

64| Spina Bifida and Hydrocephalus – With Dr. Christine Koterba

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Speakers: Christine Koterba, Ryan Van Patten, John Bellone



Intro Music 00:00



Ryan Van Patten 00:17

Welcome, everyone, to Navigating Neuropsychology: A voyage into the depths of the brain and behavior. I'm Ryan Van Patten...

John Bellone 00:25



...and I'm John Bellone. Just a quick reminder to register for the upcoming INS conference if you haven't done so already. The conference is going to be fully virtual this year, 2021. There are a number of excellent workshops and symposia and other programs available. We look forward to seeing you there, virtually, of course.

Today we speak with Dr. Christine Koterba about hydrocephalus and spina bifida. Chrissie is a board certified clinical neuropsychologist specializing in pediatrics at Nationwide Children's Hospital. She's also a Clinical Assistant Professor of Pediatrics at The Ohio State University.

Ryan Van Patten 01:03



We've got a brief intro for this episode before giving you our conversation with Chrissie. As you'll hear, we talk to Chrissie about four common types of hydrocephalus in children which are: spina bifida, aqueductal stenosis, Dandy-Walker syndrome, and intraventricular hemorrhage. But in the conversation, we didn't clearly lay out prevalence rates of some of these subtypes and a few other things. So we'll start to do that here.

Spina bifida is by far the most common cause of hydrocephalus in children accounting for about 75% of all cases of congenital hydrocephalus, while aqueductal stenosis accounts for about 10% of cases, and Dandy-Walker syndrome explains 5 to 10% of cases. The intraventricular hemorrhage subtype is more difficult to quantify from an epidemiological standpoint because the likelihood really increases in children at younger gestational ages - in other words, children who are more premature. More info to come on this.

John Bellone 02:06



We will spend most of the episode discussing spina bifida. Spina bifida is typically separated into four types going from most mild to most severe. Occulta is the first type, which means "hidden", where there is a malformation or an opening in the vertebrae but it rarely causes symptoms. The second type is closed neural tube defects, which is a diverse group of spinal cord malformations. In most cases, there are a few or even no symptoms. In the third type, meningocele, the spinal fluid and the meninges protrude through an abnormal vertebral opening. Some children with this type may have a few or no symptoms, whereas others may have paralysis and bowel and bladder dysfunction. The last and most severe form is myelomeningocele where the spinal cord is exposed through an opening in the

spine and typically causes significant symptoms. Most of our conversation with Chrissie will be focused on myelomeningocele. Neural tube defects such as spina bifida are slightly more common in girls compared to boys and in Latinx women compared to non-Hispanic White or Black women. As we discussed with Chrissie, folic acid is an important vitamin for women who are pregnant or who may become pregnant in order to reduce the risk of spina bifida and other neural tube defects.

Ryan Van Patten 03:38



One more caveat before we move on. You'll notice early on in the episode that I mentioned the clinical triad of "wacky, wet, and wobbly" to characterize normal pressure hydrocephalus. The word "wacky" can sound a bit pejorative if it's taken to mean that people with NPH are crazy or incompetent. But the "wacky, wet, and wobbly" phrase is simply a mnemonic to use to remember the three classic symptoms of the condition which are cognitive impairment, incontinence, and gait disturbance. So, in saying that, I don't mean any offense. And, with that, we give you our conversation with Chrissie.



Transition Music 04:17



Ryan Van Patten 04:26

Okay, we're here today with Chrissie Koterba. Chrissie, thanks so much for coming on NavNeuro.



Christine Koterba 04:31

Yeah. Thanks for having me. I'm really excited.



Ryan Van Patten 04:34

Likewise. We want to spend the majority of our time today talking to you about hydrocephalus in children, but a few questions may relate to adults and older adults. To start, can you tell us about hydrocephalus broadly? What is it and how does it damage brain tissue?



Christine Koterba 04:51

Hydrocephalus is basically a condition where there's too much fluid in the brain. Typically in the brain, there's a cerebrospinal fluid which surrounds or kind of bathes the brain and fills the ventricles or the spaces inside of the brain. What happens in hydrocephalus is there's just too much of it. So that can increase the pressure in

the brain and that can lead to damage over time because it can cause stretching or straining of different parts of the brain.



Ryan Van Patten 05:25

Talk a little bit about hydrocephalus as a disconnection syndrome and the damage to white matter pathways.



Christine Koterba 05:31

Hydrocephalus particularly damages the white matter of the brain. What can happen is it can damage the white matter tracts of the brain - like the corpus callosum, for instance. The longer that somebody has hydrocephalus that is untreated or uncontrolled, that can lead to greater damage over time. The biggest area where we see this is in the periventricular white matter, or the white matter that surrounds the ventricles, where there might be more of a buildup of the cerebrospinal fluid. Fortunately, up to a certain point, these changes can be reversible when a patient might have treatment for the hydrocephalus, like shunting, which I think we'll talk a little bit more about.



John Bellone 06:19

You mentioned the stretching of those axons. My assumption is that that's why the white matter is disproportionately affected, because you have these long fibers, these long tracts, and there are lots of areas where they can get stretched and damaged potentially.



Christine Koterba 06:36

Exactly. I think what's tricky when we see white matter damage is it's not just the white matter that's damaged, or it's not just those structures that are damaged, because the white matter is obviously connecting multiple parts of the brain. We might have white matter damage but then the parts of the brain that the white matter is connecting are also going to be damaged. So we might see impairments in those functions controlled by those areas as well, if that makes sense.



John Bellone 07:04

Yeah. And that'll play into the profile that we'll talk about later, right? I've also heard that the damage is more posterior versus anterior. I'm not sure why that might be. Is that your understanding, too? Is that it's differentially posterior, the damage?

Christine Koterba 07:21



I'm not exactly sure why that is. But what's interesting is, as we get into talking more about spina bifida, which is a condition that can be affected by hydrocephalus, that's another condition that really has a lot of impairments in the posterior regions of the brain as well.

John Bellone 07:41



Maybe something to do with neurodevelopment. I'm not sure.

Ryan Van Patten 07:44



In talking about hydrocephalus, we want to cover normal pressure hydrocephalus as well. With the clinical triad - the three symptoms of the way we always remember it is "wacky, wet and wobbly." In other words, people with NPH have cognitive impairments - wacky. They often have incontinence - the wet. And they have gait disturbance - the wobbly.

Christine Koterba 08:07



Yeah.

Ryan Van Patten 08:08



Tell us a little bit about NPH. What is it? Who gets it? And how do we treat it?

Christine Koterba 08:13



NPH is a condition where there's too much cerebrospinal fluid and the ventricles become enlarged, but the pressure in the brain doesn't really change. You're right, patients that have NPH exhibit this classic triad of symptoms. It can range from mild to more severe, depending on the extent of the NPH. It's much more common in adults, especially older adults. As adults get older, their risk for NPH increases from their 60s, 70s, 80s.

I don't see older patients, I work with kids. [laughs] But when I was preparing for this, what was interesting to me, and what I think is probably very challenging for adult providers, is differentiating between what's normal aging or what's dementia and what could be signs that we see with NPH. Because as adult providers recognize probably with hearing the symptoms, they aren't totally specific to NPH.

You asked about the treatment as well. I think shunting is a common treatment for NPH, but I don't know that these patients necessarily have to be shunted. I think it probably depends on the extent of the hydrocephalus.



Ryan Van Patten 09:32

Yeah, that's my experience.

John Bellone 09:32



Sometimes it works, sometimes it doesn't. There are also many neurological diseases that cause atrophy, neuronal tissue loss, and that when neurons and glia die, the CSF fills that void. This is sometimes referred to as ex vacuo. You know, vacuum, it creates a vacuum - thus vacuo. Would you call this hydrocephalus as well?



Christine Koterba 09:57

Again, this was something that as I was preparing for this, I was reading up on and...



John Bellone 10:02

I know you're a pediatric neuropsychologist and we're asking you all these questions. [laughs] Just to cover our basis.



Christine Koterba 10:07

[laughs] It took me back to studying for boards.



Ryan Van Patten 10:10

[laughs]



Christine Koterba 10:11

What was interesting to me is I was coming across some different studies where radiologists were talking about how to differentiate between atrophy and hydrocephalus in older adults. It sounds like it is not just a clear, easy thing to do even for the people who are reading the brain scans to figure out. So I think it is something different. One of the reasons why it's important to distinguish the two is because you can treat hydrocephalus and you're not really going to be treating just brain atrophy, even if there is more CSF in the brain. That's what I would think it comes down to and why the differentiation is important. Because that would make a difference in how a patient is treated and maybe what their prognosis is as well.



Ryan Van Patten 11:02

Related to what you were just saying, can you talk about the difference between communicating and non-communicating hydrocephalus?



Christine Koterba 11:10

Yes. Communicating hydrocephalus is basically when there is not an obstruction. What happens is that there is an impairment in [the] brain's ability to absorb the CSF. There's too much CSF because the brain is not absorbing it. Non-communicating hydrocephalus, on the other hand, is where there is an obstruction. There's something that's blocking the flow and keeping the CSF from flowing around the brain like it's supposed to.



Ryan Van Patten 11:39

That's helpful. For listeners to make this distinction, we were talking about atrophy. Some process leading to the death of neurons and glia and then CSF fills that void. But that's not necessarily hydrocephalus as we classically think about it. As we classically think about it, it's typically either communicating, in which case there's a problem with reabsorption of CSF, or non-communicating where there's a block and then there's, again, too much CSF but for a particular reason, not just because neurons are dying off.



John Bellone 12:14

Right. You'll sometimes still see it, though it is referred to as ex vacuo hydrocephalus. But, right, there is a reference there for sure. Most cases, in my understanding of hydrocephalus, are secondary to another neurological condition. Well, if you will, primary. How do you think about this distinction between primary and secondary types?



Christine Koterba 12:35

This is a really important distinction to make because typically in the cases that I am working with there is a medical cause that is underlying the hydrocephalus. That is sometimes more important to be thinking about than the hydrocephalus itself. Because a patient presenting with a medical condition that might be causing hydrocephalus might also be showing characteristic cognitive or neuropsychological impairments related to that medical condition more so than the hydrocephalus.

Actually, it's interesting because we don't get very many cases referred to us that only have hydrocephalus. I have followed up before with our neurosurgery team

asking, "What happens to these patients? Why don't they come in for neuropsychological evaluations?" I don't know what your experience as adult providers [is], but for us, the neurosurgery team maybe places a shunt, they treat the hydrocephalus, the kid goes home, they might never see them again. They don't really know if they have cognitive problems or not. I think those kids tend to do better than the kids that have a medical condition that is causing them to have hydrocephalus. Does that make sense?

John Bellone 13:47



Yep. That's a good distinction to make. We'll talk about some of those conditions right now. I want to dive a little bit deeper into the types of early hydrocephalus. There's several - spina bifida, aqueductal stenosis, Dandy-Walker syndrome, intraventricular hemorrhage associated with prematurity. We got a lot on our plate here to cover. [laughs]



Christine Koterba 14:06
[laughs]



John Bellone 14:06

Just to start, if you can, briefly summarize aqueductal stenosis, Dandy-Walker, and intraventricular hemorrhage. Then afterwards we'll talk more in detail about spina bifida, which is a more common cause of childhood hydrocephalus.

Christine Koterba 14:21

First, aqueductal stenosis happens when there's a blockage in the passageway between the third and fourth ventricles, which is called the aqueduct of Sylvius. What happens is that this becomes narrowed or blocked. This can be due to many different reasons - infection, hemorrhage, tumor - and then what happens is the fluid is basically blocked from the obstruction and that leads to hydrocephalus.



Another one that you mentioned is Dandy-Walker syndrome and this is another cause of congenital hydrocephalus. This is when the fourth ventricle is enlarged, because the outlets are partly or completely closed. Then what happens is part of the cerebellum fails to develop. This can also be associated with other forms of abnormal development in other parts of the brain and that might determine how this would be treated depending on the extent of the abnormalities.

You also mentioned intraventricular hemorrhage. This is most frequently seen in babies who are born extremely premature. When babies are born extremely

premature, there's a range of medical conditions that can come along with that. There are things that can affect multiple organ systems and different parts of the brain. One of the things that we sometimes see is an intraventricular hemorrhage. What can happen that can then lead to the hydrocephalus is you have these small blood vessels that line the ventricles, they can rupture and that can lead to bleeding. Then there can be damage and scarring that can cause difficulties with CSF being absorbed. So, again, like we talked about, when the CSF can't be reabsorbed by the brain, this can lead to hydrocephalus.



John Bellone 16:16

My understanding is that the blood vessels in premature...what do you call...infant? In a...in a...



Christine Koterba 16:23

A baby. [laughs]



John Bellone 16:24

Yeah, good.



Ryan Van Patten 16:26

Wow. You're really...



Christine Koterba 16:27

[laughs]



John Bellone 16:27

My wife is eight months pregnant. I should know the term of my child.



Christine Koterba 16:31

You're like, "What's in there?" [laughs]



Ryan Van Patten 16:33

What do you call that? That living thing inside their belly after it comes out? You're not showing your ignorance at all. [laughs]



Christine Koterba 16:44

[laughs]



John Bellone 16:46

[laughs] My understanding is that the blood vessels in a premature baby are very fragile and are more prone to rupture if a baby is born prematurely. The germinal matrix - I'm thinking back to my board review, too - the germinal matrix is right by the ventricles and that's where a lot of action is happening in terms of neural development and that's why it's more susceptible. Is that right?



Christine Koterba 17:13

Yeah. It's just like you said, they're more vulnerable in certain regions of the brain. They're more prone to bleeding and that can lead to hydrocephalus, ultimately. It's interesting, this is going off on a little bit of a tangent, but we've made so many medical advances where we are able to keep these tiny, little babies alive, that are born at 24, 25, 26 weeks. That wasn't possible not even that long ago, and that's incredible. But there's a cost for that. We see characteristic medical difficulties that they have that then can lead to more cognitive problems down the road. That's a discussion probably for another podcast. But one of the things that we do commonly see with those really, really premature babies is intraventricular hemorrhage, and that can sometimes lead to hydrocephalus.



Ryan Van Patten 18:09

Yeah, that's helpful.



Ryan Van Patten 18:21

Let's wade into the most common cause of childhood hydrocephalus, spina bifida, which is a neural tube abnormality. What goes awry with development here?



Christine Koterba 18:32

I've been most excited to talk about spina bifida because it is one of my very favorite populations to work with. I really like it. I don't know what it is, I just think it's such an interesting condition. Before a woman even knows that she's pregnant, this is when the neural tube is developing. I think of it as you have this little cluster of cells that then is becoming this neural tube, and there's an opening along it that almost gets zipped up. What happens with spina bifida is, as this opening is closing or getting zipped up essentially, there's a defect and a protrusion where the spinal cord and the meninges and nerve roots bulge out of that closing. You can actually see it when they do an ultrasound during pregnancy with a baby. They can see on the back where the spinal cord is, they can see a fluid-filled sac protruding out of the back. What happens is you have all this stuff on the outside that's supposed to be on the inside and that leads to further abnormalities in brain development and

lots of different difficulties that we'll talk a little bit more about. But that's the most severe form of this, spina bifida myelomeningocele.



John Bellone 19:52

What are some of the other types? There's myelomeningocele and then there's a couple of others. Occulta, for example.



Christine Koterba 20:00

Yep.



John Bellone 20:00

Can you talk us through some of the different types?



Christine Koterba 20:02

Myelomeningocele is the most severe and associated with the most long term difficulties. Occulta is the least severe, it's the most mild. Somebody might not even know that they have this. It's where the outer part of some of the vertebrae is not completely closed, but the spinal cord and the CSF, nothing is protruding outside on the back like it would be with a myelomeningocele. The skin where this lesion is might be normal. There might be some patchy hair there or a dimple in the skin, but that might be the only thing that you would notice. Somebody could essentially have this and never know because it's not really associated with any significant impairments. Meningocele is a step above that. That can sometimes be associated with mild problems. What happens with meningocele is there is a fluid-filled sac at the gap in the spine, but it doesn't have the nerves in it so it's not as significant as the myelomeningocele.



John Bellone 21:11

It can still cause a buildup of CSF and hydrocephalus. Is that right?



Christine Koterba 21:17

I think it can, but not as commonly as myelomeningocele. I'd have to go back and double check on that.



John Bellone 21:24

Okay.

Christine Koterba 21:26



We rarely - I don't know if I've ever seen anybody with spina bifida occulta. I might have seen a few kids with meningocele, but typically it's the myelomeningocele. But I can go back and check on that.

John Bellone 21:37



Okay, that's fine.

Ryan Van Patten 21:38



Chrissie, what is a Chiari II malformation, also known as an Arnold Chiari malformation? How is it related to spina bifida?

Christine Koterba 21:46



A Chiari II malformation is extremely common in kids that have spina bifida. The vast majority of kids with spina bifida are going to have this. Basically what this is, is it's a congenital brain distortion where the posterior fossa - so this space in the back of the brain - is small and distorted. We also see something called tectal beaking. So the tectum has a characteristic look where it's pinched in. It looks like it has a little beak and then the contents of the posterior fossa are herniated through the foramen magnum. This is really a structural defect in the cerebellum. Like we were talking about with other forms of hydrocephalus, this leads to an obstruction that then can cause hydrocephalus because the CSF is not flowing around the brain like it's supposed to be.

John Bellone 22:35



Can you briefly mention the other types of Chiari malformations as well? Because the Chiari II is just one type.

Christine Koterba 22:42



There's actually a few different [types], which I wasn't as familiar with because we typically aren't seeing people with other types of Chiari malformations. Type II is associated with spina bifida. The other one that is most commonly seen is a type I malformation. This is where there's a herniation of the cerebellar tonsils, and it can range in severity. This is something that is oftentimes an incidental finding. In kids that I've seen who've had a type I Chiari malformation, typically they might have had headaches or they might have had brain imaging for another reason and they end up finding that they had a Chiari I malformation. Sometimes it might be associated with headaches, sometimes it might just be a totally incidental finding.

Sometimes these kids will have mild cognitive difficulties or they might have headaches or maybe neck pain, but a lot of times Chiari I malformations are asymptomatic. I don't know as much about the other types. I was reading about a type III and a type IV, but they're extremely rare and I've never seen anybody with those other types of Chiari malformations.



John Bellone 24:06

Gotcha. Do we know how common paralysis is secondary to a spinal lesion spina bifida?



Christine Koterba 24:14

A good way to think about spina bifida is that a lot of it is going to depend on the level of the lesion. The higher up the lesion, the worse [the] child outcomes are going to be. It really is everything that's below the level of the lesion that is going to be impacted. If you have someone who has a fairly high level myelomeningocele, everything below that is going to be impacted. They're going to have reduced sensation, they might be unable to walk and have to use a wheelchair for mobility...



John Bellone 24:53

Incontinence, potentially.



Christine Koterba 24:55

Yes. I would say the vast majority, even the ones with lower level lesions have what's called neurogenic bowel and bladder, where they don't have sensation for their bowel and bladder. They're not able to empty their bladder completely and they also have difficulty with bowel movements as well. Even if a patient is physically doing pretty well, and they may be able to walk fairly well on their own, they still oftentimes will have the neurogenic bowel and bladder.



Ryan Van Patten 25:28

In terms of congenital hydrocephalus, to what extent can the skull expand in order to accommodate the increasing CSF and the intracranial pressure?



Christine Koterba 25:40

One of the things that is very different in working with patients who have congenital hydrocephalus versus hydrocephalus that might impact adults, is the skull's ability to expand because the sutures are not fully formed. In an infant, you hear doctors talk about the soft spots in their head. You have to be really careful with those

[spots] because that's where the suture has not completely formed yet. This is important when the baby's being born, obviously. The skull is not fully formed and their head is, like, a little more squishy, but then it can also accommodate for increasing pressure. Which is why in kids what we see sometimes in hydrocephalus will be a really big head, because their head size might have gotten bigger as a result of that. I don't think you're going to see that with adults.

Ryan Van Patten 26:39



So that can be adaptive, though, potentially. That the skull is malleable means that increasing CSF is not pressing up against the brain so much because there's an adaptation. The head is growing larger as opposed to an adult when the skull is fully formed there's nowhere to go and so brain tissue is inherently being impacted.

Christine Koterba 26:59



Yeah.

John Bellone 27:00



What neurological or neuroimaging techniques are usually used to assess and diagnose kids with hydrocephalus?

Christine Koterba 27:06



So, the first thing is, if a physician is seeing that the child's head size is large and there isn't a family history of large head sizes, that's going to be a red flag first and foremost. The next step is going to be to do neuroimaging. Do an MRI, see what the size of the ventricles looks like, and see if there are signs of hydrocephalus. Then after that point, a lot of times they might be doing things like a neurological exam. If they know a patient has hydrocephalus and maybe they have a shunt, they're trying to determine if the shunt is working properly or not.

John Bellone 27:49



On the MRI, [we're] sometimes looking for what's called sulcal effacement where the brain looks more smooth than it should be, right? The folds are not as prominent as they would be normally because the pressure is pushing them up against the skull.

Christine Koterba 28:05



Yeah.



John Bellone 28:06

Yeah. Okay.



Ryan Van Patten 28:07

We've mentioned shunting a few times, what else can you tell us about the shunting procedure? When is this used? Where are shunts placed? Where is CSF shunted to?



Christine Koterba 28:21

There's a few different placements for shunts and a few different ways that the CSF can essentially be drained into other parts of the body. The most common that I see is called a VP shunt or a ventriculoperitoneal shunt. The shunt is placed in the ventricle and then it is drained into the peritoneal cavity, which is in the stomach. They can also do a ventricular atrial shot. So, again, it's placed in the ventricle and then it's drained into the right atrium of the heart. There's ventriculopleural shunt where it's placed in the ventricle and then it drains into the pleural cavity. There can also be a lumboperitoneal shunt where it's placed in the lumbar spine region and drains into the peritoneal cavity.



Ryan Van Patten 29:15

Okay.



John Bellone 29:15

These are just all ways to bypass the normal exit of the CSF through the spinal canal, right?



Christine Koterba 29:23

Yep, exactly.



Ryan Van Patten 29:24

So that's shunting, which is one potential treatment. An alternative would be surgery. How often is surgery performed, pre- and postnatally, to repair the abnormality?



Christine Koterba 29:35

Typically, what happens with a kid with spina bifida - I'll just start from the time they'd be diagnosed. Usually, spina bifida is going to be diagnosed in utero. They might do a test where they can see increased levels of a certain type of protein and

this can give an indication that there's a neural tube defect or this can be identified on ultrasound. Typically by the time that a baby is around 25-ish weeks gestation, this would be diagnosed. Then possible treatment options would begin to be discussed.

Historically, the only option was to do surgery after the baby was born. For the vast majority of kids, probably all kids with myelomeningocele are going to have to have a surgery to essentially repair the spinal defect. I think of this as putting everything that's on the outside back on the inside where it's supposed to be. This is important because this can help to avoid things like infection and obviously can help with outcomes. So that's the first step, figuring out when they're going to do the surgery.

Now, recently, they have started some trials, probably within the past 10 years, where they have been doing this surgical repair before the baby is born. So they do this fetal surgery to repair the myelomeningocele. What they have found is that some of the outcomes are better for these kids. But there's obviously a higher risk because they're doing the surgery in utero versus after the child has been born. Some of the things that might be at a higher risk would be premature delivery or injury to the mom because she's still pregnant with the baby when the surgery is being done. They've done some different studies that have looked at these different types of surgeries that they can do in utero, and some of the outcomes are a little bit better. Sometimes there is a reduced need for a shunt after the baby is born.

So that talks about the myelomeningocele repair that has to be done. But then sometimes these kids, if they have hydrocephalus, might also need shunting. Typically the myelomeningocele surgery will be done either in utero or within the first couple of days of life. But then the shunting might be done a little bit later, depending on how severe the hydrocephalus is.



John Bellone 32:07

I see. What a delicate procedure that must be to do the surgical procedures in utero.



Christine Koterba 32:14

Yeah. I can't imagine.



John Bellone 32:16

Right. So my first question is, do you know if that reduces hydrocephalus? If they repair the myelomeningocele in utero?

Christine Koterba 32:26



Yeah. And the other thing that it can do is - and I don't know the mechanism for this, but - there was a study called the MOMS trial, and that stands for Management of Myelomeningocele Study. They [had] three main findings. One, they found the reversal of the hindbrain herniation of the Chiari II malformation. It seems that when they were able to do this surgery earlier that some of the abnormalities that we see in the brain might be reduced. They also found the reduced need for the ventricular shunting. And then a reduced incidence or severity of the neurologic effects of the spine's exposure to amniotic fluid, which can be toxic, which I wasn't actually aware of. Not that many places do the surgery, so sometimes a mom might have to travel somewhere to where they actually do this surgery to have an option to get it.

John Bellone 33:29



Gotcha. Yeah, my wife's pregnant. She's almost eight months pregnant and I think we had the full anatomy scan - was it [at] four months? Or five months? I can't remember exactly, but it was pretty early on. They can tell. Then they did subsequent different tests to look for other markers. So really, if they catch it, they're going to potentially be able to intervene months before the baby's born and prevent a lot of potential damage.

Christine Koterba 33:56



The nice thing is that when this is identified, the mom will start working with the spinal bifida team wherever the pediatric facility might be as soon as she's diagnosed. Like where I am, our spina bifida team, they know these families so well because they've been working with them since before the baby was even born. So there's this really close connection and they follow them super closely. They see the baby as soon as the baby's born. It's pretty cool to have that kind of connection like that.

John Bellone 34:32



Right. Even if you don't intervene until after the baby's born, at least you have a team all ready to go and you've already gotten all the details hashed out.

Christine Koterba 34:40



Exactly. You have a plan. You know what to expect.



John Bellone 34:44

When shunting is done in a child with hydrocephalus, how are the outcomes in terms of reducing the intracranial pressure? Does the shunting usually reduce the pressure?



Christine Koterba 34:57

By and large shunting is an effective treatment for reducing the pressure. But it doesn't come without risks. Anytime you're going to be doing surgery there are obvious risks involved. The challenging thing with shunting is that it can lead to infections and malfunctions, and then you might have to go in and have surgery again. It seems that, at least in my experience, anecdotally, either a kid will be totally fine and have no infections, no malfunctions, or they'll seem to have a lot. Sometimes they might just have one or two, but it seems like one or the other - either they've had several or they haven't had any at all.



John Bellone 35:42

Do you have a sense of how frequently they fail or get infected overall?



Christine Koterba 35:48

I saw one statistic that said an estimated 50% of shunts in the pediatric population fail within two years of placement and then require repeated neurosurgical operations. I don't know, maybe my anecdotal evidence isn't really accurate. But that creates its own challenges because, again, they're having to go in for neurosurgery and that can increase the risk for further difficulties.



John Bellone 36:14

Are there any alternative treatments for hydrocephalus aside from surgery or shunting?



Christine Koterba 36:20

Another procedure is called an endoscopic third ventriculostomy, or an ETV. This is done much more rarely than shunting, at least with the patients that I work with. I think I've maybe seen one kid who has had this, and I don't think it was a kid with spina bifida, they had another cause for their hydrocephalus. This was done more frequently before the advent of shunts. And this is done more frequently in places where shunting is not as accessible. I don't know what your experience has been like with this procedure and I don't know if it's as effective as shunting. It's

essentially where they drill a hole in the floor of the third ventricle and then this allows the CSF to drain.

John Bellone 37:04



Right. I've heard the same thing as you just said. That it's more in developing countries if the shunting technology isn't up to par with other areas. Just allows for more real estate, more room for the CSF to move. That's the extent of my understanding, too.

Ryan Van Patten 37:39



Let's turn our attention to neuropsych evaluations of children with hydrocephalus. Chrissie, you can discriminate between the children you see who have spina bifida as the cause of their hydrocephalus and those that have hydrocephalus due to other reasons, if there are differences as questions come up. To start, tell us about the characteristics of a prototypical referral that you might receive.

Christine Koterba 38:08



Typically, the referral that I'm receiving, whether it's a kid who has hydrocephalus or a medical condition that's causing the hydrocephalus, is pretty similar to most of the referrals that I receive working with pediatric populations. Typically, there's attention concerns, there are concerns with learning and memory, and the child might be struggling academically. By and large, I'd say those are the main referral questions for what we're seeing. Sometimes, especially for kids with spina bifida, because I work with a team who knows a lot about neuropsychology, they might also refer a child to us because they know that they're at risk for having difficulties. This might be before they're having problems. They want to get a baseline and see where they are if they're a little bit younger. But, typically, the things that they're presenting with would be attention, executive functioning, processing speed, those types of things.

Ryan Van Patten 38:59



How old are the children typically?

Christine Koterba 39:02



We will start seeing kids as early as preschool age, so maybe 3, 4, or 5. But it's not typically until they get a little bit older that we start to see bigger problems, especially in the kids that might have milder forms of either hydrocephalus or spina bifida. Usually when we start to see the biggest problems emerging are between 2nd and 3rd grade or 3rd and 4th grade, because that's when kids are expected to

be more independent and have better executive functions and better attention. This is where those kids really struggle.

Ryan Van Patten 39:40



As I understand, we see that a lot in development. There may be a subtle problem that's under the surface and then a child is developing and takes a step - it could be high school to college, it could be starting high school, it could be 2nd to 3rd grade - and with that new challenge, then the subtle problem becomes much more salient.

Christine Koterba 39:59



Exactly. One thing that we talk about is that in kindergarten, 1st, 2nd grade, kids are learning to read. Once they hit 3rd and 4th grade, now they're reading to learn. So instead of just learning single words and sounding things out, now all of a sudden, kids have to be comprehending what they're reading and doing story problems in math. Academically, things just get much more complex when kids hit 3rd and 4th grade. With the younger kids, kind of with what you're describing, it's like we see these problems on the horizon. We can tell parents and we can try to educate schools on what is to come. But it's not going to be an issue until we get to that point sometimes.

Ryan Van Patten 40:42



Right. Another question about the referral. What is the team specifically looking for you to do? Are they saying to just characterize strengths and weaknesses? Is it typically related to academic issues? Is it related to pre/post surgery or shunting? All of the above?

Christine Koterba 41:00



Most of the time, for the kids that I see, it is related to home and school management. So, with the example of a child who's having attention and executive functioning problems and maybe is struggling in school, what can we do to help support them and help them to compensate for any areas of cognitive weakness that we identify on testing.

Another thing that we see with kids with spina bifida is that they have attention and executive functioning problems, but they also have a number of atypical self-care tasks that other typically developing kids don't have to deal with. So, with a neurogenic bowel and bladder, they have to complete a number of daily living tasks, like clean intermittent catheterization, for instance, or shifting around in their wheelchair to relieve the pressure on their skin. These are things that other kids

don't have to deal with. On top of that, kids with spina bifida also have executive functioning problems. So it can be harder for them to stay on top of the atypical self-care tasks they have to complete. When we're getting a referral for one of these patients, it might be that this is a kid who's not able to learn how to cath or they're not cathing when they're supposed to be. Maybe we do testing and see they have significant executive functioning issues so our recommendations might be more targeted at how to compensate for those executive functioning problems in an effort to get them to complete their self-care tasks.

Ryan Van Patten 42:32



Right. You mentioned a few minutes ago that you often initially see children in the preschool years. Are you seeing them for follow up testing, repeat neuropsych over the course of years? Are they typically just a single evaluation?

Christine Koterba 42:47



Typically, we are going to see these kids, ideally, for repeat evaluations. We have a very close relationship with our myelomeningocele medical team and so they are sending us these kids frequently. We're also involved in our interdisciplinary myelomeningocele medical clinic. So we also see them in clinic and we can place a referral or advocate for them to come back in for testing. One reason that's so important is because as they are continuing to develop and as new skills should be developing and maybe aren't, that's what we want to be able to identify. And, like I've alluded to, executive functioning is a huge issue for this population. We don't expect a preschooler to be good at a lot of executive functions - they're not going to be good at problem solving, organization, attention, independent living skills, and that sort of thing. But we would expect that 12, 13, 14 year olds are going to be getting better at those things. For a kid with spina bifida they might not be. What we want to do is at those main transition points - you know, at 3rd, 4th grade, middle school, high school, and then high school graduation - we want to be seeing these kids back again so that we can figure out where they are at that time point and then help them to prepare for that next transition.

John Bellone 44:07



So executive functioning is a big issue, like you mentioned. You also mentioned learning and memory. Is there a typical profile that you see across these patients?

Christine Koterba 44:18



Typically what we see - I'll talk about hydrocephalus first and then I can talk about spina bifida. If I'm seeing a kid with hydrocephalus, the biggest things that I'm going

to be looking out for are going to be functions that are controlled by the white matter regions of the brain. These are going to be things like processing speed and then attention and executive functions. Thinking about not only the white matter tracts but also the regions of the brain that the white matter tracts are connecting. We talked a lot about frontal subcortical circuits and associated white matter tracts. Those are things that we know can be impacted in individuals with hydrocephalus, especially if they've had hydrocephalus that has been uncontrolled. Because the longer that that pressure is building up, the greater the impact is going to be.

When I'm seeing a kid with spina bifida, I'm going to be thinking about those things because of the hydrocephalus. But I'm also going to be thinking about a characteristic profile that they often show. What we typically see is low average intelligence, but there's typically a discrepancy. Oftentimes, these kids have stronger verbal skills than their visual spatial skills. The visual spatial weakness is a characteristic feature of spina bifida. What we've seen from multiple studies and a lot of the research that has been done is that, when it comes to the verbal skills, there's still some variability within those. Kids with spina bifida, their basic verbal skills are usually really good. They typically have large vocabularies and they oftentimes are extremely chatty. But when it comes to the higher level and more complex language skills, especially things like phonological awareness, verbal fluency, comprehension, and more complex skills, like pragmatics, that's where we see that they have more difficulty. They might be really chatty, but they might not have a lot of substance to what they're saying. There might not be as much rich content that there might be with somebody without spina bifida.



John Bellone 46:23

Gotcha.



Christine Koterba 46:23

Again, the attention and executive functioning deficits are a big one. Oftentimes, with the attention, it's more focusing and the ability to shift attention that we see. There's a higher rate of ADHD in kids with spina bifida, but it might not look the same as a kid with just developmental, run-of-the-mill ADHD who doesn't have spina bifida.



John Bellone 46:52

By pragmatics, you're talking about the social pragmatics for these kids?

Christine Koterba 46:57



Yeah. The other thing that we often see, just thinking about the nature of this condition, is obviously motor impairment as well. This can affect any kind of graphomotor tasks and processing speed on motor tasks. We also might see processing speed impacted on non-motor tasks as well.

John Bellone 47:22



We didn't ask you before but I'm thinking about it now. If [the child is] affected below the site of the spinal lesion, this is going to affect movement and ambulation, right? How they're able to walk...

Christine Koterba 47:38



Yeah.

John Bellone 47:39



Sometimes it even affects their arms and hands, right?

Christine Koterba 47:42



Yeah. It's not uncommon for a kid with spina bifida to either be in a wheelchair full time or to use a wheelchair for long distances. For those that are able to walk, oftentimes, they might have to wear ankle foot orthotics. These are braces that go in their shoe and then extend out their leg. Sometimes they might have to use crutches for walking. There's a lot of variability in mobility. Even if they have a lower level lesion, they still can have their motor skills impacted in their hands. Fine motor skills can still be slower or more impaired than someone without spina bifida.

John Bellone 48:28



I see. Is there a typical profile for Dandy-Walker or some of those other syndromes? Intraventricular hemorrhage? Do we see a normal profile cognitively?

Christine Koterba 48:42



The tricky thing with something like intraventricular hemorrhage is that, for a child who's going to be at risk for that, they probably also are going to have other things going on, too. What we know is kids who are born extremely premature are going to be at risk for intraventricular hemorrhage. They also are going to be at risk for a number of other things that could impact their cognitive functioning. It all goes back to attention and executive functioning problems and slow processing speed, those are all things that we're going to see across these different diagnoses. The other

thing that I should mention as well is that we do see a higher incidence of emotional, behavioral, and social difficulties in these populations. Part of that comes along with having a complex medical condition. But it goes beyond that and maps on to some of the cognitive impairments that we see that relate to the atypical brain development.



John Bellone 49:44

I see. Is the test battery any different for these kids? What does your typical battery look like?



Ryan Van Patten 49:50

Maybe hydrocephalus compared to spina bifida-based hydrocephalus compared to other pediatric populations.



Christine Koterba 49:59

Typically I would be using a pretty similar battery just because, oftentimes, the referral question is fairly similar across populations. We do, at least where I am, we do fairly long, comprehensive test batteries. If I have a kid coming in, I really want to see the range of their functions and really see where everything is. But the things that I'm really going to make sure to hit hard with these populations would be looking at the areas that I think might be impacted. So definitely looking at attention, executive functions in depth, and then processing speed. Maybe looking at the processing speed tests that are motor dependent, but then also the ones that might be more verbally based. Then you're also looking at the visual-spatial and nonverbal skills, because we know that those can be impacted in these populations as well. So getting a better sense of what's going on there. And with the verbal skills, knowing that basic verbal skills in kids with spina bifida might be intact, but then they might have more trouble with more complex or higher order verbal language skills, so making sure that I'm tapping those as well. And then making sure to get parent rating forms of things like executive functions in the daily environment and emotional and behavioral functioning as well. For older kids, I'm going to get some self rating forms too. But, thinking about how insightful or the lack of insight that some of these kids might have, if they do have executive dysfunction, they might not be the best reporters of what's actually going on. So I really want to make sure that we're getting parent report. Maybe getting teacher report as well to get a sense of what's going on day to day.



Ryan Van Patten 51:54

I'm wondering how shunting typically affects cognition. Is it common to see pre/post shunt differences? Like an improvement after the shunt is placed in terms of their cognitive performance?

Christine Koterba 52:08

That would probably depend on the extent of the hydrocephalus. Thinking about spina bifida first in this case, oftentimes, if the hydrocephalus is bad enough, they're going to have a shunt from early on. That may or may not be revised or repaired as time goes on. If they're having a shunt malfunction and they need to have that repaired, typically, we will see a difference pre and post. I've seen kids in our spina bifida clinic where you can visibly see that their shunt is probably not performing correctly, and they get sent urgently for neuroimaging. So we would see a change in cognition, pre and post in those cases.



Similarly with a kid who might have hydrocephalus not in the context of spina bifida where, as the hydrocephalus is getting worse and worse, we're going to see that impact in their overall level of functioning and that, obviously, is going to have an impact on cognition too. Another rule of thumb that I think about and a question that I ask during my interviews with kids that I know have a shunt is: how many repairs have they had? Or how many infections have they had? And what was going on during those times? Because anytime that they're going in and having to repair that or anytime they might have uncontrolled hydrocephalus for a period of time, we know that's going to impact their cognitive functioning.

John Bellone 53:42



I see. It's kind of a barometer for how many cognitive deficits you might uncover on testing or how severe the difficulties might be. Is there a standard amount of time that you wait following a shunt placement for testing? Are you able to test right afterwards?

Christine Koterba 54:01



I haven't run into that too many times. What I would go off of is how well the child is feeling and how much the parent thinks that they're back to their baseline. We have an advantage in working with kids because you have a decent reporter, typically, in their parents because, obviously, they know their kid better than anybody else. If we want to know where the child's true level of functioning is, let's give them a chance to get back to their cognitive baseline if they just had a shunt revision. The parents are usually a good judge of that, for knowing where they are. Now, the flip side of

that would be if maybe they had a shunt revision and they're seeing problems and they are getting back into school and we want to make recommendations for where they are at that time point in the context of new difficulties they might be having. Then we might not want to wait and we might want to do testing sooner rather than later so that we can make recommendations for school. It really just depends.



John Bellone 55:07

In terms of the typical feedback, how can we be most useful to the child and their family?

Christine Koterba 55:14

What I really like to do and how I approach working with families and kids and just trainees and everybody in general is, I'm not somebody who likes to use big words and overly complicated explanations. I want to explain things in a way that my parents who are not neuropsychologists could understand. That's what I want to do for the families that I'm working with. Sometimes I will pull out a picture of the brain and show them on just a diagram of the brain, "Okay, this is where the Chiari malformation is. This is what it looks like. This is what happens." Just like I've been explaining to you guys. When I'm explaining a neural tube defect, I try to explain it in a way that makes sense to me. That's what I try to do for families.



What I want them to leave with is I want them to have an understanding of their child's medical condition and how this is impacting their cognitive functioning and their day to day functioning. Because, ultimately, they're going to need to go and advocate for their child in school. They're going to need to explain this to the school who oftentimes might only see that a child with spina bifida is in a wheelchair, but they don't know how that child's brain has been impacted by their medical condition. Or if it's a child with hydrocephalus, they might not even know the child had hydrocephalus. Especially if it was something that was treated earlier in childhood, they might have no idea. That's really what I want the family to leave with - kind of the big picture. We don't need to go through every single test and talk about every score and percentile. I want them to get the big picture, to see how the medical condition impacts their child's functioning. I also want to hear from them. Is that consistent with what they see? Are they seeing the things that I'm seeing on testing? How does that fit? Or how does that not fit with what they see day to day?



John Bellone 57:12

Do you have any pearls of wisdom about the specific language you use to communicate some of these difficulties? You mentioned that you talk about the

myelomeningocele in the way that makes sense to you, and the neural tube defect. Do you have specific language that you use that would be helpful for trainees?

Christine Koterba 57:32

One of the things that I talk about with families, and I don't know how entirely accurate this is if you get to a neurodevelopment standpoint, but the way that I explain how the brain is organized in talking about white matter and gray matter in different areas of the brain is I'll talk about the idea of having highways and cities. You've got these white matter tracts that are like the highways of the brain, and they're connecting all of these different parts of the brain, all of these different cities of the brain. The cities are responsible for controlling different functions. If we have damage to those highways, the cities might not be connected. And if we have damage to the cities, one city could be damaged but then it's not being connected to that other city. What I'm trying to [do is] explain things in language that makes sense - talking about white matter tracts and talking about gray matter structures, that's not going to make sense to families unless they have a medical background.



When I'm talking about the neural tube, I'll explain it similarly to how I explained it tonight. When this cluster of cells is developing, it becomes what's called the neural tube. And when it's closing up something goes wrong with spina bifida, and a little part of it doesn't close the way it's supposed to. Then we have that sack on the outside that is filled with stuff that should be on the inside. That's why the surgery that happened shortly after birth has to happen, to push all that stuff back in. I talk about how that also impacts how the brain develops from there. Everything goes awry in that way.

I really try to meet families where they are. I think when you're early in your career and early in training, you can sometimes feel the need to use bigger words or to really make sure that families know that you're smart and you know what you're talking about. But my fear with that is that they leave having no idea what you were talking about. They might be really impressed, but they might not really understand anything you were saying.



Ryan Van Patten 59:51

Your job is not to win some contest, look as smart as you can, knowing as many vocabulary words as you can. It's to educate them.

Christine Koterba 59:58



Yeah. There's a time for that. When it comes to advice for trainees, there's a time for that. You go in and you get ready to go for your oral exam for boards. Yeah, that might be the time to start pulling out some of those big words and the fancy terminology. [laughs] But when you're working with parents who have a high school education or less, or more if they graduated college, unless they have a doctorate in neuropsychology, they might not understand what we're talking about. And then what's the point?



Ryan Van Patten 1:00:33

Yeah.



Christine Koterba 1:00:34

Right?



John Bellone 1:00:34

I really like how you explain it to your patients. I think that really helps. One thing we didn't mention early on was folic acid deficiency that potentially causes spina bifida. You want to say anything about that specifically?



Christine Koterba 1:00:50

So, that's something. I have two little kids and I feel like long before I was pregnant, that was something I was terrified about. Of getting enough folic acid because being a pediatric neuropsychologist and knowing a lot about spina bifida, that's something that I'm very familiar with. That was something that was discovered where people who had a deficiency or weren't getting enough folic acid had an increased rate of babies being born with spina bifida. Now there's a lot of foods that are fortified with folic acid, and prenatal vitamins have high levels of folic acid in them. But what I talked about earlier on is that the neural tube forms before a woman might even know that she's pregnant. So the problem is, and why it's important that there's folic acid fortified foods and that sort of thing, is that if you don't know that you're pregnant, you're not taking prenatal vitamins and you're not getting enough folic acid that can then interfere with the neural tube development. There's other things too, it's not just folic acid. There's a number of other factors that can lead to neural tube defects, but folic acid is a big one. It's something that is easy to modify.

John Bellone 1:02:09



You're always aware that the patient has spina bifida, right? Going back to Ryan's question earlier about what kind of referrals you get. There's never a child that you send them for imaging because the cognitive profile looks odd and then you discover they have spina bifida, right? This is almost always known beforehand.

Christine Koterba 1:02:28



No.

Ryan Van Patten 1:02:28



So you, the neuropsychologist, know it's spina bifida when you're seeing that patient, you're not...

Christine Koterba 1:02:36



Right.

John Bellone 1:02:38



I see. Okay. I was going to ask if you, in the interview, asked about nutrition during pregnancy, if they had any nutritional deficiencies or anything. Any screening questions that you might include in these interviews that you wouldn't otherwise?

Christine Koterba 1:02:52



The things that I want to know is when was the myelomeningocele diagnosed, when was it identified, and was the mom getting prenatal care. We might want to know, if they were getting prenatal care anyway. But I always like to know when they identified the myelomeningocele. I think that can tell more about - they might not have gotten any treatment for the myelomeningocele, they might not have had prenatal surgery or anything like that, but that can give you an indication of other types of factors that then could influence outcome. If a woman's not getting adequate prenatal care, that's going to increase the risk for other difficulties. If there's issues with the environmental conditions or socioeconomic status, obviously, those are going to influence outcomes as well, over and above the spina bifida. So those are things that I'm kind of trying to get at with some of those questions.

John Bellone 1:03:50



Excellent.

Christine Koterba 1:03:50



Then also when did these surgeries happen after birth? Does the child have hydrocephalus? When was that identified? Were they shunted? If they weren't shunted, why? Those types of more specific questions to know, early on, what was going on?

John Bellone 1:04:07



Yeah, it makes sense.

Ryan Van Patten 1:04:08



In terms of feedback to the family, the parents of the children, what sorts of resources are available in the community? What's usually on your list of recommendations that you're going through with them?

Christine Koterba 1:04:20



I love the Spina Bifida Association website. They have a fantastic website. They have wonderful PDFs that you can print off for families and for schools. They have them in at least English and Spanish, and may have them in other languages as well. What's really cool is - and I don't know if you guys have show notes or anything like that, but I can send you the link...

John Bellone 1:04:44



Please...

Christine Koterba 1:04:44



...if it would be helpful. They have a number of these PDFs, like I said. They have a really great one that is what to expect for different ages. It's written for educators and it's this really cool grid that goes through preschool, elementary school, middle school, high school, and then talks about different areas like reading, math, and the different challenges that are going to come up as the child gets older. Sometimes what I'll do is I'll just print that off and give it to the family to give to the school, because I want the school to have that, along with the child's records, to know these are the things that we're going to be facing as this child gets older. There are also other resources they have. They have some specific things about reading, in particular reading comprehension. They have things about math, because math is a big area that could be impacted in kids with spina bifida. Then they also have some really good transition to adulthood resources on their website. I really like to refer parents there. They also have this thing called Spinal Bifida U, like spina bifida

university. They have different webinars and different recorded presentations that researchers in spina bifida have done, which is really cool too.

The Hydrocephalus Association is also really good. A couple of years ago, I reached out to them and they sent me all these great materials - these little booklets and I can't even remember all the stuff they sent, but I got this huge box of hydrocephalus resources. So that was great. I think they also do early career research awards for people who are interested in hydrocephalus. That's another really good association.

One more that I really like is the Got Transition website. Kids with spina bifida or kids with other medical conditions that can impact their cognitive functioning and level of independence, a big thing we talk about is transition to adulthood and the challenges that they might face. The Got Transition website is excellent with resources for helping kids to become as independent as possible.



John Bellone 1:06:59

Excellent. We'll link to all those in our show notes.



Christine Koterba 1:07:02

Great. I can send those to you.



Ryan Van Patten 1:07:14

This has been really interesting, Chrissie. Thanks for taking the time to talk through all this with us.



Christine Koterba 1:07:19

Definitely.



Ryan Van Patten 1:07:20

Before we let you go we have a few bonus questions we'd like to ask you. These are about the field of neuropsychology broadly and not specific to spina bifida or hydrocephalus. To start, if there is one thing about the field of neuropsychology that you can improve, what would it be?



Christine Koterba 1:07:36

This is something that has been on my mind and probably a lot of people's minds recently, as there's a big push for telehealth and teleneuropsychology assessment.

One thing that I think has to change in the current context that we're in, is we need to embrace technology and we need to find ways to make our assessment tools more up to date, more technological. I think that there's a lot of stuff that we do that we've been doing for a very long time, like block design and other tasks like that, that are probably a little antiquated. Even thinking about the processing speed tests that we do with paper and pencil. Most of the kids that I see have a Chromebook and that's it. They don't have books in school anymore. That's kind of sad to me, I love books. I love the way that I grew up in school. But that's not how things are anymore. I think the biggest thing that we need to do, as neuropsychologists, is we need to make sure that we're finding ways to stay relevant. Especially with things that are going on right now, not being able to do assessment the way that we've done it. At my institution, we're exploring other things that we can do. What kinds of interventions can we provide to families? How can we make sure that we are giving families and patients the help that they need and thinking outside of the box that we've always been in? That's what I'm hoping for. That's where I'd like to see the field go.



John Bellone 1:09:20

Yeah, we definitely agree with that.



Ryan Van Patten 1:09:24

100%. Yep. We've talked about this a lot, both on NavNeuro and offline. We're with you on that.



John Bellone 1:09:30

There's always a balance between rushing into something too quickly and not having the evidence for it. There's a balance between that and staying relevant. We definitely need to strike more of a balance than we are now.



Ryan Van Patten 1:09:44

None of us are advocating rushing into anything.



Christine Koterba 1:09:48

Right. I think that's the thing that's really hard. I was telling you guys about the Butters-Kaplan West Coast Neuropsychology conference that we had. Well, we had it virtually because we couldn't be in person last weekend in San Diego. We had a lot of really great pediatric neuropsychology speakers, and Vicki Anderson was one of them. She was talking about a lot of the measures that she's been developing

that have been using more technology. One of the things that she was saying that makes it so challenging with using technology is that just as you're getting up and running and getting things going, they become obsolete. The standard way that we've been doing things might not fit with how fast technology is moving and is advancing. It really is about striking that balance. I'm sure you guys see on the listservs right now lots of back and forth about, "We can't rush things. We don't want to be jeopardizing validity or test security or those types of things." But at the same time, we're essentially in an emergency situation. How do we provide services that our patients really need and that they could benefit from? How do we keep working and keep our livelihoods and doing what we love? So I think it's a very timely topic. I think with the next generation of neuropsychologists, using more and more technology in daily lives, I think it's just going to grow and grow.

Ryan Van Patten 1:11:20



Yeah. For our listeners, for context, we're recording this episode today in late March of 2020. So we're right in the midst of the COVID-19 crisis, and there's this big push for teleneuropsychology that really has just started. Teleneuropsych has been around for a while, but this issue, the pandemic, is pushing it a lot more. So. Yeah. It'll be interesting to see where we go in that regard.

John Bellone 1:11:45



For our last bonus question, what's one bit of advice that you wish someone had told you when you were training, or maybe someone did tell you that was really the thing that made the difference for you? Just an actionable step that trainees can take.

Christine Koterba 1:11:59



Oh, I have so many. I was really fortunate at various stages of my training to have had people that gave me advice along the way. I have worked with exceptional mentors that have gotten to where I am. I can think of it on different levels. When I was applying for graduate school, my mentor at the time was an adult neuropsychologist, and I knew I wanted to do pediatrics. But he strongly encouraged me to really look at programs where I would get financial funding and that was something that I didn't really think was that important at the time, because it seems so far away. And I thought, "Oh, if I take loans out, I'll pay them all back. It's not that big of a deal. I'll be a neuropsychologist, so I'll be fine." But I took his advice. I went to a program where I was able to get funding, and I was able to work as a research assistant and get paid for that and get my tuition paid for. For people who are able to do that, I know not everybody is able to, but if you have the option, I

would definitely - that's very important. That is something that is going to impact the rest of your life. So that's an important thing.

Another thing is finding those people who you can lean on for mentorship and support and getting advice from is also very helpful. When I was applying for internship and getting ready to go on internship, I was told to cast a very wide net regionally and I'm glad that I did. It's only a year, you can live anywhere for a year.

And to finish your dissertation before you go on internship. Defend it before you leave, have it done. You will be so thankful that you don't have to work on your dissertation when you are adjusting to potentially your first full time job, which was how it was for me. Defend that dissertation before you leave. Whatever it takes, get it done. You'll be so glad that you did.

Lastly, your first job does not have to be your forever job. It wasn't for me. I was there for a year and I ended up back at a place where I'm extremely happy. You might take a job that you're not super excited about, but make the most of it. If you're not happy there, keep your eye on listservs and other jobs that come out and keep networking with people and you'll eventually get to the place where you are meant to be.



Ryan Van Patten 1:14:30

That's all great. Thanks. We'll take all the advice. It doesn't have to be one piece of advice. [laughs] As much as you have for us.



Christine Koterba 1:14:40

[laughs]



John Bellone 1:14:40

All right. Well, thank you so much for your time and talking to us about hydrocephalus and spina bifida. It's been great.



Ryan Van Patten 1:14:47

Yeah. Thanks, Chrissie.



Christine Koterba 1:14:48

Thanks, guys. This is a lot of fun.



Ryan Van Patten 1:14:49

Yeah, likewise.



John Bellone 1:14:50

Take care.



Christine Koterba 1:14:51

You too.



Transition Music 1:14:52



John Bellone 1:14:56

Well, that does it for our conversation with Chrissie. One quick caveat, we had briefly talked about the rate of shunt failure. We did some digging after the conversation and found that, although the rates vary widely by study, it seems that recent literature suggests that shunts fail closer to 20 to 30% of the time, but that it really depends on what time period you're looking at and also at what age the shunt was placed. We just wanted to clear that up. We've listed some literature in the show notes for anyone who's interested in learning more about this. And, as always, thanks so much for listening, and join us next time as we continue to navigate the brain and behavior.



Exit Music 1:15:38



John Bellone 1:16:01

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Ryan Van Patten 1:16:13

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risk. Users should always seek appropriate medical and psychological care from the appropriate licensed healthcare provider.

End of Audio 1:16:31