition requires that this injury is caused by an external force.

So that can be either being hit by something, somebody hit you in the head with a baseball bat, or it could be that your head hit something. You fall off the slide on a playground and your head hits the ground, or you're in a car accident and your head hits the seat in front of you. It can be an open or closed injury. In an open injury,

there is a skull fracture. This injury can be open or closed. It has to result in total or partial physical disability, psychosocial impairment or both.

As I mentioned before, excludes congenital, degenerative or birth injuries, a variety of other kind of brain-related impairments. So it's really in contrast to an acquired injury, which is an injury that could occur in some of those other ways I described before. So does that make sense? This is a very specific definition.

Let's talk briefly about how often head injuries occur and in whom they occur. This is data from the Centers for Disease Control who published this data on their website. And you're free to go and look at that if you have questions that you want answered about this issue. This shows cases per 100,000 people by emergency department visits, hospitalizations or death. It shows the number with a brain injury by age, so age is along the bottom, and number of people per hundred thousand, goes up to 5.

So what do you notice when you look at this graph? What hits you right away? Kids age 0 to 4 are one of the reasons that the plans that we're working with has targeted this population, kids 0 to 4, as a high risk for a head injury.

If you look at the emergency department visits, that comes out a little bit clearer. Which is the next most common age group to have a brain injury? Teenagers, young adults, yeah. And then after that? Senior citizens, yeah. It kind of starts to rise again at age 65. And the hospitalizations pattern follows kind of a similar pattern, just at a lower rate. And then death follows a flat pattern with a rise for folks who are more elderly. The point of this slide is that males are more likely to have brain injuries no matter what the age. That gender difference closes up a little bit as folks enter their senior years, but in general, boys are far more likely than girls to have an injury.

Because they have more accidents or what happens?

Maybe, yeah, yeah.

So this looks at cause.

Actually, you want to go back one slide? Without cheating, why do you think -- unless you've already seen too much. Why do you think kids age 0 to 5 might be -- 0 to 4 might be at higher risk?

Shaken baby, uh-huh. Shaken baby and child abuse, right?

What else? They've got those big heads and smaller bodies, and their coordination isn't fabulous, and you spend most of their first six months of walking following behind them like this (indicated), yeah.

So their balance isn't great, and they fall a lot. What about teenagers? Why do you think teenagers?

Driving, yeah, driving, yeah, yeah. And then what about senior citizens? Falls. So if you look at the next slide, it just shows that. It's kind of divided in a funny way, but there is this struck by and struck against category and then an assault category. But if you look at kids 0 to 4, falls are really the no. 1 cause followed by being struck by or against something, which may in some cases involve some abuse followed by motor vehicle accidents and assault. For teenagers, it's more likely to be a car accident.

I think that's an interesting thing to bring up, because there has been a lot in the media about sports and young children, brain injury conference. They talked about that a lot, as well. Certainly sports are a concern, but I think we probably don't have great data on that yet. At least on this large scale. Do you think they could be included in this struck by or struck against category?

They might be.

They might be, yeah. That's a good point, too. They might be in the struck by, struck against category, as well. Okay. So questions about that? Questions of questions about what is and incidents and prevalence of traumatic brain injury? Okay. So let's talk about what happens when you have an injury.

We're going to try to use some case studies throughout just to try to make this a little more concrete and interesting. Let's start by talking about a case study. We have a little boy named Adam, and Adam is 6 years old, and he's in the car with his mom one day, and they're driving, and he's not restrained in the vehicle, and their car is hit by someone else. Okay? And so what happens when you're hit? Your car stops pretty quick, right? And he flies forward and his head hits the seat in front of him. Let's think about what happens to Adam's brain when this happens. We've got this brain and it's kind of suspended in this fluid in this kind of rocky skull, and so when his head goes forward, his brain is also going forward, right? And it hits that seat in front of him, and his brain -- his head stops, but his brain is still going, and it hits the inside of his skull. The first thing that happens is it hits that inside of the skull, and it may even scrape a bit against that bottom part of the skull. So that part where the point of impact happens is called the coup injury, and it's that initial point of injury. It doesn't have to happen in the front part of your brain, right?

A kid gets hit on the side of their head, and that coup could be on the side of their head as well. But for Adam, it's right on the front part of his head. And then his brain is suspended in that fluid, right, so it bounces back. At the point opposite where he was hit, his brain impacts his skull at that opposite point, also causing an injury, and that's called the contra coup injury.

So there is the point of impact injury and then there is the opposite point, and then also that brain is suspended in fluid on top of that little -- I talked about the ball, right, on top of that spine.

It can move around a little bit, and so the other thing that happens is that tissue moves around and can get stretched and twisted.

So when you think about all the long fibrous processes from the axon and dendrites, neurons and tracks in the brain, those can get stretched and twisted, so there can be some microscopic damage that occurs there, too. So that's kind of the primary mechanism of injury, first the point of impact, that opposite point of impact, and then the twisting and sheering of the fibers. In addition, you can also get a hemorrhage if one of those blood vessels is rep toured -- ruptured in that initial injury, as well. So think about what happens if someone hits you in your arm, and they hit you pretty hard, and it hurts. It doesn't break your arm, but it hurts. What happens? What do you form on your arm?

A bruise, right? Kind of blood pools underneath there and it gets kind of puffy. The same thing happens when you've essentially bruised your brain in the front and the back. It gets kind of puffy and blood kind of pools there. The problem is, you have space to go here, right? And it's not a huge problem. Your brain is constrained. There is only so much space. There is not a lot of space to go.

So some secondary injury can start to happen due to that pressure. So when that swelling starts to happen, that tissue of your brain gets compressed in that skull, causing other injury. In addition -- swelling is just part of what our body does to help us heal, right? But swelling brings blood products that help us heal to be helpful so the brain can swell. You usually hear about it called edema, right?

And that overall swelling again can cause that compression. If you have a hemorrhage, that can also cause more pressure. So that pressure is a problem. If the swelling is enough that it blocks one of those places in those caverns where the fluid was flowing through so that it can't flow well, then you've got a problem, because that fluid is continually generating, and it builds up in your ventricles and those ventricles get really full, and that can cause compression, as well. Right? So those are some of the secondary factors that can really create a lot of the injury. A lot of the medical intervention is around trying to minimize those secondary mechanisms as much as possible. If the swelling gets bad enough, what will happen is your brain will do this thing that is awful and has an awful term with it, called herniated.

What that means is that hole -- remember that hole that the spinal cord goes through? That brain tissue can become so tight there's no space for it to go and it starts to push through that hole, and if you remember, what was the structure right about that hole? The brain stem, right? And so a lot of times if you have a moderate to severe injury, what the physicians are really worried about is making sure that doesn't happen, because that is what will cause death fairly quickly for someone. So a lot of the treatment that happens, and Dr. Bent will talk about that, is aimed towards keeping that swelling from causing the secondary injury. Okay?

So it becomes really important to measure how severe these injuries are, because that tells us something about what the outcome might be, and Dr. Bent will talk about that in more detail.

But I wanted to just mention some ways that we measure severity. Thank goodness for Dr. Bent, because she fixed this slide. It did read wage instead of rate. I don't know why. Looking at it this morning, I thought that's not going to work. One way that we figure out how severe an injury is by looking at a child's behavior right after they're injured. So this is a standardized way of rating a child's behavior after their injured. It's called the Glasgow coma score. Oftentimes it's abbreviated GCS in medical records. And so this rates, is a child opening their eyes? Are they doing that spontaneously? Are they doing it in response to someone's voice or to pain, or are they not opening their eyes at all? Then there is a rating for their verbal behavior. Are they talking at all?

And when they're talking, is it making any sense? And then there is a rating for motor behavior.

It's a lot like the rating for the eye opening. It has to do with, are they moving spontaneously and with some purpose? Or are they just moving if they feel pain? And is their movement localized, like if you pinch them on the right arm, are they flinching their right arm or just generally moving.

Let's say with Adam, he's in that car accident, and when the paramedics come, they notice that he's not opening his eyes, okay, except to pain. So they pinch him, and he opens his eyes briefly. And then they notice that he's talking but it doesn't make any sense, and if you ask him a question, it's completely unrelated whatever you asked him. And then they also noticed that he's moving, but there is no pattern to his movement. It's just kind of the agitated kind of movement. So they would add up -- they would score each of those areas and then add up those scores to get an index of severity.

So for Adam, his rating was a 9, which puts him kind of right on the cusp of this moderate to severe range. In contrast, let's say you have a little girl named Tasha, and she is playing on the playground. She's 4. She's playing on the playground at school and falls off the slide. It's pretty high, and she falls off the slide and hits her head. The teacher goes to get her, and she's super confused. She's kind of wandering around and not making a lot of sense. But her eyes are opening. She's answering you. She just looks really dazed. Her mom comes to get her and puts her in the car and she throws up and just seems really kind of confused. So if they rated her, she probably -- her eyes are open. She's moving purposefully.

The only issue really is that she's not responding verbally the way you would expect her to, and so she probably has a coma scale that was about 13 or 14, which would place her in that mild range.

The other way that we measure severity is by posttraumatic amnesia, and you all are probably aware that in the media amnesia is what is most often associated brain injuries, and there are always kind of these dramatic depictions of somebody who has a brain injury and forgets who they are and doesn't remember anyone in their life. That's not really the kind of amnesia we see in a brain injury. What we usually see is there may be some concern about past memories that are the most fragile memories, and so they're the ones that weren't quite consolidated or solid in your brain. There may be difficulties there.

The most common difficulties are with laying down new memory. For example, Adam, after his injury, he's disoriented, confused. He goes to the hospital, and during his hospital stay, his family notices that he keeps asking why he's there once he starts really talking. Why am I here? How did I get here? And they tell him over and over again. You were in a car accident, and it just doesn't seem to stay.

He has the same nurse almost every day and has no idea who he is and needs an introduction every time she comes, and his friends and relatives come to visit, and mom says, hey, remember when dad was here yesterday or Uncle Ned, and he says no. So just not being able to lay down those new memories afterwards.

For a kid like Tasha, what you may find is she's kind of confused and doesn't seem to be laying down new memories for a minute or so. For a kid like Adam, this lasted nine days.

That period of time where a kid is confused, disoriented and doesn't remember events or their memory is super spotty, so kind of these strained memories where they remember bits and pieces, that's called a link of posttraumatic amnesia. That is a good way to measure severity. So 24 or less of PTA, which is the shorthand for posttraumatic amnesia, 24 hours or less is considered mild.

From a day to 7 days is moderate. And more than 7 days is severe. So Adam at nine days is reaching that severe range.

But this index can get a little confusing, because for a lot of kids medically we induce a coma right away to try to help with that secondary injury piece. So this can be a little bit more confusing to figure out, but it still is pretty helpful.

Sometimes there are kids whose Glasgow Coma Scale look pretty good and they have pretty long past traumatic amnesia, and that gives you a little hint that the injury was more severe. For a kid like Adam, what we did is we gave the children's orientation and amnesia test, which is a scorable test you compare to other kids their age, and asked questions about how old are you, what's your name, who do you live with, orientation questions, and then you give them other questions and score that up and give it repeatedly so that it tells you when they come out of that posttraumatic amnesia fairly specifically. Obviously medical students can also tell you about severity, right? The things to remember about scans is they can be limited based on what you can see in that particular kind of scan. Okay?

So a cat scan is like a three dimensional x-ray. It really looks at surface structures. So a kid like Adam, you're going to see a cat scan and see a hematoma on a front and maybe a small contra coup hematoma in the back. A kid like Tash, you're going to see nothing. It's going to look fine.

An MRI may show you more. A kid like Adam is probably also going to show small lesions, probably right next to the ventricles from that twisting and sheering and those kind of more microscopic kind of injuries. And a kid like Tasha, you might have the see something like that. You might not. Okay. So they can be helpful.

When there are obvious abnormalities on an MRI, you know your injury is at least in the moderate, if not severe range. So really the combination of imaging and behavioral indexes is going to give you a best idea of where a kid is in terms of severity. Questions about that piece, about measuring how severe an injury is? Yes.

My question is just in regards to the injury severity, if this is something -- and maybe it's going to be talked about later on. But if it's something that you don't know about right away but then later on you still have -- the child might demonstrate just something that's not ordinary, can you still do, like, some of these tests that will show that this may have happened previously or something may have happened to this child as far as an injury to their brain?

You can.

So I think what you're getting at, and tell me if this is right, is that sometimes we have a kid who goes to the ER, check out okay, cat scan looks fine, and they go home and everything looks fine, but they continue to show behavioral signs. Is that right?

No. Let's say you don't know. Let's say the child bumped their head or something, but then they kind of like have shaken it off before you have even identified that they have fallen or whatever. But then you realize like that evening or something like that that he or she is just not acting like they normally do or maybe the next day or something like that. And then you're taking them to get the physical or whatever, but you don't even know that they've.

That's a really good question, and that becomes really challenging. There are times that that happens and they go and do a cat scan or MRI and find something. There are other times they don't find anything, and if you find out they've had a bump on the head, then that child comes to someone like family who do test with memory, concentration and all of those things that Dr. Bent is going to talk about.

Sometimes we can say, you know, this looks a little like a brain injury, but if we don't have a documented brain injury, it becomes really hard, and you end up kind of focused on symptoms as opposed to cause sometimes. Sometimes we can put those two things together. Sometimes we can't. Does that make any sense?

It does.

I saw a kid once who had a skull fracture as a toddler, and skull fractures aren't -- medically physicians aren't always concerned about a skull fracture. So she bumped her head, seemed fine, went through a few more days and seemed a little bit worse, and they did a cat scan and they saw a skull fracture, and the doctor said, it's just a skull fracture. Don't worry about it. And then later on, even then with this documented injury, later on they brought this child to me and said, this kid is having lots of trouble with attention and learning and those kinds of difficulties, and we did testing. I knew there was some kind of injury. All I could say is we suspect it could have been more.

When it gets further removed, it gets kind of dicey, so we do the best with what we have.

We live in different kinds of cultures, and some cultures, they don't know about how it works.

For example, if the child bumps his head, the -- sometimes they say, it's okay, but it's good to know to share when the child bumps his head how long they had the period of time to bring him to the doctor, because I hear after 24 hours, it's kind of like late and the doctor can't check if there is any brain injuries. Yeah. Sooner is definitely better, yeah. And oftentimes, the doctor is just going to tell you, it's a bump on the head, and that's great, right?

But there are times when that's not the case, and yes, telling people to take their child in sooner is a good idea. Yeah. Have them checked out, yeah. Okay.

I'm going to be talking a bit more about the two children that Dr. Diedrick had introduced, Tasha and Adam. I'll tell you a little bit more about the initial treatment and recovery course will look like. So you heard about this already for Tasha who had fallen after the slide and hit her head. Her mom took her to the emergency room. She was feeling kind of out of it. She was sick to her stomach and throwing up. What they did at the hospital was that he documented her symptoms and asked about them. They did a CAT scan, and like we had talked about already, there really wasn't anything notable on that.

They kept her there for a few hours to observe her and make sure things were starting to get better, and she was over the course of even a few hours feeling more like herself, more with it. She was able to talk in a way that made sense and answer questions in a reasonable way. So she was released home after a few hours with some instructions to mom about some things to look for and just to bring her back if they got concerned about anything. This injury happened on a Friday, and she was back to school on Monday.

So here are the initial -- here the initial kind of treatment course was pretty simple, not it too many components. But this is going to look very different if the injury was moderate to severe, as was the case for Adam. So often for moderate to severe, there is going to be some kind of emergency response, paramedics will come, the child taken to the hospital by ambulance or med flight, if that's what's needed. And then when they get to the hospital, the main things that you're going to be looking for, you're going to be looking to treat physical injuries, and you're also going to be trying to assess the severity of the brain injury and also try to prevent some of those secondary mechanisms of injury, things like swelling, problems with fluid flow to the brain, bleeding within the brain and those sorts of things, so you're going to be doing some tests to look for things and taking some precautions to try to prevent them. So for Adam, he got a cat scan, and like we already know, that showed the hematoma in the front and smaller one in the back. Later on, they also did an MRI for him, and for him, what we did see was some damage to the axons. Remember, those are those fibers that make the connections. We did see some of those smaller tears there. So looking at the scans, also some of the precautions that would be taken might be medication to reduce swelling, like we mentioned already. A child might even be medically put into a coma to reduce swelling. Another intervention that might be necessary would be to actually remove a part of the skull, and that's called a craniotomy. That if part of the cranium.

So the purpose of the inpatient hospitalization is to get the child medically stabilized and starting to recover. Now, for Adam, he was in the hospital for about two weeks. So they were assessing all of this stuff about the brain injury, but he also had some physical injuries, too. He had some cracked ribs, and he had also broken his leg, and his leg required surgery, so all of that was also addressed while he was in the hospital. So he was there for about two weeks. Once the doctors decided he was medically stable, he got transferred to the inpatient rehabilitation hospital. Here the goal is a little different. It's really recovering functioning. Once he was medically stable, he's transferred to the inpatient rehabilitation center, and he was there for about a month.

And the goal there, like I had mentioned, is recovering functioning. So the child is going to be seen by a multi-disciplinary team. And these are some of the people that might be on that team. But the point is that everybody is focusing on different aspects of functioning and providing interventions that might be needed if there are some problems in that area. So Adam got seen by physicians and nurses, and their main concerns are medical issues. He was also seen by a physical therapist. He had broken his leg, so he was having some issues with mobility and getting around. So first he had to kind of learn to get around. Once he was able to, in a wheelchair and then on his crutches. So the physical therapist helped with that. He also had some weakness on

his left side. His brain injury in the front was on the right side, and that affected some of his motor functioning on his left side. The physical therapist worked with Adam to help build back strength.

Occupational therapists will work with the child to help them with kind of activities of daily living, things like being able to feed yourself, dress yourself, basic hygiene. Occupational therapists might also work on things like hand-eye coordination, perceptual issues, fine motor problems. So for Adam, the occupational therapist was working with him a lot on some of the basic activities of daily living, plus he was having a lot of trouble using his left hand, and he had some fine motor problems, and what his mom was noticing was that he would kind of drop things, clumsier with his left hand, trouble buttoning up his shirt, using both hands to do that, and especially hard time with his left hand. So the occupational therapist could work with him on exercises and strategies he could use to build back strength and also just be able to function even though he was having some of that trouble.

He was also seen by a speech language pathologist and of course, there the focus is on speech and communication skills, and that will include real basic language abilities, like being able to express yourself clearly in words, being able to understand what's going on in a conversation. It will also include some kind of higher level communication skills, like being able to hold on to a train of thought in a conversation without kind of getting off topic, being able to take occurrence in a conversation. Being able to use verbal and nonverbal behaviors to communicate.

For Adam, he was having a lot of trouble finding his words. So he was having some expressive language difficulties. The words were on the tip of his tongue but he just couldn't get it. He didn't have that problem before. So the speech language pathologist was helping with those sorts of issues and train of thought. If you were talking to Adam after that first nine days where he was pretty disoriented and having a lot of trouble, even after that, he was still having some trouble. If you were talking to him, he would just kind of go from one thought to the next to the next, and you could kind of see how he had gotten there, but he was getting way off the track. The speech pathologist could work with him to kind of help him develop ways to make sure he could get back to the topic and make sure he was staying on the topic to begin with. He was also seen -- a child might also be seen by a neuropsychologist or rehab psychologist.

What they're going to be looking at, they're probably going to do some assessments for things, basic cognitive skills like attention, memory and learning. They might be doing that coat exam that Dr. Deidrick talked about, about trying to access the ability to -- ability to lay down new memories and things. They also work with the child on what we call cognitive rehabilitation, some attention drills, memory exercises to try to strengthen some of those areas that are weaker, and they might also work with the child and family to come up with compensatory strategies. So there might be some work to be done to strengthen those areas, but you can also learn some other things that help you function even if you are having problems with your memory or attention span.

So for memory, it might be something like, if you're having a hard time remembering three things that you're supposed to do, might be kind of making a list or drawing a diagram of what you need to do or keeping things on a calendar. So the psychologist might work with Adam and the family to come up with some of those strategies to help out with some of the areas that they are having trouble with. The child might also be seen by a psychiatrist. A psychiatrist is going to be evaluating kind of emotional and mental health.

If there are some problems with mood, like say someone's mood is kind of up and down or they're having trouble with kind of bouts of anger or real depressed feelings or lots of anxiety, those might need to be treated with medication. This is going to be really important during the initial recovery, because the most recovery really happens over that first three months after the injury. We'll talk more about the course beyond that, but if a child

is having a lot of mood problems or anxiety that's getting in the way of the recovery, that's a big problem. So if medications can help address some of those issues, that can be a really helpful piece of the recovery so that they're able to engage in all of these other things that they need to be doing to be getting better, and sometimes medications help along with that.

The social worker also met with Adam's family, and the social worker was really working on trying to coordinate among all the team members and also think about what is Adam going to need, what kinds of services and support is he going to need once he leaves of the rehab facility, plus also talking about some financial issues that came up after this injury. A social worker may help with that. He was also seen by a learning specialist. So a learning specialist is obviously paying attention to educational needs, assessing where his academic skills are at, trying to make a plan with the family and also with the school about how is he going to transition back to school, what supports might he need, and also depending on how long the child is in the rehab facility, they may be getting academic instruction there.

Adam was actually doing a bit of academic work. These are kind of the main players that will at least do evaluations of the child's functioning in all of those areas, and they will be offering interventions and therapies if needed. So that's what Adam's inpatient rehabilitation involved. He was there for about a month. Inpatient rehabilitation, they really keep you as busy as they can and involved in as many therapies as you're able to do. And the goal of the inpatient rehabilitation is to have enough recovery of functioning that you can go home and continue to refer from there. So you're not all the way better by the time you've been discharged from the inpatient rehabilitation, but you're able to kind of -- you may not need the same level of services and you're able to kind of keeping into in the recovery process but now from home.

So after a month, Adam was discharged from inpatient rehabilitation and then continued his rehabilitation as an outpatient. So he was at home, and he would come back into the rehab center, and he was still doing speech in language therapy a couple of times a week, occupational therapy and physical therapy, but he wasn't doing it every day and was able to go home and then come into the clinic to do that. And the last point here is kind of building back to school- this can be a pretty gradual and step-wise process after a traumatic brain injury and might involved different steps.

For Adam, he ended up doing homebound instruction for about two months after he left the inpatient rehab facility. A child -- rehab facility. They might need it if there are medical problems, physical problems or cognitive problems are severe enough they're not going to be able to function well at school. They may need that for a while, and Adam does. Getting back into the regular school, you might do that, as well.

Adam, he started going to school for just a few hours a day. It was a gradual process to see how well he was able to keep up. Fatigue was a big problem. He got really worn out really easily, so he could only do a few hours at a time. By building in breaks, he was able to do more and more. So over time, he was able to build back up to full details. Even though kind of school re-entry is the last point on this graph here, it's not the end point of recovery. So just when the child comes back to school doesn't mean that they finish their recovery and they won't need any more services or supports, not that it means any problems they're having won't get better over time. The process of recovery is really an extended one. This is kind of a general graph of what tends to happen. What you see is that the quickest recovery is over the first three months, generally speaking, but you continue to see recovery and progress even over the whole rest of that year, next nine months, but at a bit of -- next nine months, but at a bit of a slower pace. From 3 to 6 months after the injury, you see more change, but a bit sure.

From 6 to 1 months after the injury, you see more change but kind of at a slower pace. For the youngest kids, we actually really want to think about the recovery process as happening more over 3 to 5 years after the injury. You can still see recovery. You can still see change over a fairly extended period of time. So if the child coming back into school or day care or other sorts of activities that they were doing before, we really need to be thinking of them as still in the process of recovery. The other thing I want to mention is recovery is a variable process. I was giving you examples from Tasha and Adam. These are just examples. There are lots of different things that could happen along the way. For instance, for a child who was maybe less severely injured than Adam, maybe from inpatient hospitalization, they didn't need inpatient rehab and were doing outpatient services and were able to transition back to school more quick. So there is a lot of ability. And there are a lot of factors that influence how recovery goes. I'm going to group them into three different categories here.

Certainly, some of the qualities of the injury, especially the severity of the injury matter, and are going to impact recovery. But there are other things that matter, as well, in terms of how the child was doing before the injury and where they were developmentally when they were hurt and a lot of different factors about the environment and about the family matter, as well. I'll go through each of these areas in a bit more detail: so certainly the severity of the injury matters. And generally speaking, kids who have more severe injuries, like in that moderate to severe range, are going to have more problems after their injury, they're going to have more problems across different areas, and they're going to have problems that last for longer and some that could be pretty persistent or even permanent. That's especially true when it comes to what we call neuro cognitive outcomes. And those are basically things like attention, memory, basic intellectual abilities, what we call IQ, learning, those sorts of outcomes. Those are very heavily influenced by the severity of the injury.

Now, this graph comes from a study that looked across multiple studies following kids after their brain injuries. It followed them for about a year after their injuries, and overall, this is what they found. It didn't hold for every single case, but these were the trends. This line here, the solid line, these are a healthy group of kids who didn't have an injury. What you see in terms of their attention and memory, those sorts of things, they show age appropriate gains over time. They're developing the way that kids should develop. This line here, this dotted line, are kids with a mild injury, someone like Tasha, for instance, who would hit her head at the playground and had gotten the concussion. They're looking a little bit worse after their injury, but what happens over that course of the year is they're catching back up, they're recovering, and they're getting really back to normal. By the end of the year in terms of these cognitive outcomes, they're looking the same as kids who vice president been injured.

So that's really good. What we see for kids with moderate injuries, it they're looking worse relative to the other two groups, but they are still developing, and they are still making progress. The problem is they never quite catch up. They're making kind of developmentally appropriate progress, but it's at a somewhat lower level. So they're not quite catching back up at any point over that year. , and the kids we worry about the most, of course, are the kids with severe injuries. What's happening for them is a little bit different. So they're most affected in terms of their cognitive outcomes, attention, memory, learning, and they are making progress. They are getting better, but their rate is slower than any of these other kids.

So what happens over time is that they're falling further and further behind. So you see this gap is widening here. They're behind but not as behind as they are six months later. That's really a problem. What could end up happening is they might actually look worse in some sense a year out, but mostly it's because they look worse relative to other kids, other kids have developed and grown and just kind of outpaced them, gotten ahead of them. They're still better than they were doing after their injury. They've shown some progress, but it's at a slower rate. So something about kind of the normal development in these areas got knocked off course. Okay? So in general, the more severe the injury, the more severe cognitive problems you're going to see and the more

long lasting that they're going to tend to be. While we're talking about severity, I also wanted to talk just a little bit about the most mild head injuries, which are concussions.

Now, we generally think about concussions as not such a big deal. We don't tend to think of them as having these really significant or impairing or long lasting problems, and for the most part, that is the case. But concussions are really important to talk about, because they're the biggest category of brain injuries, so if you look at all the kids who end up with brain injuries, 80 to 90% of them are going to be in this category. So you're going to be a lot more likely to encounter a kid who has had a concussion than a kid who has encountered a moderate to severe brain injury. So this impacts a lot more kids. Some of the symptoms of a concussion, following a concussion, a kid can have some cognitive symptoms, like trouble with forgetfulness and concentration. They could have physical symptoms, like complaining of headaches, feeling dizzy, especially if they're moving, feeling really tired, having trouble with sleep, like falling asleep while waking up at night, sensitivity to light or sound.

These are all some common symptoms that can follow a concussion. And this is what happened for Tasha, the little girl who hit her head on the playground. So she was kind of out of it that first day. She complained of feeling sick to her stomach. She was also -- she also talked about feeling dizzy when she would get up or turn her head kind of quickly. She would feel dizzy. She also for weeks after her injury kept asking people to turn off the lights and didn't know why everyone was talking so loud. So she had some of the sensitivity to light and to sound. Her parents also thought she seemed a little bit more forgetful. They also noticed some mood changes, too. For Tasha what they noticed was she just seemed kind of more cranky and irritable. They described her as being really pretty easygoing and natured little girl, but now she was kind of getting mad real quickly over things that would bother her and just kind of crankier and touchier than she was. And those are some common things that you can see.

Now, for the most part, those issues are going to resolve over time, but people can be surprised. Sometimes they can last just a few days, which is more like we would expect, but they can last as long as one to three months after the concussion. That's not that unusual. That's what happened for Tasha. A lot of these physical things got better over the first couple of days. She wasn't feeling so dizzy anymore, wasn't having headaches, but some of the other stuff persisted for a bit longer. She was still getting really tired. She was still a little bit more forgetful. That went on for a couple of months, and she was still having this moodiness for a few months after her concussion, and that's not so unusual. You can see those symptoms even for as long as three months after the injury. But there is some controversy about whether or not kids with concussion really have long-term problems, kind of beyond that three months. And some people would argue, no, really, you don't see that with concussion, but there seems to be a subset, a small group of kids who do show some pretty significant problems that can last for a while and be pretty persistent, and it seems like the kids who are most vulnerable to have kind of long-term problems after concussion are the youngest kids, so kids younger than age 7, kids whose injuries are more serious, even within the mild range.

Here is certainly a more severe end of the mild range. Kids who were doing worse before the injury in terms of how they were doing academically or behaviorally or emotionally, and kids whose families weren't functioning as well before the injury. Those seem to be the kids that are most at risk. Now Tasha was really doing pretty well before her injury. She was good-natured, a friendly little girl. Her teachers thought that -- preschool teachers thought she was a little ahead of the game. Starting to learn to read, no problem picking up basic number concepts. They thought she was a little bit ahead, plus her family had a lot going for them. Her parents were married. They both had pretty comfortable jobs. Her mom was able to take a little bit of time off in the couple of days after her injury, which was real helpful, because Tasha was getting tired a lot. She couldn't kind of go right back to preschool, so they were able to take the time they needed and able to kind of check in with her

and make some adjustments to their routine as she was getting better. Those are also protective factors, factors that predict better recovery.

Now contrast Tasha to another little girl, Sarah. Sarah had a similar injury, a fall at gymnastics, same kind of thing, bump on the head. Mom took her to the emergency room. The CAT scan didn't show anything. She was released home, but Sarah's background is a lot different. Sarah had a previous history of physical abuse, and from what we can tell from the medical records, she probably had a previous TBI. She's been in foster care and she had been removed from her biological parents' custody and been in a few different foster placements. In her current foster placement, the parents were appropriately concerned about Sarah, but both parents were working. They didn't have the ability to take time off or else they would have lost their jobs, so they weren't able to have that kind of careful attention that Tasha's parents have to be able to get time off, make adjustments to how she was doing those first couple of days. Those are also risk factors. What ended up happening is Sarah tended to have longer term problems. One of the things that we see for younger kids with concussions, they seem to be at a higher risk for having problems picking up reading skills and upper level language skills.

That's what happened for Sarah. She had trouble kind of picking up some of the basic reading skills before, and that remains a real struggle for her. So she didn't have as good a recovery after her concussion as Sarah, and it seems like the kids who are most at risk for having trouble are the kids with this combination of risk factors. This study here followed kids after their concussion. So you can get a sense of how likely is it that the kid is going to have long-term problems after a concussion. You can see here the majority of kids really didn't have any problems. 64% had just one or two symptoms. They all were admitted basic basically within that first month, probably even the first few days, and for the whole rest of the year, they're really not having trouble. That's 64% of the kids. Plus another 15% of the kids, they had a higher level of symptoms initially, but those went way down over that first month, and then over that first three months.

So a year out, they're looking just fine, too. So that's almost 80% of the kids. Almost 80% of the kids a year out are having very few problems associated with this concussion. Unfortunately, there are these of these other two groups of kids. Here we've got 12% of kids who are having a moderate number of symptoms, something like three or four symptoms after their concussion, but the problem is that those symptoms pretty much stay, and they're still there a year later. And then this other group of kids, this other 9%, were having a lot of symptoms, like 10 symptoms, and they get better, but they're still having significant symptoms a year later, and that was about 20% of the kids. So in this study, about 20% of the kids were still having some problems related to their concussion a whole year later. So what that suggests to me is that, you know, we want to take concussions seriously. We can expect that for most of the kids they're symptoms are going to get better and they're going to do just fine, but there is going to be this subset of kids who are still having problems and who still may need a combination of supports even after a mild injury like a concussion. So that was talking about the severity of the injury. Let me just kind of check in with you there.

Any questions about any of that stuff about the initial recovery or about the severity of the injury, how that matters?

The things you say, if the child has something in the past going on, like physical abuse or any kind of stuff, if she or he has an accident in the brain, this can make it worse to the child to recuperate, you know, with the time?

Yes, absolutely. We've got to keep in mind -- I'll talk about this. This is a really good question to ask for this next part I'm going to go in to, how the child was doing, including how they were doing medically, if they had a previous insult to their brain, like a head injury or developmental problem with their brain or their health functioning. That's all going to matter, because remember the brain injury is happening to a particular kid, and if

this particular kid was having other problems ahead of time, especially other kind of brain legalitized problems, they're going to be especially vulnerable, and it could make a preexisting problem each worse.

For how long will the child have one or more of those symptoms, for how long? One year, lasts for three years or it's hard to.

It's hard to say. For the overwhelming majority of the kids, those symptoms are probably going to go away within days to a few months. Okay? Most kids, those symptoms are going to go away. But there is a subgroup of kids that are a year later showing symptoms, and sometimes it can be kind of a permanent problem that they have, but most of the kids for concussions, those symptoms are going to go away pretty quickly.

Does the child take any prescription or does it just go away naturally?

There are some medications that might be somewhat helpful, like with attention, and I'll talk about that in a little bit, but for the most part, those symptoms for most of the kids tend to resolve themselves, kind of go away on their own with some kind of environmental support that we'll talk about. There are some things that can kind of help if they're given some extra time to be processing information. They basically kind of time in support to help adjust and cope with some of the differences they're noticing. That can help their recovery along. But for the most part what we're talking about is those symptoms tend to get better on their own. Does that make sense?

Yes, thank you.

Yes.

You may have addressed this, but what is the risk or how does a second concussion before the first concussion has healed impact the outcome for a child, and I assume there is some importance there of knowing about that so you can take precautions to let that first concussion have time to heal.

I'm not going to talk a whole lot about that later, but obviously you really want to protect that brain if you know there has been an injury. If you know there has been a ..., you want to be especially careful that the child doesn't get another concussion or head injury. The scary things, the kids are more at risk after having one. Let's say if they're recovering and unsteady. They will be at more risk to be getting into accidents and that sort of thing, and that can be especially bad to have multiple concussions or one injury on top of another one, especially if it's close in time to the first injury. So you're going to want to be really careful for this kid to keep their brain as safe as possible, because they will be even more vulnerable. Having a second concussion isn't the same thing as having a first concussion. If they have had some other insult to the brain, that's going to be another risk factor for having some problems, absolutely.

So we are going to talk about things about how the child is functioning as well. One of the big things we think about that is really- relevant to this group is the child's age, where they are developmentally when injured. Unfortunately, preschool kids, kids younger than 7 yrs, are at a real disadvantage when it comes to TBI. They seem to be more affected by TBI than older kids or adults. Can anyone imagine why that might be? Why would preschoolers, little kids, end up having more problems, let's say, with attention and memory and basic kind of thinking skills.

Some of those brain connections aren't already made.

Absolutely. That's exactly it. Yeah. The types of skills in abilities -- abilities -- skills and abilities are -- that are most vulnerable are the ones that haven't developed yet. They will have formal education, so less learned information, less consolidated skills, and those are the ones that are going to be most vulnerable. That surprises people sometimes. Sometimes when you think about the brain you think about, okay, well, younger kids are kind of more are -- resilient, their brains can compensate and heal, but actually when it comes to TBI, what we see consistently is these little kids will have more problems and more long lasting problems than older kids and teenagers and adults, and the reason we think that is because, exactly like you said Linda, what's most vulnerable is the stuff that's still developing, and the youngest kids are the ones developing most.

So the types of things that we tend to see more problems with for preschoolers relative to older kids or adults, younger kids are more likely to have disruptions to their basic intellectual function. I'll refer to that as IQ, and we'll see more about that later, whereas older kids and adults might have kinds of the same IQ level after their injury as before, younger kids are more likely to see disruption because their basic intellectual abilities are still developing. Younger kids have a problem with expressive language, being able to communicate clearly with speech, have more problems with attention and tend to show more academic problems relative to kids that are older when they are injured. So where the kids are at developmentally really, really matters. What we've been talking about already is how the child is functioning before the injury also matters.

So if they've already had some kind of brain injury or they had some kind of congenital condition that affected their brain or their development, that impacted -- the impact of the TBI, is probably going to be worse. For kids who had a prior learning disability, problems with behavior, academics or emotions, those kids tend to have more problems after the injury relative to kids who are functioning some better. So we think about, again, when we were talking about Tasha and Sarah, Tasha was doing really well before her injury and ahead of the game. We think of her having a little more of a cushion to fall back upon. Say her skills had been high average. Even if she's just doing average after the injury for a little while, that's not so bad, but if a kid a lower down, maybe towards the end of the below average range, if they take the hit, that's going to be more significant. They have less to protect them and less to fall back on.

The other set of factors that matters a whole lot are things about the environment. Of course, the child's main environment is the family. A lot of research kind of tells us about different aspects of family functioning that really matters how kids do after a brain injury, and actually -- I'm not sure if you would be surprised to know this or not, but when we look at outcomes, long-term outcomes of academics, behavior, functioning, it's this stuff that matters way more than the injury severity. The injury severity matters a lot for the cognitive stuff. This stuff matters a whole lot for kind of how kids are functioning in the world, including the academics. So the selective things that matter, is the family functioning pretty well. If you have a tight-knit, pretty cohesive group of people who are pretty able to adjust and problem solve and those sorts of things, that's a real protective factor. If on the other side you have a family where there is a lot of fighting or there is a lot of distance or separations and those sorts of things, those might be risk factors.

Also the resources, including economic resources that a family has also matters. What the research will tell us is kids with TBI coming from disadvantaged families, they tend to show more academic problems, especially with kind of reading and other academic skills relative to kids from more advantaged families, and some of that may have to do with access to the quality and types of treatment and recovery services that they can access. Also part of the thinking is that, unfortunately, for some of those kids, some of their academic skills might have been less well consolidated before, so that might be part of an issue, as well. Also, there are certainly other sorts of supports that matters. The kind of social support that a family has matters as well, too. This family, do they have extended family in the area that can help them out? Are they tied into a church community or other community? The source of supports a family has matters, too.

Also the adjustment to the injury. These injuries can be a big deal. Think about Adam's family, in the hospital for two weeks, inpatient rehabilitation two months, homeschooled after that. That's a huge set of changes for the family. How that family is adjusting to the changes is going to determine how well the child does. This is an important set of factors to focus on, especially folks working with families and, working with families in their homes to be thinking about how the family is doing is going to play a critical role in how the child is going to do with the injury. Later on, we'll talk about what are some interventions for teams that will be helpful to help kids recover from their injuries. We had talked a little bit about how variable the recovery process is and some of the factors that influence how the recovery goes. But in the next part, we're going to talk about some of the problems you can see, especially in terms of some of the cognitive skills.

Back to our case of Adam to illustrate a lot of these problems. Multiple areas of functioning that can be affected by a TBI, and that would include physical and sensory issues, cognitive functioning, behaviors and emotion, and of course, all of these things can have influences on how kids are doing in the world, how they do in terms of their academics and learning, how they do in terms of their social functioning, how they're doing in just being able to take care of stuff at home, take care of themselves, grow to be more and more independent. So we'll talk about each of these areas and then we'll also talk about the effects and practical problems that can come from each of these issues in these areas. So going back to Adam, the little boy who was in a car accident, for the first two or three months after his injury, he was having kind of a lot of the physical and sensory problems that are up here.

One thing that he really noticed, and this persisted for a while was fatigue. He would get really worn out really easily and doing stuff that used to be no problem for him before really made him tired. Sometimes this would be physical stuff, but even more often, it would be kind of mentally challenging stuff. Doing schoolwork really tired him out. He also had a little bit of trouble with sleep. He had some trouble falling asleep and some trouble with waking up a lot of times -- three or four times in the night, where that hadn't been an issue for him before. He also complained some of headaches, and he remembered he had some orthopedic problems because he had broken his leg. So he was also recovering from a broken leg. He also had some other motor problems. He had that left sided weakness and fine motor skill problems, especially with his left hand. He also for a little while had some vision problems, some blurred vision, just kind of not seeing things quite as clearly as he used to.

A lot of these issues for him resolved over the first few months after the injury, although some of the fine motor problems continued and the fatigue was a problem for him for a while. And you can see that there are some other physical and sensory problems that a child might have, including headaches. There's a somewhat increased risk for seizure after a TBI, although it's not all that common. Some problems with bladder or bowel control problems might occur, some problems with temperature regulation, which is a funny thing to think about, but also some other problems with vision or hearing or sensory sensitivities, motor problems, including balance, stability, strength, coordination, those sorts of things. You might see some of these issues in a kid who has had a TBI. Now, one area that Adam's mom and his dad and his teachers were really worried about were thinking skills and cognitive problems. And one thing that they really noticed was problems with memory. The sorts of things that they were noticing for him was just, you know, you would say something to him, and it would seem like it was in one ear, out the other.

So mom might say, you know, go upstairs and put your toy cars away. Mom would follow up ten minutes later. He had gotten to his room but was just kind of playing around. She would ask and it would generally seem he had no idea what she had asked him to do. The teachers would say the same thing, and they had a little concern about memory. There are different components to memory, different pieces that can be affected. Storage is being able to take in the information and process it long enough that it gets stored at least briefly. Retention is being able to hold on to that information over time, like putting it into long-term memory so you can use it later.

And retrieval is being able to pull it out of that long-term storage, to get that information when you need it, and all of those issues can result in what we might call a slower learning curve, that a child might need more repetition, more review, going over things in more detail to help them learn.

Now, what we could do is we saw Adam in the neuropsychology clinic, and we can do formal tests that look at different aspects of memory that help us pull apart each of these aspects so we can understand what about his memory is working pretty well and where are some of the problems. So when he came into the clinic, this is two months after his injury, and he did this whole battery of tests for us. The memory test that we did, what they showed us was that first of all his visual memory was better than his verbal memory. So his memory for things that he saw was stronger than the things that he had heard, things that were told to him, and that can happen. There can be some evenness with one aspect of memory being stronger than another, and for him, his visual way better. The other thing, when we were looking at verbal memory, we looked at some different things. First, we read him some stories out loud and we asked him right away, you know, retell us that story.

So that's looking at immediate memory, how well are you able to store and take in that information and use it right away. Adam's memory there wasn't so great, but it was better for stories than it was for words, because we also just read him lists of words, and they were really just asking for memorization. So he did better when information was given in a meaningful context. He did better when he had a story to peg it into than he did when you just said remember these 15 words. That's a clue for us, and that's important when thinking about functioning in the world and what sorts of things are going to be helpful for him. The other thing we do, which always feels also bit mean. We put those memory tests away, do other things and then a half hour later go back and ask about that story and word list again. What we're trying to get at then is retention and retrieval, how long someone is able to hold on to that information. For Adam, this was a real big problem. He didn't remember very much at all of that story or that word list. But we then gave him clues. We asked him some kind of multiple choice questions. He did a lot better with those. So with that information, what might you guess is going on? So he was able to come up with some of the information but only when we kind of pulled it from him, only when we kind of gave him some of the clues. What area do you think was his weakest, if you had to guess? Where were things going wrong for him in terms of his memory? I think that there were some storage issues.

Retrieval. Retrieval.

I think you're all right. I think his biggest area was retrieval, but also weaknesses in other areas, so kind of a trick question. His initial storage wasn't great. He wasn't holding on to a ton of information but he was getting some. His retention was tricky because he wasn't remembering a whole lot after a half hour. He did better when we gave him clues, so there was more that he remembered than when we just said tell us the story. When we said, was the little girl's name Debbie, Ann, or Sarah, he could remember that. So something was there. The information had gotten in somewhere. He just had a really hard time effectively bringing it back out of his memory. So that's good for us to know, that he's getting more in than it might seem like if we just asked an open ended question like tell us the story, tell us the words.

So that's going to be important information when we're trying to make a plan for what sorts of support systems is this guy going to need. So he might be the sort that does a little better with multiple choice questions than he would with like a short answer saying, tell me what you know about this or tell me about that. He's going to need much more cues and reminders and supports. But it seems like at least some of that information is getting in there. So we wanted to make sure we understood how his memory was working really well, because there were definite concerns in that area. There were also some worries about attention. The slide has a couple of different aspects of attention. The only thing to know about that is that attention isn't just kind of one thing, but there are

different components, although the specifics of that doesn't matter so much. For Adam, he was having some trouble. His parents and teachers noticed it just seemed like it was hard for him to keep track of his thoughts or to pay attention to more than one piece of information at a time and he would kind of get distracted more easily than he was before.

Skills that we call executive functions. That's a group of skills that they help us with things like organizing, planning, setting priorities, kind of coming up with a logical approach to solving a problem or completing a complicated task, and those sets of skills help us regulate our behavior and help us regulate our emotions, so it's a really kind of important set of skills that can be affected by TBI. What was happening for Adam, Adam's parents were talking about problems that sounded to us like working memory. What working memory is the ability to hold on to multiple pieces of information in your mind at a time while you're working on them. An example might be being able to remember a phone number, that you might be able to hold on to those 7 or 10 digits, long enough to be able to write them down, or doing simple math problems in your head. Those all rely on working memory, being able to hold on to a few things at a time and being able to do something with them. He was having trouble there. That was kind of like the example I gave before. His mom would tell him to do two things, and he only really got the first one.

That's what his teacher said, too. If you told him to do three things, he would get lost after the first one. You kind of had to break it down to do one at a time, check to make sure he had done it, then give the next instruction, make sure he had done it and do the next thing. He could do each of the three, but when you gave him three at once, it was too many to hold on to and he would lose it. He was also having trouble with organization. His mom said his school folder was a mess. He would bring it home after school. Gaps everywhere, no kind of organization. Stuff that was supposed to come back between home and school wasn't getting there. He was losing things, couldn't keep track of his favorite toys, and that was a change in his functioning from before. So he was having some organization problems. Just to touch on some of the other things that are mentioned up here. Some kids can also have real trouble with mental flexibility. What that really gets at-being able to kind of shift gears, to shift from one activity to another without getting too stuck on the thing you were doing before, to be able to handle it if the rules change or the game changes or something like that, to be able to kind of say, okay, we're not doing that anymore, we're doing this. Abstract thinking can also be affected. We saw this a little bit with Adam. That kind of blends into these next areas, too, about communication skills.

Adam had a really hard time figuring out jokes and figurative language and stuff. He was having trouble with this abstract piece, thinking at this non-literal, non-concrete level. Those are some of the issues with the executive functions. As I was mentioning, he was also having some trouble with his communication. Remember from before early on he was having problems kind of finding his words. They were getting on the tip of his tongue, but he couldn't quite figure out what he wanted to say or find the words. This was really frustrating for him. You can imagine if you can't quite get your point across, you just sometimes say, just never mind. You know what I mean. And then just kind of give up on that. But this was happening to him repeatedly, so this was really frustrating for him, and he would get really kind of mad if somebody else didn't understand what he was trying to say.

He was having trouble with that first part there of organizing his verbal responses. He was also, remember, having trouble kind of keeping on topic. He would kind of get talking about something, and one thought would trigger another that was kind of related, and another kind of related, but you would realize he got kind of way far afield from where he started. Other people would be, like, what are you talking about now? Where did we get to this, kind of roll their eyes and not get where he got to. It seemed like he was having trouble with comprehension. What his mom would notice, she would ask a question, but his answer didn't quite match. It

was in the ballpark, but it didn't seem like he quite got what she had meant. He had some trouble understanding what people were saying to him or asking of him and wasn't quite right there.

There are some other aspects that can be affected, too, when it comes to communication. This wasn't as much of an issue initially because he was a younger kid, a first grader, but organizing written response, especially if you're asked to write whole paragraphs or essays, something you have to really organize and build an argument. That's a combination of both your executive organization skills plus your communication skills, so something like that could be impacted. Also aspects of discourse. What discourse basically gets at is your ability to convey a message effectively. The sorts of problems you might notice that would be their sentences are shorter or they are saying fewer sentences than before, or they are telling you a story that seems less to the story or fewer details.

Those are some problems in discourse. You might also see some problems with nonverbal communication. What that really refers to is all the ways that we communicate without saying anything. So all the time, and I speak a lot with my hands, so I don't know what I would do if I couldn't do that. But we talk a lot with our hands, gestures and body language. We coordinate our eye contact. We use facial expressions to go along with and augment what we're saying. And kids who have had a TBI can sometimes show impairments in those areas so that their eye contact doesn't seem quite as comfortable as it was, maybe not showing the range of facial expressions they were. They don't seem to quite match.

The situation doesn't quite match the emotion that you would expect it to. Not quite using body language or gestures as effectively, and that's what Adam's parents noticed. What they noticed was that before his accident, when he was telling a story, he would get all into it, really animated, do all these things to kind of show you in addition to telling you what was going on. But after the accident, they noticed he didn't do that as much. He didn't tend to kind of act out things and use as many gestures as before. He was also having some problems with personal space -- space. He would get up really close to people and talk in their faces, which if you can guess, people didn't really like, especially other kids who didn't know why he was doing that. Sometimes he got kind of teased about that because it was strange. He also had some problems with social information processing. What that gets at is kind of your ability to take in and understand all the social messages that we're getting all the time, and that's actually really complicated when you start to kind of break it down and think about that. Just like we communicate in all of these ways, we're interpreting how other people are communicating, too. So if somebody decided to turn their back away, I might decide, well, they're not so much interested, that kind of thing. If you're rolling your eyes, you might be saying, it's time to wrap it up. We take in a lot of information besides just what we're told, information about tone of voice and those sorts which things tell us a lot about what the message is, and kids following a brain injury may have some trouble interpreting some of those clues, so they're not always able to respond appropriately, because they're not getting the full message.

Social information processing also includes things like being able to figure out how to solve social problems, and social problems come up all the time. What kinds of social problems do you see among preschool kids? What kinds of problems do they get into with each other?

Sharing.

Absolutely. Yeah. That's a big social problem. So how do you negotiate that? I want to use this, but he's using it already. Some kids do better or worse with that. So that's a social problem. How do you share, how do you negotiate? If you're in a fight with someone, how do you get out of it? Kids with brain injuries can have more trouble with those sorts of things, and that was true for Adam.

I want to get back to this first column in a second. But let me just ask, any questions about these sorts of cognitive problems? What I want to emphasize is there is a lot of variability. Not every kid with a brain injury is going to show problems in all of these areas, but these are the sorts of things to be looking for that can result from a brain injury, especially an injury that's more moderate to severe these are some of the problems you might see. Any questions about memory, attention, that executive function or communication piece? That's a lot of problems you could potentially have. I did want to talk a little bit about this intellectual function piece, the IQ piece.

We talked about this because this is an area in addition to some of these other cognitive areas where young kids, kids younger than 7 years, really seem to be more vulnerable than older kids or adults when it comes to a brain injury. That's what we saw for Adam. What we saw for Adam was we had to come in and we did an IQ test, and you're looking at kind of basic verbal reasoning skills and visual basic reasoning skills, and we're also looking at things, something called processing speed, which is just how quickly you can process information and how quickly you can do some simple tasks. Now, for Adam in, terms of his IQ, it came out to be in the low average range, and that seemed to be about where we probably thought he was before just based on how he was doing in school.

He was having trouble in some areas. His kindergarten teacher had noticed he wasn't really picking up some of the pre-academic skills as well as having some trouble with number concepts, some trouble with learning how to read.

So we're guessing that maybe his IQ was about the same after his injury as before, but it's our best guess, because there wasn't any reason that this kid would have had a neuropsychological evaluation before his injury. So we thought that that was maybe about the same. But one area that was really quite low and we think probably most likely affected by this injury was his processing speed. There he was well below average, plus what mom and the teacher were telling us was consistent with that. So the sorts of things that they saw, it just took him longer to do everything. In school, he was doing a work sheet in the same amount of time the other kids could finish the whole thing, he was maybe getting half done.

He had a little bit of homework, and maybe it would have taken a half hour in the past, but now it was taking more like two hours to get through. Plus it was getting real frustrating for him and he would do anything he could think of to get out of it. Plus it was taking longer to get ready in the morning and those things. He seemed to need to take a longer time to think about things, a longer time to get his answers together. At home and school, they were noticing changes in processing speed, and we saw that on our tests, as well, so it just kind of slowed down processing speed. This, by the way, is very common that you would see that after a brain injury in an older kid or an adult, as well. Go ahead to the next slide. This is looking at IQ. Now, what happened for Adam was, we had him back in our clinic several times after that initial visit, so we got to see him two months after his injury. We also got to see him when he was about 8, when he was about 12 and when he was about 16. So we kind of had multiple points of data on him and could see what happened in terms of these cognitive area in terms of what areas got better and which areas didn't. If you had to guess without looking at those, which lines do you think was Adam? What do you think happened in terms of his IQ after we saw him that first time?

The bottom line.

Yeah. That bottom line is the one we get most worried about. What happened for Adam, and this is from a study that followed preschool aged kids, kids 2 to 7, for five years after their brain injury and focusing specifically on IQ. What happened for him, which is what happened with this whole group of younger kids with severe injuries, is his IQ actually dropped over time, so when he comes back two years later, his IQ was now on the borderline range. It had been the low average and now it was below average. That's where it stayed each of the

other times we saw him. The thing that's important to know about IQ scores, they're adjusted for age. These scores are adjusted for age. What that means is that for a kid who is showing typical development in their intellectual abilities, they'll have about the same IQ score when they were five, again when they were 7 and 9 and so on.

If they're kind of keeping up and making developmentally appropriate gains, they're going to have about the same score, because the scores are correcting for age. So we see here that the solid line at the top, that's the healthy kids who didn't have any injury. And they're showing about the same IQ score at each of these assessment points over 5 years. So that's what we would expect to see if things are going normally. What we see for the kids with the severe injuries, though, like Adam is his score actually dropped over time. Now, he wasn't actually doing worse than he was before. He just wasn't keeping up at the same level with the other kids. So he probably got more right on that IQ test when he was 8 than when he was 6, but relative to the other kids whose development, he wasn't keeping pace, so his score is actually going to look worse. His intellectual abilities didn't get worse compared to where he was before, but he's falling behind the other kids. That process does tend to stabilize, though. It doesn't just get worse and worse and worse for IQ.

So at about 2 and a half years out, that tended to stabilize and kids are showing a reinstatement of a normal developmental process, but it's at an overall lower level. For the kids in the study, these scores are following towards the low average range, and Adam a bit lower than that. On average on this study, they had had average IQ's at the point after their injury. Two and a half years later, they dropped to low average and stayed at low average from that point forward. Now, what might you guess would be kind of Tasha's line, the little girl who had the concussion? We've already eliminated two of them. It's not the bottom and not the top. Between those other two, what might you guess would kind of classify a concussion or mild injury in terms of recovery? It's hard to say which one is the second one. It's that one actually that -- I am too short for this.

It's the one that goes up like this and this goes over. So what's happening for her and for the kids with the mild injuries, her IQ actually looks a little bit lower than the healthy group, but she's showing that recovery over that first year or so and then stabilized kind of progress from there. So for the kids with the mild injuries, they can show that IQ might be affected some, but they're showing that recovery over that first year, and then they're kind of holding steady. They're showing developmentally appropriate progress over time. That's what happened for Tasha. When she came in, her IQ was looking like more in the low average range, but with the lower end of the average range, but when she came back a year or two later, she was more towards the top of the average range, which is where we thought she probably had been before. Something a little different happens with the kids with the moderate injuries.

They're not showing that same recovery that the mild group is, but they're also making developmentally appropriate progress. You see they're following kind of midway through. They're not showing that initial recovery but also not losing ground, so they're showing -- relative to the healthy kids, they're operating at a somewhat lower level, although here in this study, it was still average. But they're not showing those gains that the kids with the mild injuries do. So we're going to talk a little bit about IQ here and also just pause to see if you have questions about that and a couple different lines on this graph that are hard to see. Here it seems like it's another example of where the severity really matters, also the age of the injury matters, because this is specific to preschoolers, and this isn't what we see for older kids and adults. Usually the IQ isn't affected as much for them but it is for younger kids because of what we were talking about earlier. The IQ is still developing at that point.

What it looks like it happens for Adam and those severely injured kids, something in that developmental process is disrupted for even two and a half years after the injury. Any questions or thoughts about that piece? Okay.

All right. So thinking about the sorts of problems that can come up in coming in addition, in -- cognition and thinking. Adam, he's going this slower processing speed. Things are taking him a long time. He's having lots of trouble with memory, especially holding on to information for a while and getting that information out of his memory when he needs it. He's having some problems with attention, having some problems with executive function, regulating emotion, plus he's having problems with communication, both what he says and kind of using nonverbal communication and understanding social information. What kinds of problems might you think he might end up showing, let's say, in terms of behavior? What might you expect if these are some of the cognitive problems that he's having? So you're thinking some of the problems that you might see in a kid who has ADHD. What sorts of things might you see in a kid who has ADHD?

Maybe overactive.

He's over here when everybody else is over here.

Maybe aggressive.

Okay. Any other thoughts? Problems with impulse control, with activity level, with being able to follow where he's supposed to be, maybe some problems with aggression, absolutely. Go ahead. So you read my mind in general, I would classify some of these issues as kind of problems with regulating your behavior and regulating yourself, knowing where you're supposed to be and supposed to do and thinking through consequences. Like you guys said, these kids might have problems with poor judgment, doing things before they really think them through, some impulsivity. There may be also problems with aggression.

That will come up on a later slide but fits here. Sometimes kids following a TBI can show more aggressive behaviors. And then understandably, kids might also struggle with low motivation, lethargy and apathy in parts that they are more tired. Things wear them out more than they would have before. Plus, if they're having all of these cognitive issues, It's probably interfering with their ability to kind of keep up with what's going on academically and socially, so it might be really kind of hard to just stay motivated and want to stay with it. We saw that with Adam in terms of kind of communicating. He was having trouble finishing his words, so he didn't even want to -- he would kind of give up. He would try but then thought, well, no one is going to understand what I want and would get really frustrated and might start to act out what he couldn't say with his words, so you might see some of these sorts of s. What kinds of problems might you expect kind of emotionally with mood and emotional well-being for a kid who is having these kinds of issues? There might be problems with anger and controlling anger, absolutely. Anything else that you might expect?

Some problems communicating how they feel, absolutely. Yeah.

Depression maybe. And you read my mind again. That's on the next slide. You can see a host of additional problems. Again, if we kind of look under the umbrella of problems regulating your emotions, what you might see are problems with mood changes, kind of up and down or having a shorter trigger than maybe that child had before. Things make them more mad or more frustrated more easily than before. Some kids have some problems with anger and irritability. Why might they have trouble with that?

Can't get it out.

Might have trouble expressing what's going on with them, plus there is a big adjustment going on. The child is probably pretty aware that they're functioning differently than before, that things are not coming as easily as they were before, and that could be really difficult. That could be really hard to deal with. Also some problems

with anxiety. Maybe early on for some kids, you might see they're a little more clingy or dependent or want more help, even though they may not need it. Plus they may actually need help in some areas, but just not feeling confident. When we think about little kids, sometimes little kids present depressed symptoms and anxious symptoms in a way we might expect, but sometimes they present them differently. What would you be on a lookout for if you wanted to keep an eye out for symptoms and mood problems? What sorts of behaviors would you want to be keeping an eye on that might tip you off?

Crying.

Crying, sure.

Withdrawal.

Withdrawal. How might that manifest?

They separate themselves over in a corner.

Absolutely. They prefer to play alone where they used to like to be with a group.

What also might you keep an eye out for if you were worried about mood?

Sleep.

Sleep, absolutely. Are the feelings all over the place, are they coming and going a lot more quickly than they did? Absolutely. You guys are right on the ball. Sorts of things I'd be looking for are changes in sleep. Some of it might be related to the injury. Some may not be. It might be related to mood. Sometimes it's hard to tease those things out. Are there some changes in behavior, like, more irritability. Sometimes depression might look like than saying I'm really sad. You might see the child is more tearful and crying more. Sometimes in terms of anxiety, they might complain about aches and pains and not feeling good. There might be aches and pains, or some may be more like anxiety. It's pretty tricky. There may be physical problems, and there may also be some emotional problems coming out. It can be a little bit hard to tell, and sometimes we miss these things early on because we assume they are part of the physical recovery, and it's tricky because sometimes they are and sometimes they are not. But you want to be on the lookout for some of these changes. As you've all anticipated that you might expect some significant emotional problems for kids after a TBI, and again, some kids will have some of these issues and others may not, but there are things to be aware of. Now, taking a step back for the types of issues that we've been talking about, these physical sensory problems, cognitive thinking problems, behavioral changes and emotional changes, what kinds of problems might you anticipate a child might have academically in terms of learning and being able to function in the classroom? What might they struggle with?

Maybe writing.

Absolutely. They may struggle with writing, completing whatever they're doing, be able -- being able to finish the whole thing. You mentioned reading. Absolutely. Keeping in mind that for anybody, the skills that are going to be most severely impacted are the ones that are kind of developing or haven't developed yet. So what would that mean for preschoolers, do you think? What skills are developing if someone is 4 when they're injured or 5 when they're injured? A lot of them, right? In fact, as you can imagine, kids who are younger, like we were talking about before, are at somewhat higher risk for having more academic problems following a TBI relative to older kids who have more consolidated skills. You're absolutely right about the areas you identified in terms of

school problems. We'll see that on the next slide. So problems with acquiring reading skills will be affected. We're thinking about those were kind of coming on line and developing.

Some problems with arithmetic, some problems mastering writing. Giving the memory problems, just some kind of academic facts that could influence really any subject area and just kind of in general, kids who have had a TBI are at higher risk for being held back at some point in their school career, at needing special education support, and they're also at risk for having lower grades and a declining grade, so when we look at those kind of big picture academic outcomes, they're at higher risk for problems in those areas. A couple of graphs from one study that followed kids for five years after their injury. The study was cool because it followed three different groups of kids, younger kids and older kids. Kids who were between 5 and 7 when they were injured and compared them to kids who were teenagers, 12 to 15, when they were injured and looked at a couple of academic areas to see what happened. This is looking at math achievement, how they were doing with math. And what you'll see here, the red lines are the younger kids, and the purple lines are the older kids, and then the dotted lines are the more mild to moderate injuries and the solid lines are the severe injuries. What are you noticing here? Let's take the older kids. What's happening for them in terms of math? They're getting better, yeah. They look worse at the beginning, right? So their math has certainly taken a hit after their injury. We don't have a line on here for kids who weren't injured, but an average score would be about 100. So kids are going to have a pretty straight line at about 100.

So relative to that, their math has really taken a hit, but it's getting steadily better, and it's getting better over four years, so that's kind of a good reminder that the recovery process is a long one. Even four years later, they're showing some improvement over the year before. And then it kind of stabilizes here, kind of plateaus. But what's happening for the younger kids? Yeah, they look okay at first. They're hanging in there. They're in the average range. The mild to moderate kids even look a little bit better one year out than they did after their injury, but they're showing steady declines over time, even up to five years. What do you make of this? Why would this happen with math? Why would they look okay and then have problems later? What do you think might be happening there?

The math is getting more complicated later, and what happened was the TBI impacted some of those upper level abstract thinking skills, some of those executive functions, plus it also impacted attention, and attention plays a big role in being able to do math problems, and what happened was, the younger kid didn't really need all of those skills to do the math they were doing when they were 5 and 6, but they surely did need them when they were in fourth grade, fifth grade, sixth grade and beyond. So the TBI affected the skills initially, but the child wasn't really expected to use them until later, so we saw a late onset problem. You might have thought math was okay, but it was a few years out that you're starting to notice problems with math that we think, in fact, were related to impact from the TBI. But we didn't see it until years out because they aren't expected to use all of those upper level abstract thinking skills until later. How come the teenagers get better? What do you think happens that accounts for this improvement?

Do you have any guesses about what's going on there, kind of why they show pretty good gains?

They have the basic knowledge.

Yeah. Those math skills were much more firmly consolidated. And those consolidated skills are less disrupted by the injury. There was some initial disruption, certainly. They're not doing very well in math right here, and it takes a while to build back up, but those were more consolidated skills and those skills were covered, absolutely.

The next slide looks at spelling. Spelling overall didn't look as badly affected, but you still see kind of a similar thing. In both older kids groups, you see more improvements, and then we'll also look at reading. And reading, it's kind of a similar thing. The kids aren't doing too badly, but there is a little bit of a downturn kind of five years out for these kids, even with the mild injuries, but worse with the kids with the severe injuries, but you're seeing better recovery for these older kids where those reading skills were better consolidated. So really it just kind of underscores the point that across the academic areas where skills are just emerging and just building in preschoolers, there is more risk for academic problems relative to kids who were older when they were injured. Let me just ask if there are any questions about that, kind of the academic piece.

Would where the injury occurred at -- it would have an impact, also, on the outcome that we're seeing there?

It could. It's tricky, because these brain injuries often have if diffuse impact, so they're actually really affected those connections to different areas of the brain. Although if there is a specific kind of insult to a specific area, those functions might be more effected, and I didn't know if you wanted to add more on that.

So there could be an effect, right. So there could be an effect of where the location is, but for young children, even more particularly than older children and certainly than adults, first of all, their skills aren't as localized. Those connections with still developing. The other thing is that, you know, part of reason yes used to think younger children were actually more resilient was because the brain would kind of rearrange to compensate. What we discovered, though, is that rearrangement isn't necessarily helpful. Okay? So that some of those skills might move to another part of the brain or be localized in a different area if a particular area of the brain is impacted. Say language, okay? But the problem is, then those skills move into an area of the brain that was supposed to be used for something else, right? So a lot of times it's really tricky for little kids to think about localization. And so psychologists who do the kind of work we do, you'll see a lot more talk about the location of injury, because adult brains are more crystallized, but for little kids, we tend to focus less on localization and more on function, if that makes any sense.

So we had kind of previewed this. Oh, yeah. Another thing that I think -- I guess my question is, children with shaken baby syndrome that I've seen, one thing that I've noticed with that, it seems like it's not localized in that there is no pattern of where their delays are. Like, if you have a child that, for example, has seen cerebral palsy, which was before birth, you can kind of estimate if it's going to serve a pattern, strengths in the other area or stuff like that, and there is a the pattern, but children with shaken baby, it seems there is no pattern to it. Is that correct or not?

I don't know that I'm an expert in shaken baby, but I can kind of think about this -- I need to start turning this on. Okay. But we usually kind of think about this in terms of what we've learned so far and what you know. So shaken baby, first of all, these are really young infants, right? And second of all, the injury itself is pretty diffuse. So in shaken baby, what you're looking at is lots of that microscopic kind of injury, right, because the shaking involves a lot of the twisting. So one issue is that you're probably going to see more global impact because of the age range, and then the other issue is probably the nature of the injury. Although again I'm not an expert in shaken baby and I'd have to look at that a little bit more. Does that make sense, though? So what you're thinking about is an unevenness of strengths and weaknesses that sometimes you see in older kids who have had an injury, right? , and you're not seeing as much unevenness in those kids, and it's probably why, the generalized nature of their injury and age.

I have a question. The brain injury has to be physical or can be emotional?

Well, here we're talking about a physical injury that happened to a brain. What kinds of more emotional injuries are you thinking of, kind of traumatic events?

Exactly.

You can certainly see some of these sorts of problems in kids who have experienced something psychologically traumatic. But what we're talking about more today are physical injuries of the brain resulting in some of these problems.

And that's where I think things become complicated and where we sometimes be helpful as psychologists. Sometimes it's hard to pull those piece pieces apart. We have kids who have been injured and suffered trauma, and we're not always able to pull that apart. There was some recent research just out in the last week or so about the impact on the brain of traumatic events. We all know that experiences certainly affect the developing brain, but we can look at the patterns that the child is showing and get some idea of what the different contributing factors could be and how much of a contributor an injury might be.

Just take a little -- we talked a little bit about how kids were doing academically. We've kind of alluded to how they would do socially. What kind of social issues do you think these kids would have given the cognitive issues they might have, emotional issues they might have, behavioral issues they might have? How might that play out in terms of their social interactions? Their separation makes them have to get attention another way.

So they might get frustrated, might not be able to express themselves real well, so they might tend to act out more than another kid might, which might manifest in problems of aggression, absolutely.

A lot of confusion in their brains.

They're feeling a little bit kind of confused. The other thing to be thinking about, too, remember that part about the communication part, the nonverbal communication part and the social information processing. If some of these kids are having trouble just interpreting information from the social world, interpreting what it means when somebody's voice raises or when their eyebrows kind of go together and they look like they're not happy, if you're not understanding some of that effectively, how do you think that might play out in terms of how you come across to other people? If you're missing a lot of clues you're getting, what happens?

You're not acting appropriately.

Yeah, you're responding kind of off, and then you're probably not getting very good feedback from other people because they're not sure where you're coming from. These kids might tend to be -- have problems with loneliness or being left out, that they just can't kind of keep up socially.

They might seem defiant.

They might seem defiant when, in fact, they're kind of confused or got a little bit lost. Also with the impulsivity, one thing people might notice is sometimes these kids will kind of blurt something out or talk out of turn or that sort of thing, and it's more of an impulsivity problem. It could also be a defiant problem, but it may not necessarily be but it might get interpreted that way. They might kind of talk or do before they act and without intentional consequences. They're going to have more trouble with solving social problems. Sometimes they might come across this way. They might come across bossy. They might not realize the effect they're having on other people, plus there has been so much they haven't been able to control. They might be trying to do the

best they can to control the situation. We're going to play this way. You do this. You say this, and I'll do that, that kind of thing.

That doesn't tend to go over really well. That's not going to build your popularity or make other people want to hang out with you. On the flip side, some of these kids could also be more vulnerable to kind of follow in the crowd. This is what happened for Adam. Adam had a lot of social strengths, and he did okay socially for the most part, but the one worry that his mom had was kind of more about this, that he tended to be more of a follower, and she worried over time that he would get in with kids that weren't a good influence and he might have -- might not have the good judgment on whether it was a good idea to keep up with them or bail out of that activity. But you can see the sorts of social issues that stem from other problems from behavior regulation, emotional regulation and all of those cognitive areas. Along the same lines, what kinds of problems might you expect for just kind of day to day practical living skills, your ability to get up in the morning and get yourself dressed and ready for school, those sorts of things? What kinds of issues might you anticipate there, just being able to get your stuff done?

The slowness that you said earlier. It takes more time.

So basic stuff might just take more time. Getting up and getting dressed might take longer, absolutely.

You might not know how to sequence the events.

Absolutely. Some of those organizational problems might get in the way, kind of doing things out of order or losing pieces. When you're taking a shower, remembering to -- remember some parts to wash but forgetting to wash your hair, that sort of thing, yeah. What else might you see?

You probably argue more.

Absolutely. That's definitely one thing you can see.

Part of that is having a little bit less of a strong filter and also some of the frustration that can build up. Let's take a look at this next one. There can be lots of different problems and just kind of practice day to day functioning like you guys mentioned. Just basic stuff might take longer because of some of the physical and cognitive problems. The child might need more help with some of the basic self-care, hygiene issues, or just because the speed issue might slow them down. We talked become some of the -- there might be some clinginess or dependence, anxiety. The child might want more assistance even though they don't physically need it. How about when it comes to safety and just kind of judgment about how to operate when you're out in the world? What would you be worried about?

They would be very vulnerable to others and poor judgment.

Yeah, yeah. Might be vulnerable with the influence of other people, maybe trusting people that you shouldn't. What other things might you be worried about, just kind of basic kind of personal safety type stuff? Worried because of impulsivity that they maybe wouldn't look both ways, just kind of runoff. That's something that happens for Adam, something his warrants would worry about. As soon as they pulled the car over, he would just jump out and go without looking around and see if it was okay to do that. Also just things about kind of knowing what do you do if there is an emergency and you need to get help and who do you call and those sorts of things. There might be concerns in that area, and also just kind of basic self-direction about being able to think through what are the things I need to do and what are the steps I need to do them in, things like chores,

cleaning up after yourself, doing laundry, making sure your homework is done, those sorts of things, because those things in the executive function, planning problems, a child might need more help and structure in those areas to help get through that stuff. You might find that maybe whereas they could kind of entertain selves for longer -- entertain themselves for longer before, they might need reminders. We'll kind of stop there, because we'll move into talking about the sorts of things you can do to support these kids, but let me just stop and see if there are any questions about the sorts of problems and any aspect in functioning that a kid might have after a TBI.

Could there be, like, a lack of focus?

Certainly.

That would go along with some of the attention problems. It might be real hard to keep your focus on something to long enough to finish it, absolutely. Any other kind of thoughts about some of the impacts, the cognitive and behavioral impacts of TBI? Another one I'm wondering about is children that we see that can't get engaged in play. You know, they flip from one thing to another instead of getting real involved in doing the scaffolding and some of those kinds of things. Is that something that you would see?

You might. The things that that triggers for me, there may be kind of a social skill problem there about knowing, well, how do you invite someone to play or how do you get started on something. There could also be an executive function -- part of one executive function is being able to initiate a behavior, knowing how to get started on something and that could be a play activity, a homework assignment or knowing how you start when you need to sort your clothes into the dirty and clean pile. So there could be a problem with getting started. There might also be a social problem about being able to -- how do I -- if I want to play with someone else, how do I do that or what do I say? That's something you might see. Of course, keep in mind, as I'm sure you're already thinking, a lot of these problems aren't specific to a brain injury. You might see them associated with other sorts of problems that kids have, but that example could be something that you could see in a kid who was affected by a brain injury. Any other thoughts about some of the impacts and some the problems that you might see?

So we'll move into the next piece. Some of the things you can do to help, to help support a child who has had a brain injury. First, just a couple of framing comments. An educator's role is really an integral one. What we see in terms of research and clinical evidence as to when you follow kids over time what really helps them is when everybody working together works as a team and collaborates and shares information. What works less well and when nobody knows what else anybody else is doing. What's hard for the kids is generalizing what I learned here and doing it over here. So it's really important and sometimes the educators -- sometimes the educator is the one who is pulling all the pieces together to figure out, okay, what are some of the things this child is working on in terms of communication skills.

What are some of the occupational therapy skills they've come up with? What are some of those memory strategies and how can I make sure to remind the child to use them here or reinforce them to use them here? We see in the research when everyone is really collaborating and all the players know what everyone else is doing, and prompting the child to use all of those strategies in everything they're doing, that's when they really tend to benefit the most. When it's just going and doing this in speech therapy twice a week for 30 minutes, it's not always generalized as well. When you're able to work with these providers and pull in the pieces, it helps. Sometimes it is someone in the school program that can be in the best position to be a point person for that.

It's a big responsibility, but sometimes it makes the most sense. Collaboration is really, really important, certainly collaboration with parents, as well. They're going to know their kids the best and notice a lot of things. Keep in really close contact, that you're telling them what you've noticed and they're telling you what they're seeing at home. That's going to be really important. Also as an educator you're in a really good role to have a real careful eye on these kids. Really the message I want you to take home after what can happen after a TBI is there is a lot of variability. It's going to depend on a lot of different factors and there might be problems in some areas, but others the problems might pop up later that weren't apparent initially and some might get better quickly, too. So if you're seeing this kid pretty frequently in a real world context, you're going to be able to give real world evaluation to the parents and other treatment providers to let them know how they're doing, what you think is going well and what you are kind of worried about. And you're also in a good spot to be able to introduce some accommodations and supports. We'll talk about more specific ideas in a minute. Certainly parents play a critical role of being able to see this child every day and watchful attention for changes, things you see that are going differently for this child now than they were before the injury. Again it's really important for parents-to-be communicating with all the providers and letting them know what's going on. Parents are clearly going to be the strongest advocates for supports and services for the child.

Speaking to a parent after child with TBI, I think the main message is to be watchful about any changes and concerns that you have and to keep in mind that this child really may need some supports and services at school and in the different activities that they're doing. So for instance, you might need to ask for an educational evaluation to see if there is eligibility for services and those sorts of things. The parent is going to be the strongest advocate for the child. This last point, it's really important to be attending to how the child is doing but also be attending to how the whole family is doing. And there I want to take you back to when we were talking about how big a role in environmental factors play on how well this child is going to do. If the family is really struggling, if they were struggling before, if they're struggling to adjust to changes that -- have come in after this injury, then the child is probably going to do worse. It's very important for parents-to-be thinking about how everybody is doing, not just the injured child, because it's directly going to impact that injured child. It's also important to keep your eye on that as a provider, to be thinking about how is this family doing? Does the family need supports? There are supports for families that can be really helpful in helping the recovery of the child.

I'm going to talk about some specific sorts of accommodations that can be really helpful.

But I do want to throw out this caveat of I'm not giving a real detailed training of how to use these skills. So you're not going to be able to go out tomorrow and use them. But I want to point you in the right direction to some resources of the sorts of things that might be helpful, the sorts of things to look more into. The first one is it can be real helpful to have a health plan, and we'll see that on the next slide. This would be kind of going through the process of talking with the parents and the doctor just to make sure that as a school provider you know all the basic health information that you need to know, if there are any restrictions this child has, if there are medications that he or she will need to be taking at school, if there are any accommodations to address physical limitations, thinking of Adam with the broken leg, how he's going to get around the building. It would be good to have this in writing as opposed to thinking we'll deal with it as we go along. It could be real helpful in dealing with that process of talking to the doctor before the child even comes into the school setting just to make sure there is a plan in place for any physical issues you might need to know about.

Given a lot of the trouble with attention and memory and those executive functions and organization that kids can have, there may need to be some modifications to the schedule, especially given the big problem of fatigue, just getting tired more easily. So the child might need a modified schedule, and we talked about how you might

build back up to longer days of school. Maybe just go in for a little while at first, a few days a week and then building up. But also within the time spent at school, one thing that can be helpful for kids is alternating between physical activities and academic activities, and remembering that academic activities sometimes can be more tiring for these kids. Plus if you're going to alternate, for any kid, it's going to help keep their attention stay there. That can be helpful. You'll probably also want breaks scheduled in again because of this problem with fatigue.

Also keep in mind; given the chance that this child might be having a slower processing speed, you really want them at their best. If they're tired, starting to lose attention, plus slowed down anyway, you're really going to be kind of fighting an uphill battle if you don't put in some of these breaks. And along the same lines, these kids often do best when there is a higher level of structure build into their day, and this applies equally well to the school setting as it does to home. So building up as much structure, predictability, and routine as you can be really helpful. It helps structure these kids. It helps give them some of the structure that -- so they know what to expect. The other thing about routines, kind of learning routines is a different kind of memory. Once you've been doing something and doing it the same way, it will tend to stick better. We call that implicit memory as opposed explicit memory.

So for a kid who is having memory difficulties, they really may be able to remember and function well with routines of doing things the same thing. It's going to require less of their explicit memory. So that could be helpful. Some examples include -- you'll see this on the next slide -- visual schedules. You can make a routine out of almost anything. You need to identify the steps. It can be real helpful for kids to have it in a visual representation. I point you to this website, Learnnet website. It's really helpful. Lots of different pictures for different things, and you can put it together and print it out. These are just some examples. This one up there is a routine for washing your hands. Who would have thought it has so many steps, but actually, there are five steps involved. This is a visual schedule for the morning routine going from waking up, getting ready, eating and getting on the bus.

This might help structure and organize the child some. You can add view teen to a lot of different areas to the day. Maybe it's a morning routine, hygiene routine, bedtime routine, lots of different places where you can add more explicit routines. And this is one for school. So a little harder to see, circle time, playtime, rest time, snack time, helps kind of structure the child. And especially if things happen the same way every day, they'll know more what to expect and they're going to be able to function better within that structure. The other thing that can be helpful for introducing kind of new information in teaching, and again whether that's at home or school, because parents certainly do a lot of teaching, as well, instructional routine. It might just be a particular way you introduce an activity, saying now it's lesson time or activity time, just the things you say. When it's learning time, we get our pencil and paper and sit down over here, and then kind which -- kind of a structured way, say, first the educator is showing the activity. First I do it. Then all of the kids do it along with her. Then we do it, and then the child does it alone. You do it. And then there is time for feedback and review.

Whatever it is that you're teaching, if you're doing it in kind of the similar routine way, I do it, you do it, we do it, that helps build up a routine and structure and the child will be better able to be ready to learn. These suggestions are really about putting together the environment in a way that helps reduce distractions and promote attention. These are things you probably thought about, avoiding stimulation, trying to get kids away from the window, open door, air vent or around a bunch of other noisy kids and removing stuff they don't need, things that could distract them. You want to be looking for signs of fatigue and give them breaks when needed.

Again, you don't want to be fighting an uphill battle. If the kids are losing their attention, it's better to take a break than try to push. You want to keep the instruction simple, kind of remember, in some of those working

memory problems a child might have. One thing at a time, check in, make sure they've got it. The next, make sure they've got it. Next thing, make sure they've got it and presenting information in interesting and active ways. These are kind of basic things that help keep anybody's attention, but if you're doing something in addition to talking about it, if you see pictures in addition to kind of hearing words about it, that could really, help keep the attention. And also just kind of some general thoughts for helping with learning and memory.

You want to think about the pace and the amount of information you're presenting at one time. So you would never do something like this, where you have people sit for four hours and listen. You would want to -- you actually want to keep the pace fairly brisk. If you're going too slow, you might lose the kid, but you also want to be adjusting. So kind of starting with a brisk pace and moving at a good clip, but not too fast and not too slow, but you'll probably have to be a little slower for new stuff, but you also want to check in. If you kind of see the child needs to hear something again, as attuned as you can be to the child and to try to adjust to what it seems like they need.

It can also be helpful to give small chunks of information over several days instead of one, big four-hour training, that sort of thing, to be able to hear it, because it allows for more repetition and review of hearing it multiple times and linking what you already know to the next new thing and linking back to what you already know to this next new thing. Those sorts of things allow for kind of depths of processing, and so does this, presenting information in more than one way. If you're doing something, something hands-on in addition to hearing about it, if you're seeing some kind of picture or diagram or demonstration in addition to reading about it, you're going to process the information much more deeply, and that's going to improve learning. So if a kid is having some trouble with learning, these sorts of strategies might be really helpful. I'm not going to say too much about this, but there are some things that can help with some of the behavior issues and the big ideas are really, again, like with the attention issue, trying to anticipate problems and triggers and trying to avoid them.

You're going to get much further if you avoid problems before they happen than you are if you're going to have to respond to problems once they've already occurred. So you're really going to want to think about what are the sorts of problems that a kid might have. Well, a kid with a TBI might have a lot of problems with transitions and changes, with unstructured activities, to things when this is a lot of noise, a lot of people, those sorts of things. Maybe you notice that a certain time of day this kid really starts to lose it, and you want to set up the environment for success. So again, reducing the stimulation level, distraction level, giving breaks, redirecting the child if you know they're kind of going down a bad road and trying to swoop in there and redirect them toward something else, and also given reminders and cues, like, in the hallway, we keep our hands to ourselves, those sorts of things, just trying to set up the environment to avoid the problems. It's also really helpful to give lots of specific positive reinforcement for the good behaviors that you see, and specific is the key word here of really trying to let the kid know exactly what it was the kid did that you looked.

I really like the way you kept your hands to yourself in the hallway. Great job asking for help. Those things tend to be more effective than just saying, good job today. They may not know what you're talking about. The last two points I'll make here, more significant behavior problems, there might be a need for a formal behavior plan. I'm not going to go into details there. The school or family may want to go to a behaviorist to come up with the nuts and bolts of the plan. One tool that can be helpful is a functional behavior assessment where someone is coming in and observing and really trying to figure out what are the environmental factors that set up for good behavior and what seems to be the sorts of triggers or setups for problem behaviors, so that can be a real useful tool. So for kids where behavior is a bigger problem, a formal behavior plan can be a real helpful thing. Also just keep in mind there might be additional services that the child or family might need, and that could include individual therapy that may focus on some of the more cognitive issues, but it also might focus more on coping and adjustment, learning ways to deal with frustration, anger, some of the emotional problems we talked about.

But this piece here I want to emphasize, too, because we've been talking about how important family functioning is, and there is growing research suggesting that family based intervention, family therapies for kids affected by TBI that focus on improving family functioning and in particular helping families build problem solving skills can really be helpful and not just for the family but also for the child, that they tend to predict better outcomes for the child. So keeping in mind that these might be resources that a family might want to consider, especially if you kind of get the sense that a family is really struggling, and that there might be some family factors that the family could be doing better and might need some supports.

That's something to be thinking about. The one thing that I'll say and then turn it back over to Dr. Diedrick, for a lot of these suggestions for the supports, examples for a lot of those are on our website called learn that, and that's on your resource page at the end of your slides. I just want to point to there is a lot of really great stuff there, and that website is designed by researchers and clinicians who have worked with kids with brain injuries, and there are all sorts of strategies, really good examples and video demonstrations of how to use those sorts of things, so It's a really, really great resource. In your free time, just kind of click through there and see all the sorts of different problems that they have some thoughts for. I know we went through that kind of quickly, but I just wanted to give you an overview of the sorts of things that might be helpful.

Do you have any questions about classroom strategies? Any questions about that?

Functional Behavior Assessment.

You know, it depends on how your system is set up. You're talking about how to find a functional behavior assessment. That is probably a systems question. It probably just depends on your school district. Some schools have folks who are trained in functional behavior assessment as part of their district, and other districts contract with folks who have specialty training in that area. So sometimes the regional center has the specialists that can also be quite helpful. I don't know if that's very helpful, but it has to do with how your system is set up.

Are they required to do that?

I don't know that I'm qualified to answer those kinds of rules issues. I don't know how to answer that question. I'm sorry.

I can see a problem with getting that done.

And some of it is access to people who can do it, and some of it is a funding issue, yeah. I totally understand, though, because I spend a lot of time recommending functional behavior assessments that don't get done, so there does seem to be some systems problems with getting those completed, and I think it difference a lot depending on where you're at what the barrier might be. Other questions? Before we go on to the next session, I wanted to just pull apart a couple of things. Many of the strategies and problems that we talked about sounded similar to problems you can see in other kids. There are many unique things about traumatic brain injury, but a couple of unique things I wanted to pull out for you to think about from an educational standpoint that have some practical implications with how you practice when you have a kid with a brain injury. One is, as you've probably gotten the impression, kids who have had a TBI are a moving target for quite a bit of time after their injury, and so our system of doing an evaluation once in the schools and evaluating them again three years later doesn't always work very well for these kids.

So one of the recommendations I make a lot when I see a kid with an injury is that there need to be more frequent team meetings. Does that mean you need to fully reevaluate a kid every three months? No. Because it does mean the data the teachers have collected from curriculum based measures and observations are going to be really important. Also, probably, if they're seeing a psychologist, we're going to see them probably every six months for the first year and every year for a while afterwards, and so that information will be important for you to look at, too, so that the IEP is moving with the child, right?

So Adam may start school exhausted and over-stimulated, so you're working on a half day schedule and he needs lots of breaks and he has behavior outbursts because he gets over stimulated, and you learn quickly you can't talk to Adam when he's upset because that just makes his brain implode and you have to back up, dim the lights and move him to a quiet location to calm him down, but a month later, that may not be the case anymore. He may be able to go to school for a half day and do okay. He may be a little calmer and you may be able to talk him through these problems, so it's a moving target. I think that's really important to remember, that more frequent team meetings are often going to be important, and I usually suggest, you know, the one at the beginning when they come back to school, one a month later, and then quarterly thereafter during the recovery process. But that's just a guideline.

Certainly anyone in the team who sees a major change and thinks the IEP needs modified, I think particularly in these circumstances, It's a good idea to call the team's attention to that and have a brief meeting and bring your data with you and adjust as you need to. Does that make sense? Yeah. The other thing, just to kind of be thinking about is that behavior problems in these kids, and other kids, too, but certainly with kids with TBI, often have some sort of cognitive basis to them, particularly if they weren't having lots of behavior problems before, and so just taking a problem solving kind of perspective to it is really important. So certainly kids with brain injuries can be stubborn and difficult, right, just like kids who haven't had brain injuries, but sometimes they are stubborn and difficult because the cognitive demands are too much or they can't remember what they were supposed to do, so instead they act stubborn, or they're over-stimulated and tired or a variety of things.

So just taking an open-minded philosophy and sitting down and just kind of writing down for yourself, okay, here is the problem I'm having. What could be the cause of it? And you'll find that that is the coolest thing about that website. You go to a problem list, and it says, this kid is having outbursts, and you click on it, and it lists 25 different reasons they could be having outbursts so you can click on it and read about it. And then it goes to specific strategies, so it's a really, really cool website, just kind of taking a problem solving perspective and making sure to have more frequent meetings. I think those two kinds of bigger picture chains in your -- changes in your thinking can make a big difference on how things go in returning a kid with a TBI to school. Any questions about that? Okay. So obviously if you have a -- you guys have probably all had kids who have head -- hit their heads on the playground. The first thing to do is to be practical and do what you would always do, give first aid and makes sure the child is evaluated. Before you changed the slide, and don't cheat, try to think back to the things we told you, and think about, if you're documenting this incident, and a kid has had a knock on the head, what things are going to be particularly important that you might not always think about to document for the medical professionals who will be working with him afterwards? When I'm seeing a kid, what am I going to want to see in your incident report that can help me figure out what happened with their injury?

How it happened.

How it happened, uh-huh.

What he hit his head on.

What he hit his head on, uh-huh. You're probably not going to have that. I'm definitely going to want that from the measure, but what can you document. You're probably not going to do a Glasgow rating scale, but what can you document?

Confusion, if they have confusion.

Exactly. So do they seem disoriented or dazed, do they seem confused, do they seem to have lost consciousness? And if they do seem to have, how long did it last and if do they seem disoriented, how long did that last? Those pieces can be really important pieces that often -- people just don't -- it's not anything intentional. It's not something that people usually think about trying to document. That can be really helpful. So when did the injury occur, what did the child hit his head on? How did it happen? What part of the child's head was injured? How did the child behave? Did they have a loss of consciousness? Did they seem dazed or confused or disoriented? Sometimes little kids, you can ask them what day it is and it's a shot in the dark as to whether they would know, right? But they can look pretty confused. They can kind of wander around and look like they're not sure where they're going or what they're doing. So with little kids, you have to be a little more intuitive, but you guys are good at that already. Do they have any blank staring episodes or anything looked like a frank seizure? Are they vomiting or does their head hurt?

You can tell by the way the kid is holding their head and how they're acting? And are they grouchy? Little kids -- I get grouchy, but sometimes the way you know they're having trouble is they're grouchy, really irritable and fussy, and how long did those changes in behavior last? Those are the important pieces to document.

Another thing, too, changes in speech.

That can be helpful. Usually, if paramedics come, they're going to ask you that question, but a paramedic may not think of that. So that might be something to put in a report to send with them to the doctor's office. Yeah. So then the other question comes up that we kind of started talking about before is what happens if you have a kid in your classroom who either, a, you know he had some sort of head injury, or b, you suspect he may because of his or her behavior? What to do in that case. So you guys know this as well as I do. Any kid in your classroom that has a change in behavioral functioning or cognitive functioning, you're going to want to evaluate that, right? And if there is a question on the head injury, there are two things to do. One, definitely send them to their physician to make sure there is nothing medical, realizing, of course, if the head injury happened a little while ago, the physician may not be able to pinpoint that. But if you still really suspect or you heard from the parent that they hit their head and you really see some changes, then probably the best place to go is to see a neuropsychologist, which is what I am.

And what we can try to do, although as I pointed out before, we're not perfect at this, but we can look at what's the history, what's the history of possible injury, what is the history of other problems that have been going on, and then we can do testing to look at the specific cognitive issues that we were talking about, like memory and attention and impulse control and all of those kinds of issues, and we can look at the pattern of those, because the pattern of those problems look somewhat different for a kid with a TBI sometimes than with a kid with a learning disability or an emotional problem that's underlying their learning problem and try to pull those things apart. Sometimes we can't. And sometimes the best we can say is some of it looks like a brain injury, some of it looks like something else.

There are multiple contributors, but what we can always do, even if we're not sure, what we can always do is make suggestions based on their strengths and weaknesses of things to try at school. And as you might have guessed, the kinds of changes you might notice if you have a kid who you think has had an injury that might tip

you off are irritability and moodiness, fatigue, being withdrawn and impulsive, complaining of headaches and trouble learning new information and slowed down speed of processing. You know, the other thing that sometimes happens, if a kid has had a brain injury and nobody has really connected that, it looked pretty mild, the parent went to the ER, and they said they were fine, and most of us are kind of prepared as parents that our kids will get a knock on the head and try not to be too paranoid, right, and then there are problems afterwards. If we don't ever connect those, what usually happens is that we have a kid with a lot of emotional and behavioral problems on our hands. Recognizing is so critical and parents, too, in kind of catching these things early on, because that's what happened. In teenagers what happens is, in some of these kinds of cases where the kids get sent home from the ER and they tell them they're fine, and often we have teenagers who are suicidal, having suicidal thoughts because they cannot figure out what's going on, and they can't fix it, and usually the people in their environment are not reacting positively to them, which doesn't make you feel great. So in little kids, you may see worsening emotional difficulties. And so trying to catch these things early is a good thing, and like you were mentioning, if a kid has had a knock on the head, just get them to the doctor to make sure they get at least an initial check and then kind of watching them over that post-concussive time frame to make sure they're improving the way we know they should. And if they're not, you know, identifying that to the parent and suggesting that they see their physician and a psychologist about that.

Does that make sense? One thing to keep in mind is there are lots of psychologists who can see kids with brain injuries, but not all neuropsychologists, but most of the time psychologists who are generalists don't have that special training. So certainly it can be helpful to go to a psychologist that you have a relationship with in your community or to get some of that more specific pulling the pieces apart. You're going to have better luck with somebody who has specialty training in that area usually. Questions about that? If you guys have had kids in your school that you've wondered about or situations like that before.

I have a question actually for this group. Many of them are from head start programs, and I so I guess I was just wanting to pose a question to all. In preparation for this particular training and maybe as you've seen in some of the numbers, the program information report is what head start reports on various numbers and a variety of different services that the children and families receive, and within that program information report, there is a category that has been on there, and I'm not sure for how long, but I've kind of gone past, looked at last year's and this year's numbers, and last year, from about 17,000 children that are enrolled in head start and about 21,000 that head start has served, last year we're showing that one child was documented as have been traumatic brain injury, so this year, we just got the numbers, and I was sharing with Melody a bit earlier that this year's report is showing zero.

So I'm just posing a question to this group to see, you know, what would trigger you currently in your work that might allow you to document or how are you finding out or how are you suspecting currently? Obviously with this information, there could be a -- different practices that you embed into your program, but just curious, your initial thoughts on do you think those numbers are accurate maybe based upon the information that you received today, or would you suspect that there are more children in your programs that maybe just haven't been identified as having TBI.

So those numbers just kind of stood out to me a little bit, seem to be underreported, if you will, so I just wanted your thoughts.

Well, in Missouri, It's non-categorical. In Missouri, most children are labeled as non-categorical developmental delay in preschool, so you have to tease out those that you want to put in a separate category for your report, and I think the only ones that I've ever done are ones that have come to me telling me that it's a traumatic brain injury, such as shaken baby syndrome type of thing. And other than that, a lot of times they're just non-

categorical, and they may be -- across the board, they're not specific.

I know we use a seizure assessment sheet for our children that have seizures, and this TBI, it really sounds like to go back to come up with some kind of piece of paper where we can document, and I think that that's going to help everybody else in the long run, at least at our spot, because I don't think it's something that's talked about. I think looking back, even with my children, it's like, oh, my gosh, really? You just don't think about it.

And we've been talking about that a little bit as a group, about whether or not there were places in the routine paperwork that did screen for TBI and maybe what could happen with that.

Exactly. That was going to be my next question. As part of what you do, the health shift in the first so many days, is there currently in your health history any trigger that would connect to TBI?

We ask if they've had a severe fall. That's the only thing I can think of.

I know most of our physicals are done by the PTA's. Unless we have some doctor report or some information, we don't know. We're mainly putting in for like speech, language, or it's the other category, and even when I try to get other things like autism or other things, it's like we don't really need that. So traumatic brain injury, I'm not sure where that would come from unless it was from a doctor's report that stated it for us, because the IEP's from school normally are not going to have that information in there.

We've just got one question that follows the question, did you have any serious illness, and it's do you have any serious injuries, which includes head, burns, et cetera. But I'm thinking that this is not common knowledge, and even if a parent knew that their child fell and hit their head last week, they went to the doctor's office, the doctor said they're fine. They don't think of that.

I was just going to say that from a parent perspective, having a concussion after the physician tells you, oh, they're physically fine, it's not really until people get quizzed about that or are educated about the long-term effects of a TBI that as a parent I wouldn't even think of an -- think of telling an educator about that. So it gets me to thinking how do we do better for that child over a lifetime.

All of that is really important feedback, too, with grants and things that we can look at further things we can produce, not only just the training but materials and screenings and fact sheets and things that could help with the communication between school and parent and parent and school.

I guess my question to the group is, if the question were posed, has your child ever hit their head, would that flesh out incidences?

Everybody has hit their head. It's going to be those subtle things that's going to trigger the thought process.

So the question, did your child hit their head? Has your child has any of those consequences that we just discussed today would maybe then bring it out clear, do you think? So maybe a one page sheet to screen for that? Is that what would be easier to implement or helpful to the staff or families that you work with?

I worry about another piece of paper.

I know. I know. Right. Right. So I guess in some of our discussions we've talked about what can we -- is there

something that we could modify that you currently have that wouldn't add that other piece of paper that would get the same results?

Maybe on the health question.

On the health history?

I'm wondering, too, after we do their developmental screening, those kids that you're kind of like wondering about, then do, like, a TBI screening on them or something, you know, because we always have those kids that are just kind of lffy when you do the developmental screening. You know, it's like something is not quite right but we don't know what it is. Then that's where I wonder if maybe another sheet at that time. Not do it on all the children but on those that have the red flags that you can't quite put a finger on it might be helpful.

That's a great suggestion, Linda. I was kind of thinking as you're describing that, and I kept thinking triage. But it's not triage. It's kind of that secondary -- like a risk assessment or something. Before you mentioned that, I was just kind of also thinking, because, as you know, while you all have to follow the same standards, sometimes the forms in which you do can vary. And so as we consider developing a form, I'm wondering -- and the hesitancy around, oh, no, it's another form we have to fill out. Maybe it's something along the lines of having, like, a protocol, if you will, and having this protocol and share that with programs, for them then to decide how to embed that into their current practices, so where you might have one program that would embed those questions into their existing health history form, you might have another program that chooses to do kind of that secondary assessment, if you will. So maybe it's thinking what is the standard four or five questions or protocol for them to then choose how to embed it.

You know, another thing that I was kind of wondering -- are there other things you wanted to talk about on that topic? Because I had another question for you all. Do you feel like when kids bump their head and have a concussion that parents tell you about that? You know, one thing that occurred to me that I haven't thought about before just today, as I was thinking about this is how helpful it would be for you to know that, because you may have a kid for two to six weeks who is grouchy and inattentive and tired, and -- inattentive and you don't know why. But probably the parent took their child to the doctor and the doctor said it was fine. I wonder if there is a way some of the parent education materials to kind of remind parents -- there are probably some of the materials -- in my sons schooling, you get things that say, if any of these have happened, please tell us about that so we can be responsive. I wonder if there are any materials in your training process that you could give them information about that. I don't know.

I was wondering if there is some kind of preschool parent education handout or something for TBI, because we have all kinds of parent education. I don't know -- I don't have anything on TBI as part of that, so that might be -- what happens when the child bumps their head, you know, and then kind of give some -- you know, the reminder or whatever in that or something.

Because sometimes when we see kids who have post-concussive symptoms that go away, there are times in addition to those factors that Dr. Benton talked about we wonder if one of the factors for those symptoms continuing longer than expected that they didn't get the support they needed, and so how can you get that if you don't know that it's happened. And there is not, like, a mechanism or short-term IEP. You might be able to create a short 504 plan, but there isn't really a mechanism for that either.

In your parent education, how is that delivered? Is it in a handout? Again, it's one of those things

that different programs do it different ways.

All of our children who have special needs receive a packet. Developmental milestones, something else. That would be an excellent piece of information, the TBI. That might be some of the problems that we're seeing.

Other questions that we have?

I realize that we didn't put our e-mails on this presentation, and so just in case you have questions or thoughts, I'm glad to be a resource to you, so I'll just give you my e-mail address. deidrickk@help.missouri.edu.

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