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Tools You Can Use: Enhancing Outcomes Assessment in
Children with Cerebral Palsy
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- [Calista] Well, it is my pleasure to welcome back and introduce Dr. Lisa Kenyon to PhysicalTherapy.com. Dr. Kenyon is an Associate Professor in the Department of Physical Therapy at Grand Valley State University in Grand Rapids, Michigan. Dr. Kenyon heads the Grand Valley Power Mobility Project which is the inter-professional research and service project that provides mobility training for children and young adults who are not typically considered to be candidates for power mobility use. Dr. Kenyon also presents nationally and internationally on multiple topics related to pediatric physical therapy practice, and has published multiple journal articles and book chapters pertaining to topics in pediatrics as well. She currently serves on the Pediatric Specialty Council of the American Board of Physical Therapy Specialties. So thank you again for returning to PhysicalTherapy.Com and presenting for us one again, Dr. Kenyon. And at this time, I'm gonna turn the microphone over to you.

- [Lisa] Thank you, Calista, and thank you for having me back to PhysicalTherapy.Com today. I'm excited to be talking to you today about enhancing assessment outcomes, excuse me, enhancing outcomes assessment in children with cerebral palsy. In today's world of evidence-based practice, I feel that making sure we're choosing the right measurement tools to assess outcomes of intervention is vital. And oftentimes, this can be enhanced if we look at condition-specific tools. Our learning outcomes today are that participants would be able to utilize at least two evidence-based tools to classify the functional abilities of children with cerebral palsy. We're gonna look at several of these classification tools. We're hoping that participants will also be able to discuss the use of at least three outcome measures for children with cerebral palsy that reflect the various demands of the International Classification of Functioning, Disability, and Health. Those demands of course being primarily for our purposes today, the body structure and function domain, the activity domain, and the participation domain. And then applying at least three-evidence based measures to monitor or track outcomes in children who have cerebral palsy. One of the things I'd like to do before we get started

is to thank the families who've given their permission to show photographs of their children during the presentation. We have the great fortune of working with so many wonderful children and families, and it's really nice that our families allow us to decorate, so to speak, the PowerPoint with pictures showing their children in action in doing and performing all of the activities that we as therapists enjoy seeing children being able to achieve. We're gonna start with some evidence-based tools to classify the functional abilities of children with cerebral palsy.

The tools that we're going to be utilizing are, or looking at, are the Gross Motor Function Classification System or GMFCS, the Manual Abilities Classification System or the MACS, the Communication Functional Classification System or the FCS, and the Eating and Drinking Ability Classification System or the E-D-A-C-S or EDACS depending on your preference for acronyms. It's really important to note that these tools are not outcome measures, they're classification systems that are designed to recognize and distinguish between varying levels of function in various functional domains in children who have cerebral palsy. These are important however when we're looking to utilize various outcome measures with children with cerebral palsy because we want to make sure we're getting the right fit between the outcome measure that we're using and the child's functional capabilities.

And then so it's important for us to recognize that for example within the Gross Motor Function Classification System, there could be various tools that we would use for each level of capability. And we also want to make sure that our tools are encompassing either manual or communication or less likely eating and drinking skills. But oftentimes, communication is rolled into our gross motor function examinations or something about manipulating something with your hands as part of a gross motor activity, a ball or whatever, is also integrated in. So it's really important that we are able to recognize where our child falls within each of these classification measures so that we can choose the best outcome measures for a specific child. When I say these tools

are not outcome measures, what I mean is that they're not designed for use as a outcome in interventions. So we wouldn't have a goal that our intervention would improve a child's Gross Motor Function Classification System level, for example. We would use these tools simply to classify the child's abilities. So let's start with the GMFCS, the Gross Motor Function Classification System. This is now in an expanded and revised version. The initial version only went birth to age 12, but now it goes from birth to 18 years in the ER. It's a five-level classification system used to describe the gross motor function in children and youth with cerebral palsy. So we can use it for infants to the 18th birthday, and it's based primarily on self-initiated movement with particular emphasis on sitting, walking, and wheeled mobility.

Distinction between these levels within the GMFCS-ER are based on the functional abilities, the need for assistive technology including handheld mobility devices or wheeled mobility, and to a much lesser extent, quality of movement. We want to use the GMFCS in a way that helps us determine which level best represents the child's or youth's present abilities, their current abilities, and limitations in gross motor function. The emphasis is on their usual performance, their performance at home, their performance at school, their performance in community settings. That is we're looking at what they do. We're not looking at their capability. We're not looking at what they're known to be able to do at their very best. Very few of us function every day at our maximal capability, and within these tools we're wanting to look at the usual performance, not what a child can do when the stars and the sun and the moon are all aligned.

There are general headings by level with the GMFCS-ER, although there are variations by age as we will see when we go to the website here in just a few minutes. But Level I on the GMFCS-ER is the highest level of ability. These children walk without limitations, if they're age-appropriate to walk. Level II, the child is gonna walk with limitations, not quite being able to keep up with their peers. And again, that's if they're at an age that

they would be able to walk. Level III usually denotes using a handheld mobility device whereas Level IV there are significant self-mobility limitations. The child may use power mobility like a power wheelchair. And Level V, the child is likely transported in a manual wheelchair, but depending on their manual ability may not be able to propel that manual wheelchair. Now that doesn't mean that a child who is at a Gross Motor Function Classification System Level V does not use a power mobility device, it's just it's a little bit more challenging, typically related to access methodology. Our Power Mobility Project focuses on providing power mobility training in use to children in that Gross Motor Function Classification System Level V. It's just a little bit more challenging to get because of access issues. So I tried to put in live links into your handouts. So you can actually go to the CanChild website. For those of you who are not familiar with the CanChild website, it is a fabulous tool that really helps support our evidence-based practice in pediatrics.

Many things on the site can be downloaded at no cost, including the Gross Motor Function Classification System ER and there's many different languages, many different versions. The direct link to the English version is also provided, and I am going to try to share my screen and show that to you. But my screen's looking a little different than it did here a minute ago, so let me see if, oh, there we go! So I am gonna go to here. Are you now seeing my screen here? Share. So hopefully you guys can see that. So this is a download of the GMFCS-ER, the expanded and revised version, okay. You'll see there's an introduction here, gonna try to scroll through but not too fast because I don't want anyone to get dizzy. But you'll see that there's a nice overall description here of the tool. And if we come down here, there is a list of operational definitions. For example here we have a definition for a handheld mobility device, that being canes, crutches, or an anterior or posterior walker that don't support the trunk during walking activities. Therefore something like a gait trainer is not typically a handheld mobility device. As we scroll down here, you'll see those general headings but then you'll also see a section about distinction between levels. And these are really

helpful for all different sorts of purposes, but particularly when I'm trying to determine if a child is between a Level III and a Level IV or between a Level IV and a Level V. Here you'll get into the different specifics for different age groups, and you'll see for example before the second birthday you'll see the different levels and those specifics for infants. Then between the fourth, excuse me, the second and the fourth birthday then between the fourth and the sixth birthday, then between the sixth and the 12th, and finally within the 12th and the 18th birthday. And by looking at these, you can really get a pretty good idea of where a child's functional abilities fall on the Gross Motor Function Classification System.

I'm gonna get outta that screen share mode and come back into the classroom now so we can get back to our PowerPoint. But the GMFCS is one of those very vital tools that I find is invaluable in trying to help me guide and direct the physical therapist management of the child. So when the child is at a certain Gross Motor Function Classification System level, I know that the child has certain abilities. And we classify the child's function based on his or her current performance. We don't classify based on judgments about the quality of movement or the prognosis for improvement. So I won't say, "Oh, well I think the child "will be able to walk independently one day, "so I'm gonna score them like this!" I say the child uses a handheld mobility device today, and that's how I'm gonna score it.

One of the other nice tools, and we're not gonna go directly to this link, but one of the other nice tools is the GMFCS Family Report Questionnaire. And there's even a self-report version for children 12 to 18 years of age. One of the things that I really like about this tool is certain times that I've been working, I've had to involve families and obtain family input in my examination of a child. So I needed some sort of tools that were parent report, family report. And these age-specific tools are just fabulous. As I mentioned, the two to four, the four to six, and the six to 12 years of age are all parent report. So that's available on parent report only for those three age groups. But the 12

to 18 years is available as a family report and a child or self-report version. And that active link should take you directly there. And again, I have found this particularly helpful when I used to work in early intervention we had to get family input and it was very challenging sometimes to find tools. And when the child was the right age to use that two to four year family-report questionnaire, it was a perfect opportunity for me. And again, these are available at no cost on the CanChild website.

One of the things that is interesting about the GMFCS is despite the fact that it is a wonderful tool as we'll see a little later in this presentation, we can use the GMFCS in combination with some scores on other tools, other true outcome measures, 'cause remember the GMFCS is a classification tool not an outcome measure. But we can use the GMFCS in combination with true outcome measures to actually have a way to look at how a child of a certain age is functioning as compared to their peers who have cerebral palsy. And also we can look at prognostication and where they might ultimately fall out. And that's been a very helpful tool to me that we'll come back to talk about. But one of the interesting things.

There was a study done as a survey study, done by Deville et al and published in 2015 where they looked at knowledge and translation of the GMFCS. So knowledge translation of the GMFCS in pediatric therapists. So they were able to obtain 283 responses. All of the respondents had heard of the GMFCS. 95% agreed that it was useful. 81% reported that they were confident in their ability to use it. And 77% reported that they use the GMFCS. But here's the kicker. Only 42% reported that they use the GMFCS consistently. Now I really like the GMFCS when I'm communicating with my team members. I can talk to my team members about a child's functional ability, and in combination with the other classification tools, in basically one sentence I can convey to my colleagues how a child functions. We use the GMFCS and these other classification tools in research to show readers of research articles what the function level of children with cerebral palsy is about, but we can also use that within

our assessment portions of our examination reports and things like that to better convey the child's functional levels. There are several other companion measures. The Manual Ability Classification System is one that is for children with cerebral palsy and it's used to describe the ability of children with cerebral palsy to handle objects in daily living, daily life activities is I think the technical term. It's again a five-level classification system. All of these classification tools have a five-level classification system where the Level I is the highest level of function and Level V is the lowest level of function.

The MACS is for children four to 18 years of age, and it's based on self-initiated manual ability with an emphasis on handling objects within an individual's personal space. So that means it's within a person's reach. So they do not have to use any locomotor skills to go get the object because that would flow over into gross motor skills. So it's just looking at manual ability within the individual's personal space. It can be used for children of different ages between that four and 18 years of age range, but some interpretation is needed regarding the child's age. For example, children at the lower end of the age spectrum, that four years of age, handle objects differently when compared to adolescents.

So we would expect a typically-developing child of four years of age to handle scissors differently, say, than we would expect a 10-year-old or a 12-year old or an 18-year-old. The same point concerns independence. A young child needs help or maybe supervision where an older child might not need as much help or any help or any supervision. Many times children explore with cutting with scissors at young ages, and oftentimes haircuts result. But there's a point at which we expect children will be able to be independent in those things. So classification, using the MACS should be made with reference to children of the same age. And the focus of the MACS is on determining which level best represents the child's usual performance in home, school, and community. Distinctions between levels are made based on the child's ability to handle objects and the need for assistance or modifications. Again, Level I on the

MACS is that highest level so the child is able to handle objects easily and successfully. Level II, the child is able to handle most objects but somewhat reduced quality or speed of achievement. By Level III, the child is handling objects with difficulty and needs help to prepare or modify activities whereas at Level IV, the child is handling a limited selection of easily managed objects and adapted situations whereas Level V the child requires total assistance, does not handle objects, and has severely limited ability to perform even simple manual activities. The MACS is also available in a variety of language and is available at no cost. Again, these are live links. Here's a direct link to the English version and I'm again gonna share my screen so that I can show you what the MACS looks like here. So here you can see the MACS. And we have a nice explanation here of the MACS and as we scroll down, again, I'm gonna try to scroll without too much fast movement here.

But it really has some nice ways to distinguish between each of the levels. The other thing that's available on the website is a flow chart, which is really nice. And the flow chart can really help us with those distinguished, to distinguish between levels. And again, as we head back to the classroom here, we can look at those links so that you can find the tools related to, on the website, related to the flow chart and things. Again these tools help us to classify function and are not necessarily intended to be used as outcome measures.

Occasionally I'll see them used as an outcome measure in a research activity, research report. But that's not the intent, and the authors of all of the, all of the tools have stated that they were not intended as outcome measures, those classification tools. With the success of the MACS recently, the Mini-MACS for children ages one to four was developed. We're not gonna go to this link, but I wanted you to have that active link in the file. It's very similar, it goes from a Level I to a Level V. A Level I being the highest levels of function and Level V being the lower level of function. But again, it's just a great tool to be able to classify children from one year of age to 18 years of age

between the Mini-MACS at one to four years of age and the MACS at four to 18. The Communication Function Classification System is one that is particularly near and dear to my heart 'cause it was developed here in my home state of Michigan by Mary Jo Cooley Hidecker. The Communication Functional Classification System does not consider perceived capacity, cognition, or motivation. It considers a person's role as a sender and as a receiver within the communication activity. And one thing I really like is it looks at all methods of communication. Looks at speech, oral speech like we would expect, but also at gestures, behaviors, eye gaze, facial expressions, and augmentative and alternative communication systems.

So it is a really wonderful tool reflecting all of these things. Distinctions between levels are based on the performance of the sender and receiver roles, the pace of conversation, and the type of conversation partner. So again, just like the GMFCS and the MACS, Level I reflects the highest level of ability where the individual's an effective sender and receiver of communication with both unfamiliar and familiar partners. Level II is effective but a little slower, Level III is effective only with familiar partners, and Level IV's inconsistent even with familiar partners, and a Level V is seldom effective in sender and receiver roles even with familiar partners.

Again, the CFCS is available in various language versions and there's also a universal version of the CFCS available for download for children who have other conditions other than cerebral palsy. It's kinda unique amongst the tools. And there's a direct link provided in your handout to the English version. We're not gonna go look at that, but again this is an excellent tool that was developed to classify the ability of children with cerebral palsy. When we look at using the GMFCS, the MACS, and the CFCS, we can really see and we can gain an overall picture of a child's function using these tools. And in fact, when we put everything together on a table here we could see all the many varied combinations. I've worked with children who had very high levels of gross motor function, but their manual abilities were a little lower and maybe their Communication

Function Classification System level was even lower. All different sorts of combinations are possible between the GMFCS, the MACS, and the CFCS. However, Mary Jo Cooley Hidecker did a study looking at the relationships among the GMFCS, the MACS, and the CFCS in children with cerebral palsy. Questionnaires were used describing each scale and based on the information mothers reported, the GMFCS, MACS, and CFCS levels. It was a clinic-based sample using children recruited in Ann Arbor, Grand Rapids, and Lansing, Michigan. So again, right here in my home state, my home town. And it included 222 children with cerebral palsy, various types of cerebral palsy. So quadriplegia being 38%, hemiplegia 20%. All the children were between two and 17. And there were correlations among the three functional assessments that were found to be strong or moderate.

So GMFCS level, so gross motor function was highly correlated with MACS level, the manual ability level, and somewhat less correlated with communication, and MACS and communication were moderately correlated. But that said, all sorts of different combinations of functional ability were found. If you look at the three different five-point systems, they're approximately 125 different possible combinations that could be made within or amongst the three different tools. However, 62 of these possible combinations were found within the 222 children.

So really it shows you how the, although there were some correlations between gross motor function and manual ability, gross motor function and communication, or manual ability and communication, it's not a hard and fast rule. And we really need to be using these tools across all three functional abilities to be able to best classify our child's function. The newest tool is the Eating and Drinking Ability Classification System, and it was not available for use when Mary Jo Hidecker Cooley did her study back in 2012 looking at the interactions and correlations amongst the three different tools, the GMFCS, the MACS, and the CFCS. So the Eating and Drinking Ability Classification is one that has not yet been explored in correlation with the others. But it classifies how

individuals with cerebral palsy eat and drink, and provides a systematic way of describing a child's eating and drinking ability in five different levels of ability. So like I said, sucking, biting, chewing, swallowing, and keeping food or fluid in the mouth. So those five different areas. So it's not the motor act of getting the food to the mouth, it's the motor act of the eating and the drinking. So the sucking, biting, chewing, swallowing, and keeping food or fluid in the mouth. Distinctions are made between different levels based on functional ability, the needs to adapt textures of food and drink, and the techniques used, and sometimes other environmental features.

But it does classify overall performance in eating and drinking, including both motor and sensory elements which makes it a very unique tool. Many tools looking at eating and drinking ability look at only motor or only sensory, and it's really nice that this one includes both types of elements. Again, just like all the other tools, starts at a highest level of function is Level I: eats and drinks safely and efficiently and progresses down to Level V: unable to eat or drink safely, tube feeding may be considered or is being used to provide nutrition safely.

So again, it's just an excellent tool. There are again various languages and you have to request the tools so you have to register first. It is free to register, and from my knowledge I've never received any junk email that I thought was associated with them. But these are again direct links, and all you have to do is simply register and you can get the nice tools for these wonderful classification measures. So now that we've looked at ways that we can classify children's function in cerebral palsy, let's start to look at some specific outcome measures. And as we go through these outcome measures, we're gonna consider whether they might be appropriate for children at different levels of ability within the different classification systems. Let's start by looking at the ICF. Probably most of you are very familiar with the ICF, but the ICF is a tool that allows us to look at the impact of a health condition such as cerebral palsy on body structure and function, activity, participation, and considers contextual factors such as

the environment and environmental factors and personal factors. So again, what we do is we'd have the health condition here, there'd be impact on body structure and function, and body functions might be things like seeing and hearing. Where structures might have to do with organs or the structure of the eye. Range of motion might be in this body function and structure classification, muscle tone might be in this body function and structure classification. Where activity is more something that the child is doing. Oftentimes as PTs we think of gross motor skills: walking, crawling, sitting, those types of things. And in participation, it looks like what the child's able to do in their home, community, and school settings. And again, these contextual factors relate to environmental factors such as accessibility.

Here in Michigan we have a lot of ice and snow in the winter, so that can affect a child's ability to participate and perform activities, and personal factors such as fear of falling. I know that there have been some other PT.com, PhysicalTherapy.Com webinars related to the ICF so that might be something that you would find interesting within the archives of PhysicalTherapy.Com. But what we're gonna do today is look at select test and measures reflecting these various domains.

And we're just gonna look at a couple of test and measures reflecting body structure and function. One of the things that we have traditionally done as PTs is we've really done well with test and measures reflecting body structure and function, and we've done okay with test and measures that reflect the activity level of the ICF. But we've not done so well with activities that reflect the participation measure or participation level of the ICF. So we're gonna introduce a couple body structure and function impairment level measures that would be great to use with children who have CP that have some unique things about them that I think might be helpful. But we're gonna remember that we really want to make sure our examination includes test and measures that reflect the entire ICF and not just the body structure and function level reflecting impairments within the body. So one of the ones I'd like to introduce you to is

the Spinal Alignment and Range of Motion Measure. It was developed specifically for children with cerebral palsy and it provides us more more information than just using a goniometric measurement tool would provide us for children with CP. Again, you can use this live link here. I am actually gonna take us to this live link so that you can see this measure. And we'll probably look at that here in just a little bit. But I'm gonna provide a little bit of the overview here first. It's a measure of posture and flexibility. It can be completed in 15 minutes with cooperative patients, and I love that the developers of this tool considered that some children are cooperative and some children aren't.

So it may take 30 minutes for those who have more severe physical impairments or have cognitive impairments that may make it difficult for them to understand the purpose of the test. You don't need much equipment. You just need a firm sitting surface so that the patient is able to sit with hips and knees both at approximately 90 degrees of flexion, and a surface for testing in the supine position, either a floor mat or a raised mat. If the patient is unable to attain or maintain a position that allows them to sit on a bench independently. You may need a second person to administer the test, but that person doesn't necessarily have to be another physical therapist. I've used parents to help me with this, students to help me with this.

And one of the other nice things here is I've used the word patient to reflect the terminology in the SAROMM manual. However, I have used the SAROMM in school settings and in home health-type situations. It consists of two subscales: the spinal alignment subscale and the range of motion and muscle extensibility subscale. We're gonna take a little bit of a look here at each of those. So each subscale starts with an observation of the patient's alignment and limb posture. If quote unquote normal, and I don't really like the word normal so I put it in quotations there. But I guess the word I like better is optimal alignment. Our posture is not a verb. The patient, the student, the child is given up to three opportunities to actively correct and assume the position. If

these optimal positions are assumed, a score of zero is given for the items. If the patient cannot attain normal alignment through active movement, we passively try to correct their posture and the severity of limitation is recorded. So let's look at a little bit more of the specifics of this final alignment scale. The patient should be wearing shorts and either no top or a bathing suit top or halter top or a loose top that really enables us to view the spine. So when I've conducted this in both the clinic and in school settings, I really made sure I was in a private area, private, I had like a curtain or other area. But also in today's age, I think it's really important that we be aware of maybe having a parent or other trusted adult there with us so there's never any question about what we're doing behind closed doors.

When we look at the score sheet in a minute, you'll see that the first four items are tested with the child sitting in a bench or chair with their feet supported and we really want to try to look at the child in their natural manner, their natural posture and we observe them from both the side and the back typically. Here's the scoring protocol. Zero is good, means no limitations were observed and if there were any things, the child was able to actively correct. Four is a fixed, limitation is structural, static, not reducible, and severe. So that means that even with passive assistance, the child cannot assume the position.

And one of the things that I like about this is the child doesn't have to have the right alignment. I can verbally cue them to get the right alignment because if they can actively get into the position, then they still get that top score of zero. If they need my physical assistance however, that's a different story and we begin to look upon the idea of one being good alignment with passive correction. And then the subsequent scores being that those that reflect the greater degree of severity out of alignment. So a score of one is frequently given if the person does not assume optimal alignment after three requests. Often occurs when you're examining someone with cognitive limitations because these children, these individuals, are at greater risk of subsequently

developing permanent alterations and spinal alignment and range of motion. And the score of one rather than a zero reflects this level of risk. And this reflects that sometimes children just aren't able to respond to our verbal cues. When we look at the spinal alignment subscale, again we have these general scoring procedures within the subscale. And one of the things that the manual says, if you can't decide between one score and another score, let's say, I'm gonna go back on the slides here, let's say you can't decide between a two or a three. You would try to, according to the manual, you would go the highest score and depict the greater severity so that you can better reflect the child's risk for severe limitations.

So there are four items all done in sitting and what we're gonna do now is bring up online the tool here. So again I'm gonna share my screen, and I'm gonna go to the first part of the manual that has to do with scoring. Okay, so here we are and you can see I'm on page three of the manual. The active link will take you right here. And again, this is from CanChild, which again is just such a great tool. So what I would do is I'd have the child in a bench sitting position. If the child was not able to maintain the position safely, I'd have another adult.

Like I said, I've had parents, whatever. And I'm, in this case, in this item I'm looking at the cervical spine. So I observe and I ask, if appropriate, for the child to actively correct their posture. So if they're able to achieve the picture there in figure one and reduce their cervical lordosis they'd get that top score of zero. But if they are unable to reduce that, what I do is I physically place my hands on the child, one hand on their chin and the other hand on their occiput and passively try to reduce the lordosis. And here you can see if I was able to passively correct the lordosis, it would be scored as a one. But if I couldn't reduce it, I would score it according to these figures. So a mild would be a two, a mild lordosis, a little bit more of a lordosis would be a moderate, and anything more severe would be a four or severe limitation, okay? And you'll note that there are all sorts of nice scoring verbiage, but the thing that I like best about this is the nice

pictures. We'll just kinda look at one more. Again, trying to go slowly not to try to aggravate any vestibular issues in anybody. But look at the child's spine here in figure one, nice and erect. If the child can't actively correct that with verbal cuing, then I can go ahead and try to passively correct. If I can passively correct it, it's a one. But if I'm not, I rate it as, excuse me, mild, moderate, or severe. Again, using the pictures really does help. We're gonna go back to the classroom now. And as I mentioned, I really like these, this particular measure because it's specific for children with cerebral palsy and gives me a way to objectify some of the postural alignment issues that I see in children with cerebral palsy. So I'm not just saying, "Well, I think this is severe." Well, things like mild, moderate, or severe can depend on your experience.

When I was a new physical therapist, I used to say young physical therapist but now that I'm older I say new physical therapist. But when I was a new physical therapist, I had a lot of experience with children who were, with cerebral palsy, who were pretty involved, non-ambulatory, what we now would consider at that GMFCS Level V, MACS Level V, CFCS Level V, EDACS Level V. So I had a lot of experience with that population. So for me, when a child had, like, hemiplegic cerebral palsy and was able to ambulate, I thought that their function was just outstanding because I had a viewpoint of cerebral palsy from the lens of experiencing and working with children with more severe disabilities.

So I really like how this tool quantifies those ideas of mild, moderate, and severe. When we're looking at the range of motion and muscle extensibility subscale, again we have that idea of zero being normal. And the idea of a zero here is there's not any restricted range of motion in passive testing and there are no postures typical of some children with cerebral palsy observed within the item. So both criteria, the passive testing is important to conduct for all of these items. And then a one is flexible passive, two is fixed limitation, that is a minimal. And again, we'll see some pictures related to that. Fixed that is moderate, and then finally four, fixed that is structural, static, irreducible,

and severe. For range of motion items, if a person demonstrates posturing, and we know what we mean by posturing, that is flexed upper extremities usually or sometimes severely extended and internally rotated or in the lower extremities, some of those severely extended or flexed positions. Passive range of motion is conducted and severity of limitation is rated according to the specific criteria provided in that great manual I was showing you earlier. We'll go back to that in a minute. You start by observing the person's general movement for postures characteristic of people who have a diagnosis of cerebral palsy. And therapists should be familiar with these. So it's just hip flexion, adduction, internal rotation, knee flexion, and ankle plantarflexion.

Then we test passive range of motion and score it according to criteria provided in the manual where a zero again is the top score. If the person demonstrates postures but has full passive range of motion, we would score a one. And if the person does not have full passive range of motion, we would score a two, three, or four based on individual criteria. And again, if we can't decide we would, between two scores, we'd document the highest number. So if we thought, "Ooh, gosh is this a two or a three," we would record the three. And you'll see why that becomes important here in just a minute. Determining end range can be a challenge.

For the most part, a firm end feel will be found as a result of soft tissue stretch or capsular stretch. For example, passive ankle dorsiflexion with the extension. The movement is usually stopped by tension in the gastrocnemius, and passive external rotation of the hip is usually stopped by the joint capsule of the hip. Completing the summary score sheet can be a little bit of a challenge and is important to kind of look at. But let's go first to the online version. Gonna try to share my screen here. And again, look at the items here for the SAROMM. In particular, we're gonna look at the items, a couple of items related to range of motion. And there's a number of them here. But items five and six relate to hip extension. Here you'll note that it's done in supine. We observe hip extension range of motion and conduct a Thomas test as can be seen

in the picture below, so here we can see that. What we look at is if there's full range of motion and no hip flexion posturing issues, we would score a best score of zero. But if there is hip flexion posturing, we'd look at and see if full range of motion is present and if so we'd score a one. And if there are limitations within hip extension, we would look at if it is mild, moderate, or severe based on the limitations provided. If we kind of scroll back down, of course we repeat this on both legs. If we kind of scroll down, we would look at hip flexion. And again, the specific ranges are provided here. So we don't have to guess, "Ooh, is this a severe limitation or is this a mild limitation?" It's provided for us, again the Thomas test is right there. Some of the other items, look at hip adduction, and we'll just take a look at that one quickly. Again, this is available at no cost at the CanChild website.

And as I had mentioned earlier, the CanChild website has a ton of resources, many of which are available at no cost. So we're gonna go back to the classroom now. And one of the things that I really like about the SAROMM is there's some published information out there that tells me how I can use this information as part of my evaluation. Now as PTs, we recall that the examination is our history-taking, our systems review, and our test and measures. Our evaluation is where we synthesize information gained in those three components of the examination to come up with our other aspects within PT management.

So the diagnosis, prognosis, developing the plan of care and things like that. So after we record, after we complete the SAROMM, we record the value for each of the items on the summary score sheet. And again, that's provided for you at no cost online. And what we do is determine a summing of the scores. We do a hip score, a knee score, an ankle score, and an upper extremity score. And we determine a range of motion score by summing these items. And then we also get a total SAROMM looking at summing the Spinal Alignment and Range of Motion Scores. The main thing is we can use these mean values to plot on a graph on the last page of the scoring sheet to have a visual

representation of the information. We're not gonna go to that yet 'cause we have a lot of stuff to cover today. But Wright and Bartlett in 2010 published a manuscript related to the results of their study about distribution of contractures and spinal malalignments in adolescents with cerebral palsy, looking at observations and influence of function, gender, and age. And you can really use this information. I'm gonna provide the citation for you, it's right in your handout. But really this can help us to look at the associations between age, gender, and function in terms of contractures and spinal malalignment. So it used the SAROMM, the GMFCS, and then the activity scale for kids to look at things.

And it included 225 adolescents, 125 of them were male, mean age of 14 years, 18 months with a one-year standard deviation, one year eight months standard deviation in age. And SAROMM scores were looked at by GMFCS levels and item scores, and the various body regions were presented in this manuscript. Correlations between indices and function and SAROMM scores were greater than 0.70. So males with GMFCS Level I or V, obtained higher total SAROMM scores than females, and I think that's supposed to be four or five in that first bullet.

And age was significantly associated with SAROMM scores and GMFCS levels in Levels IV and V. Age and gender were factors for modified outcomes, and the data provides benchmarks for evaluating impairments in adolescents with CP and spinal malalignment as well as range of motion and contracture, and support the role of function in contracture development and possibly the role of function in prevention of contracture development. So as you can see here, the citation is provided for you here. Many of you may be able to access this online at no cost. If you're having trouble accessing it, I like to go to my public library. They will often help you obtain articles like this and others related to the professional literature. Typically there's a limit of the number of articles per month, but like at my local library I can get up to five general articles requests fulfilled at no cost each month. And many area libraries offer this

service as well. It's a great help in our evidence-based practice. There are also some functional lower extremity strength tests that I really like. They were developed by Olaf Verschuren, and you can see again I've provided you with the citation here. Handheld dynamometry has been shown to be a reliable tool with children with cerebral palsy. But I don't know about you all, but handheld dynamometry is a little challenging for me in my clinical setting. In my research setting, I might have a good high-quality hand-hand dynamometer. But they're very expensive, and so I don't have one in my clinical setting. And to be honest, I don't have one in my particular research setting because that's not the focus of any of our research.

But I've oftentimes felt like my manual muscle testing for children with cerebral palsy who were able to participate was challenging, and I wasn't quite sure of the validity and reliability of the results. The literature points to some variability in that regard with children in general, let alone children with cerebral palsy. So I love the functional lower extremity strength test.

And you'll see that children who have different levels of function may be better suited to performing these tests, 'cause for all of them you have to be able to do independent standing and you have, for the last one you have to be able to perform transitions. I guess all of them you're doing some level of transition. And those are all independents. So oftentimes, these are used primarily with children GMFCS Level I or II, but also could be used for children GMFCS Level III if they were able to stand adequately by themselves. That's a rare bird, but it could happen. So moving forward, in these functional lower extremity strength tests, what you do is you count the number of repetitions a child completes in a 30-second time frame. Outside of the specifications for counting a repetition, quality of movement is not a consideration. So for the lateral step-up test, all you need is a 20-centimeter bench, which translates to roughly I believe it's a eight-inch bench, and for those of you who are using more of the standard English measurement system. And a stopwatch, many of us on our phones

these days have a stopwatch, so that's done. So the child performs a lateral stepping technique and stands with the lower extremity to be tested on the bench and the other foot on the floor. The feet are parallel and shoulder-width apart. The child steps up on the bench unilaterally for 30 seconds and we count the number of appropriate repetitions achieved. And an appropriate lateral stepping technique is defined as achieving a position within 15 degrees of full knee extension on the extremity being tested. The test is performed bilaterally, of course. The instructions to the child are just to make sure the child understands the activity, and is able to perform a couple of slow practice repetitions to ensure the child understands the task, and ensure that the child is safe. You want to make sure that the step isn't unsteady or unstable or anything like that.

And then the child is instructed to perform the lateral stepping as fast as he or she can until told to stop. And I tried to stay pretty close by just in case the child becomes unstable. I don't walk away from the child, I'm within an arm reach. But again, the child has to be able to perform it without upper extremity assist. We count the number of repetitions that meet the requirement, and so the units of measurement are the number of repetitions. For the sit-to-stand test, we use a bench that's high enough for the child's feet to be flat on the floor with hips and knees flexed to 90 and again that stopwatch.

And the child performs sit-to-stand transitions for 30 seconds without use of the upper extremities. We instruct the child in the activity, we help them perform a couple of slow repetitions to make sure they're safe, and they're instructed to perform the sit-to-stand transitions as fast as possible until told to stop. Again, what we do is we count the repetitions and so the units of measurement are number of repetitions. And it's again the child's hips and knees must be within 15 degrees of the extended position for a repetition to quote unquote count. Again, I stay very close here so that I can make sure a child's safe. For all of these tests, I might have the child wearing a gait belt. Not

holding the gait belt 'cause that would violate the test, but it gives me something to grab onto if the child becomes unsteady. For the half-kneel to stand, we use a mat and a stopwatch. And again, the child performs transitions, this time from half-kneel to stand for 30 seconds without using the upper extremities. And we perform this one bilaterally as well, this test bilaterally. Again, the child is instructed in the activity, performs several slow repetitions to ensure that they understand it, and then is told to perform the transition as fast as he or she can until told to stop.

Per the guidelines, repetitions of appropriate technique are counted and this time an appropriate technique is a standing position with both legs and knees within 15 degrees of the extended position. And again, we count the number of repetitions. Again, I like to be really close by on this one. This is an activity that oftentimes children have really vastly different scores, i.e. number of repetitions that they can do on one side versus the other, one lower extremity versus the other. Another test by Olaf Verschuren is the 10 by five-meter sprint test. And I bring this up as a way to encourage us all to think of agility.

You know, agility is a body structure and function component that really is something that is important in our activity and our participation because it really reflects our ability to change direction in an effective and efficient manner or to stop and start in an effective efficient manner. One of the things that I realized when I started looking at agility was that agility was something that I needed to consider in my plans of care for children and making sure that my children, whether they were independent, ambulated, or walked with a reverse walker, a posture control walker, whatever you want to call it, Lofstrand crutches, canes, walking poles, whatever, or if they've walked independently I needed to work on agility 'cause that ability to change direction in an effective and efficient manner is vital to function. So within the 10 by five-meter sprint test, the subject performs a continual sprint along a five-meter course until the 10 sprints have been completed. So you execute nine turns during the test. You use cones, tape, and a

stopwatch. So all of these activities within the, all of these tests and measures within the body structure and function domain that we are looking at are very low-check and perform with minimal equipment. A five-meter course is set up, and again the child performs that continuous sprint. You will let the child warm up and you instruct them and you use a stopwatch and time is recorded to the 10th second so the units of measurements are in seconds. And there are reference values provided based on work by Verschuren. We will not go to this link because of time today. But this is an excellent tool that allows us to look at a child's function within their GMFCS level. Now again, this is gonna be primarily for children GMFCS Level I or GMFCS Level II, perhaps Level III.

But it is really going to, this reference, and using the reference values are really gonna be helpful for us as we try to look at the functional capabilities of our children. Many times, like when I'm working in a school system, I have to show that the child is functioning differently than a typically-developing child or their age-norm peers. So I like reference values. But comparing a child with cerebral palsy to children who don't have cerebral palsy just gives me a way to say, "Yes, the child, cerebral palsy "creates functional issues for them."

The idea of reference values that are specific for children with cerebral palsy allows me to compare the child who has cerebral palsy, my patient, my individual patient, my individual student with cerebral palsy with other children of cerebral palsy and gives me a way to look at not only how they're doing but maybe how they've responded to intervention, particularly as we look at some of the other measures, some of the other tools. Looking at the activity level for children who have cerebral palsy, there are a number of great test and measures that we can use and there are several test and measures that are perhaps specific for children with cerebral palsy but several that could be used for children who have other conditions. I think one of the most commonly used measure for children with cerebral palsy is the Gross Motor Function

Measure or GMFM, and the Gross Motor Function Measure is a fabulous tool. It was originally developed in the late nine, late '80s, excuse me, and included 88 items designed to evaluate change in motor function over time in children with cerebral palsy. In 2002, it was updated and introduced in a 66-item format that was also designed to evaluate change in motor function over time in children with cerebral palsy. So there are two versions of this. The GMFM-88 and the GMFM-66. What we're going to do is look at the GMFM-88 first and then we'll discuss the GMFM-66. But both of these tools are widely used in pediatric physical therapist practice. Nice thing about the GMFM is the score sheet is available for download for free. We're gonna actually go to that now.

I'm gonna share my screen and we're gonna go to that. So again, going to, um, the, CanChild website, we can download the Gross Motor Function Measure Score Sheet. Both of the GMFM-88 and the GMFM-66 use this score sheet, and we'll see it's kinda typical. You try to assign the GMFCS level. That's a nice thing that helps you remember. As we'll take a look at in a minute, there's a general scoring key where zero means the child does not initiate the item, one means they initiate the item, two means they partially complete the item, and three means they complete the item. It's important to differentiate between a true score of zero, the child doesn't initiate or is unable to initiate it, which means a Not Tested especially when we're going through other versions.

But you can see here that the GMFCS has different items, or excuse me, the GMFM has different items here. And here, like in lying and rolling, you'll see that there are 17 different items increasing in the ability and amount of skill performed or required. And then there's other different domains, lying and rolling is just an example. Here you'll see an asterisk. That means that the item is represented on the GMFM-66 as well as the GMFM-88. Importantly what you notice here is it's just the item, doesn't give you the specifics of the scoring. And you really need the manual for the specifics of the

scoring, the zero, one, two, and three, because there's some general scoring guidelines but not anything that would tell us exactly what the specifications are for a specific item. And as we'll see here in a minute, that can be quite variable by item. There's general guidelines, but there's a lot of variability. We're gonna go back to the classroom now here. So I'm gonna stop sharing. And the GMFM is a tool that is unique in that it was the first condition-specific tool that we as pediatric physical therapists had for children who had developmental issues. When the original tool, the GMFM-88, was released it was the only game on the market and it still is one of the best games on the market.

Prior to this, we only had norm reference developmental measures such as the original Peabody Developmental Motor Scales to use in our practice. So the GMFM was a great boon to our practice as physical therapists. And as we look at the 88 here, I think you'll find that there's some nice features to this tool. So it's again designed to measure change in gross motor function in children with CP and it's standardized for use with children with cerebral palsy. It's a criterion-referenced measure. So it's not designed to compare one child to another, nor is it designed to compare to a reference group, and it was standardized for use for children five months to 16 years of age. It covers gross motor skills observed from birth to five years of age in children with typical development.

So this is an important specification here, this idea that really a typically-developing five-year-old should be able to perform all the skills on the GMFM easily. And this is important 'cause we might have some children who are five, six, seven, eight, nine, 10, whatever who function at that GMFCS Level I who will be able to easily perform all of the skills on the GMFM-88 or 66 and actually achieve a ceiling effect. So other tools might be appropriate for them when we're looking at their change in gross motor function and status. And we'll look at those as we progress through our time together today. But the GMFM-88 is appropriate for children or adolescents with CP whose

gross motor skills are at or below those of a typically-developing five-year-old. As an aside, as this is not a presentation about children with Down Syndrome but it's also been validated for use in children with Down Syndrome. And again, the manual explains their use in Down Syndrome. Five dimensions are included within the GMFM-88: lying and rolling, sitting, crawling and kneeling, standing, and walking, running, and jumping. Each item is scored using a four-point ordinal scale from zero to three. And generally what happens is a zero means that the child doesn't initiate the task being tested.

One is they initiate the task doing about 10%. Two is the child partially completes the task doing 10% to up to 100, just below 100%. And then three is completes the task as outlined. The score sheet, like we said, doesn't provide any specific scoring criteria for each item, so the manual is needed for the specific criteria for each item. We're gonna see why here as we look at a couple of specific items. But for each item, the child is allowed three maximum trials and a spontaneous performance of items are included within these three trials.

So a child cannot be given three trials and then later be scored on spontaneous performance of an item. For any reason that an item is not tested, the item is scored zero within the 88. This means if a child refuses the item or is physically unable to attempt an item, it should be scored a zero. Under certain criteria and conditions, and these are outlined in the manual, the GMFM-88 can be performed with children using aides and orthoses. What you do, and it's all outlined in the manual, is you first administer the 88 using the aide or orthoses and then you administer, sorry, you administer it without the aide or orthoses and then measure it with the aide and orthoses. And this can be really great. I use this multiple times within specific domains to look at the impact of an orthotic device. So what was the impact of the, like perhaps a dynamic ankle-foot orthosis versus a traditional ankle-foot orthosis. Or a supramalleolar orthotic versus a dynamic ankle-foot orthosis. I really found that to be a

helpful tool and also looking at different ambulatory aides as well. Scoring for the GMFM-88 is typically presented as a percentage for each dimension, and it's a percentage for the total score of all items. And oftentimes what we do is present this in a table. So you can see here what I've done is again this particular report I had the subtest, the raw score here, and then the percentage. And that's typically how things are presented for the GMFM-66, excuse me the 88. The 88 doesn't provide any guidelines concerning frequency of administration.

But it's shown to be responsive to change over six-month intervals, and it's generally more responsive in change in younger children. Clinically-important changes in percentage scores between administrations of the GMFM-88 will vary, but typically it's thought that five to seven percentage points would be a medium positive change within a domain. The GMFM-88 is the measurement tool of choice for children with cerebral palsy who have severe motor disabilities like GMFCS Level V, or for very young children because both the children with GMFCS Level V and some Level IVs and very young children, infants, toddlers will be functioning primarily in the lying and rolling dimensions.

And it's also again like we said very good to use for assessments of aides and orthoses. Before we move on to the GMFM-66, I just want to come back to that idea of a need for the manual. Now the manual's gonna provide a lot of guidance in using both the GMFM-66 and the GMFM-88. But when you're scoring, you really need to have that manual in front of you. There's items where the general scoring schema does not take into account how the child performs and is not reflected. And it's stuff like, you know, three steps, four steps, maybe the item is the child's going up and down the stairs reciprocally and maybe the scoring criteria reflect not initiating but also then a one, how many steps the child has to go up reciprocally in order to receive a score of one, things like that. So it's very important. When looking at the 66, it's really important to remember that it's only for use with children with cerebral palsy. And again it's

designed to measure change in gross motor function in children with CP but it can only be used with children with cerebral palsy. It's an updated version of the GMFM-88 and in fact is the GMFM-88 minus the 22 items! So we use that same score sheet that we used before and that's freely available online. Again remember you need that manual to adequately and accurately score it. The items on the GMFM-66 were identified through Rasch analysis as being the best predictors of gross motor function in children with CP, so they're really great. The 66 was developed because the 88 was viewed as having limitations. Like we mentioned before, the 88 cannot be used to compare between two children.

So two children with the same percentage scores on the GMFM-88 can have very different scoring profiles and functional abilities. And another factor for some people, I never really found this to be a factor, but for some people the large number of items on the 88 was difficult. Many children might have problems with endurance and may not be able to complete all the items on the 88, and so therefore the 66 was felt to be superior. All the items are administered in the same way, and scored between the same way on the 66 as they were for the 88. Except it's really important to differentiate between an item that's not tested and a true score of zero. On the 66, children are not penalized with a score of zero if they refuse items.

But it really is important to differentiate between a Not Tested and a not tested because the child couldn't do the item. For example, if a child is not ambulatory, they cannot assume the test position and therefore they could not initiate it so we would mark those as zero. We would not mark those as Not Tested because we would go through each item and determine if the child is able to use the, assume the test start position. And again, this is so important, the GMFM is only for children with cerebral palsy. We can look at scoring the GMFM-66 and while scoring the 88 was really easy, we just added up the raw points within each domain and we got a percentage for each domain. Because of the way scoring is done, we need to take the raw scores and enter

them into a computer program to accurately get our scores. There is a program called the GMAE, the Gross Motor Ability Estimator. The second edition is the one that's most widely out there, although there is a third edition that is coming out. I've had a little bit of trouble using the GMAE-2 on my Windows 10 computer. So I'm really looking forward to a new app that is now available, and I'll tell you about those in a minute. But the GMAE converts scores and plots them on the interval scale of gross motor function as opposed to the ordinal scale used in the GMFM-88. So we can't just use the 66 and score it in the same way we do the 88 using raw scores only. We really need this Gross Motor Ability Estimator to be able to score. And the GMFM-66 cannot be scored without this gross motor ability software.

You can download it at no charge, the GMAE-2, but again I'm having trouble with the GMAE on my Windows 10 computer. I actually started having trouble on my Windows 7 computer. The most updated version of the GMAE-3 is available through the GMFM App+. And that's available at a cost, but it is quite reasonable. It is starting at I believe it was \$99 Canadian. The GMFM-66 does not provide guidelines concerning the frequency of administration, but it has been shown to be responsive in similar ways to the GMFM-88 over six and 12-month period. There are fewer items on the GMFM-66 so that's a definite advantage.

And if a child refuses an item, there's no penalty like there is on the GMFM-88. I sometimes find that a real advantage, especially for my children who are very expressive in their independence and want to refuse items as a way to show their independence. And it can be nice, although usually, you know, if you create a positive testing situation we can get children to do every item. It's really nice if a child does not have to do every item because of a behavioral issue. There are interval properties on GMFM-66 scores that allow for comparison in change between children, and it's the measurement tool of choice when doing research involving children with cerebral palsy. There are two things, two newer versions called abbreviated versions of the GMFM-66

that I really like and I use these clinically all the time. In research, they're not the best choice because the GMFM-68 abbreviation versions estimate the GMFM-66 total score. But in clinical practice, I really love these. So if you were to go to this link here, you could find the GMFM-66 Basal and Ceiling level administration form, and the GMFM-66 Item Set administration form. We're gonna actually look at each of these. We're gonna start with the Basal and Ceiling level form and I'm actually going to bring up that tool for you. So we are familiar with the idea of Basal and Ceiling level approach. It's similar to the approach used in the Peabody Developmental Motor Scales where you have three successes in a row as your basing level and three zeroes in a row for your ceiling level.

Let's, let me share my screen and bring up that tool so that we can take a look at it here. So as we look here, we can look at the Basal and Ceiling level. First here, again the score sheet is available at no charge but you would need the GMAE-3 to be able to, I guess you could probably use the two, I've used the two, but the three is the preferred version these days, that computer software to score it. So if we scroll down here and trying not to move too fast, what we'll see is we need three consecutive threes as a basal, three consecutive zero as a ceiling except for when we're considering floor and ceiling effects. And you have to have a minimum of three items total.

And on the started points, the suggested starting points for age and GMFCS are available as a guide. So here, and you would come in here and see that here you would start for a child with GMFCS Level I, II, III, IV, or V at all ages at this certain item. And then you'd again try to get three three's in a row and three zeroes in a row to determine your Basal and Ceiling level. Many therapists like this and the literature has reported that this is the preferred method, and perhaps it's because we as physical therapists are familiar with this from the Peabody. But as we head back into the classroom, we'll find that there are, there's another item which is used in abbreviated version which is

called the Item Set which I actually prefer. But the Basal and Ceiling level has its benefits and we could really administer many fewer items. And we have differences in how we go about testing children with GMFCS Level I. But as I mentioned, I like this Item Set version. And the Item Set version uses a scoring algorithm in which you have a number of decision items on the GMFM-66 that guide the therapist towards a pre-determined set of items relevant to the child's established level of function. So let me again share my screen here and we'll look at this within the score sheet. So looking at these item sets, what we'd note is that the first page which I'm not showing you, is just like the other GMFM score sheets. And again, this is available at no cost to download, but you need the manual to score the individual items in the GMAE again to get an overall gross motor function measure 66 items that score. But here what you do is you look at certain items, Item 23, Item 67, Item 85.

And depending what the child scores on that item, the raw score that they obtain you use a different Item Set. So you could really administer as little as 15 items. So if you administer the item, "Sit on the mat, "arms propping, maintains five seconds," and the child scores a zero or a two you're gonna automatically go to that Item Set 1 and only administer 15 items. If the child scores a three on Item 23, you're gonna go to Item 67 and repeat your process. Did they stand with two hands held and walk forward 10 steps? If they scored a zero or a two, was there a one or two on that? It would be Item Set 2.

If they scored a three, you'd go to Item 85, and if they again were scored a zero, one, or two on "Holding one rail, walks down four steps "holding the rail, alternating feet," you'd go to Item Set 3. If they scored a three, you'd go to Item Set 4. So you're administering substantially fewer items, either 15, 29, 39, or 22. So that's substantially fewer items. As we go back to the classroom, there's an advantage in this, right, because I only have so much time during my examination session. And administering the full 66, if you're very familiar with it you can really rock and roll with it. If you have a

really cooperative child, might be able to get through everything in under 30 minutes. I can usually do that without a problem. But that really makes it difficult for me to be able to get a whole lot of other things done within my examination timeframe. The Item Set version is the preferred abbreviated version for children who have unilateral CP or hemiplegic cerebral palsy. We're seeing more and more in the literature this idea of unilateral CP, meaning involvement on one side and bilateral CP, meaning involvement on both sides. That would be our quadriplegic or diplegic forms. And so I just mention that as a way to get the terminology across. Although for almost 35 years here, I've been using terms hemiplegic, diplegic, and quadriplegic so sometimes it's hard for me to move beyond those.

On both the Item Set version of the GMFM-66 and the Basal and Ceiling level edition of the GMFCS-66, sorry, GMFM-66 are reliable and valid. But if the primary goal of an assessment is to measure change over time, the complete 66 should be considered the criterion standing especially in research. Now I mentioned there was a way to use your GMFM, excuse me, your GMFCS level and your scores to look at prognosticating and estimating if a child is functioning at an appropriate level as compared to their peers and this is called the motor growth curves. And what you do here is you use a child's GMFCS level, age, and GMFM-66 scores to look at motor growth curves. So motor growth curves describes a pattern of motor development grouped by GMFCS level.

The, if you look at the individual curves, they are kinda similar to the idea of growth charts that are used to follow height and weight in children. And these motor growth curves are designed to help understand the growth motor abilities of children in each level and how they change with age, and to estimate a child's future motor capabilities including how much independence a child is likely to achieve. On the motor growth curves, what you do is you plot the 66 score, the GMFM-66 score, on the vertical axis by age which is on the horizontal axis for each of the five GMFCS levels. And a child's

relative ranking compared to other children can then be determined within the population-based sample. With repeated scoring over time, it's possible to determine whether a child is functioning as well as expected, better than expected, or less than expected as compared to children in their own age with cerebral palsy. So what you can do is you can plot it out using the graphs with the coordinates, or you can go the tabulated reference percentiles which is how I prefer to do that. And you find the table for the child's Gross Motor Function Classification System level, you scan across the row that's closest to the child's age, and find the number that is closest to the GMFM-66 score. And the score corresponding column gives a child's approximate percentage score and that is the percentage of children in the normative sample that the child is expected to outperform.

And remember, unlike raw GMFM-66 scores, which measure motor ability, the GMFM-66 percentiles measure only relative ability compared with other children of the same age and same GMFCS level. Using these tools, we know that the age by which children with cerebral palsy typically achieve their expected 90% motor developmental potential can be estimated. So children with GMFCS Level I will achieve 90% of their expected gross motor developmental potential at age 4.8, GMFCS Level II at 4.4, age, GMFCS Level III by 3.7 years, IV, 3.5, and V, 2.7.

And this can really help us to prognosticate a child's abilities and function. Within the gross motor trends, there's a tendency for children with lower motor development potential to reach their limit more quickly. But it's only for use with children with CP and children who function at GMFCS Level II or V may be at a disadvantage, two, three, or four, excuse me, may be at a disadvantage when looking at their GMFM-66 curve plotted on the motor growth curves. And this is because in the GMFM-66, you're not supposed to use any aides or orthoses. And orthotic devices and ambulatory aides are helped, felt to help children at Levels III, IV, and II to perform gross motor skills at a higher level. So you could be at a little bit of a disadvantage there. We also must

consider whether the normative sample that was used to create these motor growth curves is appropriate for the child that we're looking at, and we also have to understand that evaluating percentages change widely over time. The motor growth curves, there's a link to that tool right there so that you can look at that tool. But there's also a link here for the tabulated reference percentiles. I just find those easier to look at. And then also I mentioned briefly the GMFM App+ which is an app that includes the Gross Motor Ability Estimator version three that's needed to score the GMFM-66 as well as the GMFM abbreviated, GMFM-66 abbreviated versions, the Item Set and Basal and Ceiling version.

But you can also use it for the 88 and the 66. And it looks like it's a great tool. I haven't had a chance to purchase it yet. It just recently came out. But it provides you with spider charts which are really cool and really give a great visual for parents and other professionals for GMFM-88 scores. Looks at individual items and GMFM-66 scores with 95% Confident Intervals and Item maps. And then it also automatically plots your motor growth curves, which is fabulous, at a press of a button. And this right now is available for single-user PC and Mac computers, but it's coming soon for Android and iOS. I think it's gonna be a great tool to have on our iPads when it becomes available. I want to kind of briefly look at the challenge module.

Now when we look at the GMFM, the Gross Motor Function Measure that we just talked about, remember we said it was for children who were five years of age, excuse me, children who function at the level of the typical development of a five-year-old. So children who had Gross Motor Function Levels I who were pretty high-functioning and older, above age five, may have a ceiling level affect on the test. Meaning that their score's so high on the test that it's hard for the test to depict any change following intervention. And for those children, we might want to look at the challenge module. This is now being called the challenge, but I'm using that older challenge module to reflect that it's part of the GMFM family. But it's an assessment of advanced motor

skills designed to extend upon the functional foundational skills of the GMFM. It's for use with children who are ages six years and above and function at GMFCS Levels I or II, especially one. The tests are considered to contain skills that are important for children and youth to be able to perform in school and recreation and focuses on speed, balance, coordination, integration of upper and lower limbs, and dual task performance where they're doing maybe a thinking task as well as a motor task. It's 20 items, five-points response scale, a zero to four. Takes awhile to administer and requires a 10-meter track that can be set up. It does require certification. There's an active link for it there listing the certification procedures. I'm really hopeful that this is gonna transition to being available as an online certification program but I'm not sure that that's gonna happen.

It does require that you pass a test, and there's an active link to it for those of you who are interested. I want to just briefly provide an overview of the TUG for children. I think many of us are familiar with the Timed Up & Go. It's very easy to administer. It assesses functional ambulatory ability and dynamic balance. Doesn't require any special training or equipment. And really all you do is takes, looks at the time takes for the individual to go from sitting in a chair to standing up and walking three meters, turning around, walking back to the chair, and sitting in the chair.

In children, usually the protocol can be adjusted by using a chair with or without arms, with or without a backrest, with or without shoes, with or without orthotics. But most authors suggest that whatever version you use it should be consistently used. So you do it pre and post test or pre and post intervention and that you explain what should be done and even demonstrate to the child before doing it. Psychometrics, whoops, I clicked too fast. The psychometrics are excellent. It's got great intra-rater reliability. It's strongly correlated with the GMFM-88. And it discriminates between Gross Motor Function Classification System levels. Reference levels are available. Cut scores, it's supposed to be cut scores there, not cur scores, based on z scores are available. And

that could be really helpful for those working in the school district. And there's even some, a modified TUG with reference values for preschool-aged children. So here's where you can find. This is an active link, we're not gonna go there, active link for children who are school-aged. Remember you can use cut scores. I wanted to briefly look at the Functional Mobility Scale. This is one of those quick and easy tools that I really like to use. For the purpose of time, we're not gonna go to this but I love the Functional Mobility Scale 'cause what it does is it looks at a child's ability to walk and be functional in their mobility at three different distances: five yards, 50 yards, and 500 yards.

And it's a parent-reported measure where we can have the parent rate each of these distances between one, uses a wheelchair or may stand for transfers or step with assistance of another person all the way up to six. And we did some nice work suggesting that the distance child's Functional Mobility Scale score was particularly sensitive to intervention at 50 yards. Here's a direct link to the measure. We're not gonna go there for time. The Chailey Levels of Ability are some nice tools to be able to use with our children particularly at the Gross Motor Function Classification System Levels IV and V, and it documented stages of motor development in prone, supine, floor sitting, box sitting, and standing.

Box sitting is what the English call bench sitting. It's an observational score, and all you do is match what you're seeing in the child with components achieved on a list. And you record it, and so it's a very straightforward. For example, different levels within box sitting is the child can be placed in the sitting position, needs support, trunk can be brought forward over the sitting base, et cetera. But at a different level, it would be more or less would be needed. For example, at Standing Level 7 if the child's able to stand independently releasing the hands. So in this tool, a higher level promotes higher function. And this can be a really nice tool for all levels of ability, but I find it particularly helpful with our children at GMFCS Levels IV and V. And there's a direct link to the

measure. Again today we won't be going to that, but it is available for a free download and there's a nice manual that goes along with it. Some select participation level measures. Participation again is something that we as PTs often find challenging to look at. One of the tools I really like is the Participation and Environment Measure for Children and Youth, or the PEM-CY. The PEM-CY is a parent-report measure for children with disabilities ages five to 17. And it assesses participation as well as the environmental factors influencing participation at the same time. And this is great, of great help because it can help us to identify things within the environment that we can change to improve a child's participation. It measures participation in home, school, and community as well as of course the environmental factors. And it's available, there's a charge for it.

I believe it's \$99 Canadian, but I'm not 100% sure. And that's an active link. There is also something called the CPCHILD that I really like and that's the Caregiver Priorities of Child Health Index of Life with Disabilities. It is a tool that measures caregivers' perspective on health status, comfort, wellbeing, functional abilities, and ease of caregiving for children with severe developmental disabilities. So it can be used with children with CP, particularly at levels, GMFCS Levels IV and V, but it can also be used with children with severe disabilities who do not have CP which is a fabulous part.

And it's been developed to measure the effectiveness of interventions intended to improve or preserve outcomes for children with severe disabilities. The manual and the score sheet can be downloaded at no cost. And I believe you have to register for that. They like to track again how it is being used. But there's no cost, and I've never received any spam related to it. There's a few other potential measures that I'd like to kind of look at. I'd like to look at the PEDI-CAT. The PEDI-CAT is the Pediatric Evaluation of Disability Inventory Computer Adaptive Test. Some of you might be familiar with the PEDI, the Pediatric Evaluation of Disability Inventory that was a paper and pencil or paper and pen type version. That was very popular when it was first

developed and a great tool. Just a wonderful tool, I used it an awful lot. But as much as I love the PEDI, I love the PEDI-CAT even more. The PEDI-CAT measures abilities in three functional domains: Daily Activities, Mobility, and Social Cognition, plus a fourth domain of Responsibility. So if I need a tool that measures across more than just mobility, I use the PEDI-CAT. And oftentimes, I administer all domains of the PEDI-CAT. So the Daily Activities, the Mobility, the Social/Cognitive, and the Responsibility domain so that I can look at how a child is functioning across domains. For example, with one child that I was working with with spina bifida who we thought had the ability to improve some of her gross motor function, I was able to show using the PEDI-CAT that her Daily Activities score and her Social/Cognitive scores were pretty much at age appropriate levels. It was her Mobility scores that were lower than age levels. And I would use that for justification with the insurance company to justify and her, and get approval for her therapy visits. It can be used with all clinical diagnosis across all settings for children up to 21 years of age.

So it can be used in the school district, and it can be used by parent report or by clinicians or educators who are familiar with the child, which is advantageous, of course. It uses Item Response Theory, which I won't bore you with, but it's a statistical model to estimate children's ability from a minimum number of the most relevant items from a set of items within each domain. Each domain starts with a mid-range item. And the next item that comes along will be either a harder or easier item than that mid-range item, depending on how the person responded to the first item. So it's a parent report, therapist report measure. And it's available for purchase. There is an upcoming free webinar later this week. If anybody's interested, I could probably do a computer search on that. And they're also going to be unveiling fairly soon the autism scales within the PEDI-CAT. So this is one of those tools that is up and coming. I've used it in clinic as well as research settings. And it comes in a Spanish version, which has a printout in English which is very very helpful for me because I do not read Spanish. So it's nice that my families can complete it in Spanish and I can see

everything in English. Some other potential tests and measures that I just want to go through a little quickly are the Canadian Occupational Performance Measure and the Goal Attainment Scaling or GAS method. So each of these provide a framework for developing patient/client centered functional goals that can be objectively assessed. And functional goals that patients or families have typically reflect either the Activity or participation Domains of the ICF. And I've used the COPM and the GAS, Goal Attainment Scaling, in both clinical and research practice. So the Goal Attainment Scaling, here are some different links to tell you about it. There is something on the rehabmeasures.org list, also on CanChild.

Both of those are available for free. There was also I know a Goal Attainment Scaling webinar done by PhysicalTherapy.com not too long ago. I want to say it might have been in October or November of this year, so, October of this year, I think. So that might be another tool for you to be able to use. The Goal Attainment Scaling is, once you get the hang of it, is very easy. Many school districts use it, that's where I used it was in a school district. The Canadian Occupational Performance Measure is available for purchase.

There's now an online version. I prefer the paper version just because I'm used to it and it's very easy visually for families to see. I like the COPM because I, you start with a functional family interview, so you go over different functions and areas of concern that the family has, and from that list of identified functional concerns. So parents can prioritize or the child if they're capable can prioritize their needs, their goals, their concerns. And I can make referrals. If all of their concerns, for example, relate to bathing and dressing I'm gonna refer them to OT, for example. But if they have concerns within locomotion and mobility, I'm going to be able to use those to really target my physical therapy interventions. Again, it can be used as a parent-report measure or if a child is old enough, capable enough, the child can participate in scoring the COPM. Oftentimes I have the child and the family separately score and it's

fascinating to see the differences. One of the things I wanted to briefly mention was early identification of cerebral palsy in young infants. Right now we have the ability to diagnose cerebral palsy earlier than we ever have before, and there are a couple of test and measures that are used within this that I just want to highlight. We're not gonna go into in any detail, but highlight so that you can be aware of them. Now back recent, ah, this wasn't all that long ago there was a publication in JAMA Pediatrics regarding "Early, Accurate Diagnosis and Early Intervention "in Cerebral Palsy, Advances in Diagnosis and Treatment" by Iona Novak, et al. You can see that long author list there. But what this article said was historically, a diagnosis of CP was made at about 12 to 24 months of age. I would even say in many areas of the country that I have worked in, that it was made later than 12 to 24 months of age.

But now based on the work by Novak and her team, we can now make this diagnosis of CP before six months of corrected age. Now it's important to realize the difference between a PT diagnosis and a medical diagnosis. And cerebral palsy is of course a medical diagnosis, but if I can get some information together I might be able to help facilitate the medical diagnosis. You guys might recall sensitivity and specificity and some of you might be cringing at these terms.

But sensitivity reflects how many patients with a diagnosis tests positive. So people who actually have a diagnosis or a condition testing positive. And specificity is the false positive rate. So both of these things are important. But as we, like SPIN can help us to rule a diagnosis in. So if we have high specificity, a positive test rules in the diagnosis. And with sensitivity, if we have high sensitivity SNOOUT tells us that a negative test rules out the diagnosis. So getting back to this article, before five months of corrected age the most predictive tools for detecting risk for cerebral palsy are term-age magnetic resonance imagery. Which is great, but you know, not everyone has access to an MRI. However, the Prechtl Qualitative Assessment of General Movements has a 98% sensitivity, and the Hammersmith Infant Neurological Examination, or the

HINE, has a 90% sensitivity. I'm liking those values there. And these are both tests that physical therapists can become certified in. After five months of age corrected, the most predictive tools for detecting risk for cerebral palsy are MRI or the HINE with 90% sensitivity, or the Developmental Assessment of Young Children which has an 83% C index. So between these two slides, the HINE really stands out to me, that Hammersmith Infant Neurologic Examination. So I wanted to provide some information about the HINE, just some general overview information and perhaps allow people who are interested to seek some more information about it. It's for infants two to 24 months of age, I believe that's corrected age. It has 26 items looking at cranial nerves, posture, movements, tone, and reflexes.

And it has good interobserver or inter-rater reliability even in inexperienced raters, which is an important factor I think when we're looking at a good diagnostic tool. It takes only five to 10 minutes to administer, and so we can easily fit it into a clinic visit, perhaps high-risk infant follow-up visits, or my general evaluation or examination for a child who has a developmental delay, young child with a developmental delay. Each item is scored on an ordinal scale from zero to three. Individual scores are added together and a global score is obtained.

A minimum score of zero is possible if all items are scored at zero, and a maximum score of 78 is available if all items are scored at three. And there's guidelines provided to help us determine and interpret score. But the HINE can be used for lively assessed infants at neurological risk, both infants born preterm and at term. It identifies early signs of CP in infants who have neonatal brain lesions, and longitudinal assessments allow for differentiation of transient and more permanent abnormalities. You can register for free and get more information about the HINE at hammersmith-neuroexam.com and that's an active link for you. They even have some great videos and stuff that are wonderful to work through. So here we've review, or we end the form of our formal PowerPoint slides and have the opportunity for a few

questions. As you're gathering some thoughts for questions, I want to point out that my email address is on the screen for you so that you'll be able to contact me with any questions or concerns. And I'd also just kinda like to remind everybody that we looked at everything through the lens of the ICF, the International Classification of Functioning, Disability and Health today. And we know that as PTs, we've historically done really well at picking test and measures that reflect the body structure and function domain of the ICF. So those range of motion measures, those tonal assessments, things like that. We haven't done as great a job at looking at activity, and certainly have had less success in looking at participation. I'm hoping that you'll kinda consider some of the tools that we looked at today.

The COPM, Goal Attainment Scaling can be used to reflect functional goals and functional identified occupational performance areas of concern at both the activity and the participation levels of the ICF. And the PEDI-CAT is a nice tool. PEDI-CAT doesn't fit nicely for me into one of the domains of the ICF. I think it kinda crosses over some of the body structure and function, some of the activity and some of the participation.

But it's a great tool, and really can help us to get a great snapshot of a child's overall functional capabilities. Remember all the links here provided for you are live. And I highly encourage all of you to check out the CanChild website, that's CanChild.ca. I have no relationship with CanChild other than I'm a frequent visitor to their site to use their wonderful resources. But there's a lot of educational materials there for free. A lot of test and measures that are available there for free or no charge. I used to have a boss that said nobody really felt something was valuable if it was free, but if it was available at no cost or no charge that was a different story. So I hope that you all have enjoyed this. I'm not seeing any questions in the Q&A. Calista, did you have any questions for us today?

- [Calista] I don't either, and I don't see any questions as well. I just see a comment there, it said, "Thank you," and of course we want to thank you again, Dr. Kenyon, for all your work and presenting for us on PhysicalTherapy.com. And I think we'll go ahead and close out today 'cause I don't see any other questions!

- [Lisa] All right, well thank you all very much. Have a great day.

- [Calista] And have a great day, everyone. I'm gonna officially close out the classroom.