Wheelchair Mobility: Power Add On Options And Use For Manual Wheelchairs

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- [Fawn] Today's topic is Wheelchair Mobility: Power Add On Options And Use For Manual Wheelchairs. Our presenter today is Michelle Lange. She is an occupational therapist with over 30 years of experience and has been in private practice, Access to Independence, for over 10 years. She is a well-respected lecturer, both nationally and internationally and has authored numerous texts, chapters, and articles. She is the co-editor of Seating and Wheeled Mobility: A Clinical Resource Guide, editor of Fundamentals in Assistive Technology, 4th Edition, NRRTS Continuing Education Curriculum Coordinator, and Clinical Educator of NRRTS Directions Magazine. She is a RESNA Fellow and member of the Clinician Task Force. She is a Certified ATP, Certified SMS, and is a Senior Disability Analyst of the ABDA. Welcome Michelle, thank you.

- [Michelle] Thank you Fawn, and thanks everyone for your time today in joining us for this course on wheelchair mobility. We're going to be focusing on power add on options as well as a few other options to help optimize self-propulsion for people who are using manual wheelchairs. This is a really exciting cutting-edge area and I hope that, again, it's helpful to you and to the clients whom you serve. We have some learning outcomes today. This is CEU-approved course. The participant will be able to one, define alternative drive mechanisms and provide examples of three types. Two, describe clinical indicators for alternative drive mechanisms, and three, describe clinical indicators for PAPAWs, and we'll talk about what that word is as we move along. So this is what we will be covering. We're gonna talk about a category of seating and mobility equipment called alternative or alternate drive mechanisms. This is not a very consistent term. You might hear a lot of different terminology around this area, but this is the term that's utilized in our latest text on seating and wheeled mobility.

We're going to talk about how these alternate drive mechanisms provide assistance for self-propulsion of a manual chair using either a lever drive, an arm-crank drive, geared hubs, a reverse pushrim drive, or those PAPAWs, push rim-activated power assist drives. Now this is part of a series of webinars that are designed to prepare you, the participant, for the Seating and Mobility Specialist exam. This is a certification that's offered through RESNA. They have two certifications, the ATP, or Assistive Technology Professional as well as the SMS or Seating and Mobility Specialist. If you are pursuing your Seating and Mobility Specialist certification, you have to already have received your ATP. We do have a series of courses on occupationaltherapy.com designed to prepare you for that particular certification, and again this series here is designed to provide more advanced information in preparation for the SMS. But regardless of whether you're interested in one of those certifications, I really hope this does help you develop more advanced seating and wheeled mobility skills because that helps any of us do our job even better.

So there is a mobility hierarchy out there. We may start depending on the client with a more dependent manual wheelchair, something that a caregiver perhaps pushes for the client. The client is unable to move on their own. From there, we certainly try to determine if a client can be independent with a manual chair and propel it on their own. One of the courses in this series talks about ultralight manual wheelchairs which are specifically designed to optimize self-propulsion. From there we have alternate drive mechanisms and these are designed to improve efficiency of a manual wheelchair for self-propulsion, and then finally we have power mobility, power wheelchair options, for someone who cannot use any of those other options in order to achieve independent mobility. So our goal with these options is to improve the mechanical efficiency of the system. You know, manual wheelchairs have been around for quite awhile now, and haven't really changed that much. If we look at those really early early wheelchairs that you might see occasionally in somewhere like the Smithsonian or even in an antique store, the seating has certainly changed a lot. The position of the wheel that we use to

propel might have changed. Some of those very early early manual chairs positioned the main drive wheel towards the front. But overall, we have the same design. The seated person within this wheelchair grasps a wheel and pushes it forward and that's how the wheelchair moves.

We have had design changes, again, that we discussed in the ultralights course to optimize that propulsion but some of the strategies we're gonna talk about today are an attempt to change the efficiency of how this wheelchair works. Can we give this a mechanical advantage so the user has to exert less effort, and again as a result is more efficient in their propulsion. One advantage of these alternative drive mechanisms as well is that by sticking with something that's improving a manual wheelchair rather than moving to a power wheelchair option, we're maintaining the ability of the client or caregivers to transport this device. It gives a little more versatility, flexibility to the user, and many people are going to prefer the aesthetics of their manual chair as opposed to moving into power. Now it is well documented that people who self-propel a manual wheelchair, even if we have set it up as well as we can, as again, we discussed in our last course on ultralights, that people who self-propel are prone to repetitive stress injuries, particularly of the shoulders and wrists, as well as pain. People are aging with a disability, well we're all aging, and this is really becoming a problem.

Many years ago if someone sustained a spinal cord injury, for example, their average lifespan was only six years! Now people who have sustained a spinal cord injury, may live close to a typical lifespan. So this person may be propelling for decades! It's very important that we keep in mind that even if this person's doing just fine with their self-propulsion right now, that they're at high risk of these repetitive stress injuries and pain, and this can worsen to a point where this person can no longer use their manual chair at all. So if there are some things we can do preventatively so this person can stay with manual mobility as long as possible, then that's part of our job in looking at mobility. So these additional options to increase efficiency of a chair, are designed for

a person who can self-propel but perhaps has upper extremity injury and/or pain or is at high risk for that. Now it might be a little harder to convince someone who is successful and not experiencing injury or pain right now to consider these options. It may be difficult to convince a funding source to consider these options as well unless there's already an existing issue. But if this person has upper extremity injury or pain, decreased cardiopulmonary function, meaning, "Well, I can only push so far so long "with so much effort before it just takes too much "of a cardiovascular toll on my body. "My heart rate goes up, my breathing rate is up too high." Or perhaps this person has simply decreased strength and endurance. These clients can often benefit from alternate drive mechanisms. Also a person who is less efficient in mobility secondary to aging with a disability or aging in general. You know, I sure wish I could do all the things I did sometimes when I was 20 years old from a physical activity standpoint. Maybe I could have climbed a 14er then. I live in Colorado, we have a lot of tall mountains here. It would be difficult if not impossible to do that now as I've aged. I don't have the same strength and endurance. Well, the same with our clients.

So some of our clients may have been more efficient in their mobility in the past, but they're getting older and aging with a disability can take a toll, it can make aging more of an impact on this person's body, it can speed up that process. This may be a long-term manual wheelchair user who's lost efficiency, they're just not doing as good a job as they used to in terms of overall time and distance and effort. And it might be a manual wheelchair user who does fairly well over smooth level surfaces, excuse me, but is having difficulty with slopes, varied terrain, and/or long distances without help. So perhaps this person's propelling through the community okay, but boy, if they get to that ramp that's leading into that building they might have difficulty with enough strength to get up that ramp to prevent themselves from rolling back down. They might have difficulty slowing themselves so they don't go barreling down the ramp when they exit the building, those longer distances or bumpy roads could be too challenging as well. So we have several different non-powered options, as much as the title of our

course today is power add on, we are talking in general about alternate drive mechanisms and that includes non-powered and powered options. So let's start with these, and this includes geared systems, lever systems, and arm-crank systems. So let's start with our geared systems. A gear system sits between the handrim and the wheel, and consists of either a geared hub or something called a reverse pushrim drive. And there's an example here called the IntelliWheels. It's called their easy push wheel because the gear system helps with self-propulsion and increases the efficiency of it. So how does this work, well a standard manual wheelchair handrim has a 1:1 ratio. So if I push, let me get my pointer here. If I push on my wheel, I'm going to go a set amount of distance for each push. So I give one push, my wheel goes a certain distance. Of course it's going to depend on the slope and the terrain how far I might go. So again, typically we have this 1:1 ratio. With a geared system, we have 1:2 ratio for propulsion on inclines or on something called high rolling resistance surfaces such as carpet. If you've ever had a chance to try to propel a manual chair, and if you haven't I would encourage you to do so, if you're pushing on nice smooth linoleum, it's really not too difficult but if you move over to a different type of surface such as some nice plush carpet, it's much more difficult to push. It increases more resistance to the wheels as they attempt to roll, so we call this rolling resistance.

So now when I give one push on the wheel, I go twice the distance on those surfaces. It reduces the amount of upper-extremity effort that's required to get up a ramp, and it also reduces the abdominal activity on steep ramps. Imagine if you're sitting in a manual chair, you're really trying to get up that steep ramp, not only are you putting a lot of upper-extremity effort in, you're gonna have to start pulling in your core too and that is maybe good for you and I if we wanna work out, but may not be as possible for some of our clients to execute. So who is this appropriate for? Well, a geared system can be helpful for users who could not otherwise traverse certain environments without this system. Maybe they can't manage those slopes or varied terrain. Also for users with reduced upper-extremity strength because they're going to get twice as much

distance out of their effort as they otherwise would. Another option is reverse propulsion, pulling back on the wheel actually moves the manual wheelchair forward. So this is reverse of how we typically use a wheelchair, right. So typically we push forward, and this is called RoWheels because our motion here is similar to rowing. This pulling action uses a different set of muscles than if we are pushing on the wheel. So we have muscles involved in our upper back and shoulders. These are larger muscles than some of the muscles we use when we're pushing forward. By pulling back, it encourages a better posture because we're encouraging trunk extension and scapular retraction as opposed to pushing where we're pushing the scapulas forward and more rounding the shoulders. It also reduces the risk of shoulder-related injuries because of the pattern that the client is using, and it minimizes the impact on the handrim. This is a big deal. When people typically are pushing a wheelchair forward, the way that the hand collides with the handrim can create a great deal of force through the wrist, and this can lead to some of those repetitive stress injuries again. So this is a very unique option, although not too many people use it.

A lot of these options are a lot easier to understand too if you have a chance to hop in and try them, so I would encourage you to work with your local supplier or these manufacturers and say "Hey, could I go ahead and try out "one of your systems so I have a better idea "of how it works?" So geared systems, the user needs to recognize the need to change gears. This is on the initial system because sometimes the user has to choose whether to change gears or not, similarly to how we would ride a bicycle. Geared systems also add weight. Now most of the weight is by the hub on the axle of the wheel and that means there's less impact on propulsion than if the weight was in the front or back of the chair, it's in a good spot in terms of center of gravity. It can help people to not roll back on slopes. So if I'm trying to push up a ramp and my hand slips on that wheel or I just get a little too tired, I might begin to roll back. These geared systems will often only allow movement forward if I'm not actually pulling back, and that means that all my effort goes into moving up the slope rather than, "Oops, I have

to overcome that tendency to roll back down." And it reduces the amount of force required to brake when going downhill. Geared systems in general can work similar to a bicycle. When I was a little kid, I had a bike that didn't have gears. I had to turn my feet on those little pedals to turn the wheel, so one turn of the pedal was one turn of the wheel. As I got older, I got bikes that had speeds. So I got a three-speed or a six-speed or a 10-speed or whatever how many speeds we have available to us now. Those gears mean that depending on what gear I'm in, one turn of my pedal could result in multiple turns of the wheel. It makes us more efficient. It also helps us deal with certain terrain. I'm going to change what gear I'm in if I'm going up a hill or if I'm going downhill and maybe need to slow my rate of descent.

So we do the same thing with a wheelchair and again with these reverse system options, we have a different set of muscles we're using which improves the amount of strength we can put into the task, we're using larger muscles, and improves posture, reduces tendency towards injury. So two very different options with these geared systems. Our next option is a lever system. Now there have been some lever systems that have kind of come and go on the market. So some that you perhaps have seen in the past may no longer be available. The initial purpose of some of the lever systems on the market was to accommodate a one-handed driver. So let's say someone's had a stroke, they really can only propel with one hand now, and our typical one-armed drives where we have two handrims on one side can be difficult to use. They require a large hand span, a very good grip, and quite a bit of strength to move these things around. A lever arm came along to allow control of the wheelchair motion with only one lever.

We do have some options, though now, that are being used to help someone be more efficient on their manual chair. So instead of adding on a one-armed drive or a one-armed lever onto a more standard weight or lightweight chair, we have some lever systems like this one pictured here that are on ultralight chairs designed to make the

task more mechanically efficient. So the lever arm increases torque compared with the traditional handrim that we grasp and push. Typically levers are placed between the frame and the wheel and as a result, it does not add a lot of width to the chair. This is the challenge when we're using a system such as this. Sometimes the lever system also includes gears to make it that much more efficient, and in general a handle is easier to grasp than a handrim. And they may be less likely to cause injury to the wrist as well. Now steering can be done in two different ways. Differential motion or dedicated steering. This sounds a little confusing, let's look at them. Well, first is differential motion. Differential motion is where when we pull back on one side and push forward on the other, it turns the chair. So we pull back on the one side, push forward on the other to turn in that direction. This is similar to some child toys out there.

So it might be that you've had a chance or your children have had a chance to sit in a toy where there's two big wheels on the side and to turn you pull one wheel back and you push one wheel forward. This is also what we do in a manual chair, right? If we wanna make a turn, this is exactly what we do on the wheels, it's just that now we're doing it with the levers. In a dedicated steering mechanism, we might only push the levers back and forth. This is particularly the case when there's only a single lever, like for a one-arm driver and we turn the handle of the lever itself to indicate what direction we want to go. So on this particular system, we have differential motion. On a dedicated steering mechanism, there might be a different style handle here. We have a handle kind of going off to the side and depending on how we turn the handle, that will turn the chair. This is a rather unique chair here. You can see that there's one single larger front caster out in front, rather than two. This makes the chair longer. It can make it quite efficient, but it's going to have a rather large turning radius and this could be more difficult for maneuverability, particularly indoors.

So lever systems are more mechanically efficient than a standard handrim. For the same amount of effort, the user can achieve a higher speed and there's actually been documentation that heart rate and oxygen consumption are less when moving through a same distance, same environment, with a lever drive as opposed to a manual wheelchair. So this is less demanding, less strenuous, more efficient. Why aren't we using it, well we'll talk about some of that but most people are not using lever systems. It is something that I think a lot of people are not aware of, and it just doesn't seem as intuitive or typical to people who are used to seeing a more standard wheelchair. Finally on our non-powered options, we have armcrank systems. These are often used in handcycles, and so are not typically used for everyday use but more for recreational use. The user can be upright as in this picture here. There's also recumbent options. Many people use recumbent bikes for exercise, and may or may not have a disability. The gears are very similar to those on a bicycle so that one turn of the hands, in the case of this young man, translates into more than one turn of the wheel.

The drawbacks of armcrank systems is they're bulky. They really are designed primarily for recreational use rather than functional use. They have reduced maneuverability because of this long size you see here, and aesthetically, well, might look cool enough for recreation but probably not for cruising through my school or workplace. Most of these systems now are synchronous, meaning that the arms turn together and this has been found to be more efficient where in the past the arms tended to move separately like we would with our feet on pedals. Well, that works well for our feet but for our hands, generally it's more efficient if we can move both hands together in the same pattern of movement. That continuous movement is less straining and more efficient than handrims. So if I am pushing on the handrims of my manual chair, I have, I'm in contact with the handrim, and then I let go, and I have to come back and make contact again. By using these little handles on a recumbent option like this, I can keep my hands on there providing this continuous movement.

Again, that is less strain on the body and more efficient. I can achieve longer distances at higher speeds, and the recumbent position shown here reduces air resistance and it's part of the reason this is sometimes used. So again, armcrank systems typically used for recreational purposes, and even though these are quite efficient, are not practical for everyday use because of their size, their bulk. Usually it's something that's either attached to an existing wheelchair or is a secondary wheelchair. So how do we justify these systems, whether we're looking at a geared system, an armcrank system, a lever system? Well, it allows the manual wheelchair user to maintain their independence in mobility without having to switch to a power wheelchair. Switching to a power wheelchair has all sorts of issues including cost and accessibility.

A power wheelchair's very heavy and it's difficult to get in and out of inaccessible vehicles and locations. The cost of these systems is typically less than a power chair but not always, some of these can be quite expensive and that is important to keep in mind. So now we're going to turn to our powered options and see what our options are there. And this brings us to this unusual word PAPAW or pushrim-activated power assist wheel and that's what that acronym is for. It's just quite a mouthful to say pushrim-activated power assist wheel and so instead we say PAPAW. Now this can either be a motor that is in the hub of the wheel such as the one pictured here on this Quickie Xtender. So we replace the typical rear wheel of a manual chair and instead place this one that has this actual motor in it. The motor is designed to make the chair more efficient by giving a boost to the client's efforts. We also can add a motor external to the frame such as the SmartDrive which is getting very very popular. It is also added on to an existing chair to help the user be more efficient. These are both considered push-rim activated power assist options even though they are not, this particular external option, is not replacing the wheel. It is often activated by the client pushing on the wheel.

So how do PAPAWs work? Well, it's a hybrid system and this is exactly, by hybrid I mean it's somewhere in between I have a manual wheelchair or I have a power chair. We're adding power to the manual chair to increase efficiency of self-propulsion. The client is still propelling on their own. It measures the force imparted on the pushrim by the client's arms. It amplifies that force through an electromechanical system. Specifically it amplifies the propulsion phase. So when the client is touching the wheel and pushing forward on the wheel, it results in faster speed than the client would have without the PAPAW and increased force, and that force not only contributes to increased speed but also increased power or torque over varied surfaces or up or down slope. It also extends the recovery phase. Now in self-propulsion, the recovery phase is when the client's hand has left the wheel, dropped down and is preparing to grasp the wheel for the next stroke, and hopefully the chair is continuing movement throughout that time. So while the client's hand is returning to the wheel, the chair is more likely to go further and faster because of the efforts of this powered wheel. So what does that mean exactly, because that's kinda the engineering description of that. Well, a typical push on the handrim results in more force to propel the manual chair further per stroke, and with more force up slopes and over varied terrain. Very very cool.

So someone can continue to use their manual chair but go faster and further. There are two modes of operation in PAPAWs and this includes intermittent and continuous mode. Well, what do those mean? In intermittent mode, the motor only engages in response to force on the handrim. So it's only used when needed, and this may be safer for some users and this is an example of one of these from Frank Mobility. You can see here too, let me grab my pointer, that these wheels are removable. Someone's pushing a button in on the axle and removing this wheel, and you can simply place the standard wheels back on when desired. So the nice thing about intermittent mode is if I'm not actively trying to drive my chair, I'm not trying to push my chair, it's not going to go. It only goes when I put that effort into it. I could even reach down and push a

button on this hub on some of these systems and turn it on or off or use some form of remote to say, "I wanna use this right now," or not. As opposed to continuous mode where the motor is turned on by the user and the chair starts moving. It moves on its own, even if the client doesn't touch the handrims at all. Now if they don't touch the handrims, they're not gonna go where they wanna go, however. The handrims are used for course corrections. So I turn the motor on, either by pushing a switch or using some type of Bluetooth device. So for example the SmartDrive utilizes this little wristband and I can use this to say, "I want to turn on the motor," and the chair will begin to move and I use those handrims for course corrections. This is great for long distances and doesn't require very much effort. So if I'm going a long distance for awhile, I can go ahead and turn this on, just correct my course, and when I get to where I want to, turn the system off. Depending on the system, there's different strategies for turning it off. It does require that the user has to pay attention because the chair's gonna keep moving until I tell it to stop, and that could mean a safety issue if I'm not working with a client who can be attentive.

As a part of my job, since I do a lot of education around seating and mobility, I often attend larger seating and mobility conferences such as the International Seating Symposium, and often a company like SmartDrive may have options there for people using a manual chair to borrow their device during the conference because oftentimes people have to traverse very large distances to get from hotel rooms to a certain session at this conference, or just to get through a convention center. And often there's carpet, and this can be very helpful for clients. And so you'll see a lot of people utilizing something like this to keep them moving and just simply again make those course corrections. So these PAPAWs translate handrim forces into direction of movement. So typical manual chair I push the chair forward and that's where the chair goes. I push those wheels forward on the handrims, that's where the chair goes unless I'm using those RoWheels that reverse that mechanism, my movement is gonna translate into

forward movement of the chair. Now these power assist systems have to determine how to react to forces on the handrim.

So the original systems that first came out were comprised of something like you see in this picture here where there's a wheel on each side and it has a separate motor and a separate little brain, a little computer brain that translated those forces into movement of the wheel. So some of these systems react differently to forces on each handrim because it's like having two completely different systems on either side of your chair. Well, most people, even really good manual wheelchair self-propellers tend to push with a little more force on one side of their body. A lot of it is because we tend to have a dominant side. It could also be for other physiological reasons. This can make steering the manual chair more challenging if you're not pushing with exactly the same force on each wheel. It is the most similar to typical manual wheelchair propulsion because that's how it works on a typical manual chair. If I push a little harder on one side, my wheelchair is going to tend to deviate or veer to that side.

But some of our newer systems read forces on both the handrims together and that makes propulsion smoother. So these are smarter electronics that kinda even that out and can determine whether someone's attempting to go in a generally straight direction like down a hallway or whether they're attempting to actually make a turn. And these again can result in a smoother course down a long straight area like a hallway or a sidewalk. So what are our applications in using PAPAWs? Well, for a client who's not an efficient manual wheelchair user but perhaps is reluctant to move to a power chair, and that's a lotta people. I recommend a lot of power chairs and so I get very excited about them, but my clients may not be as excited as I am and that's okay if this client does not wanna move to a power wheelchair and that might just be personal preference. It also could be the fact that this person doesn't have an accessible vehicle or a home, even for someone who has an accessible vehicle and home, sometimes that vehicle may not be functioning.

Sometimes my destination may not be accessible. It's easier to manage that in a manual chair even with the addition of PAPAWs than it is a power chair. Another huge advantage of PAPAWs is injury prevention. What can I do to prevent development of those repetitive stress injuries in the shoulders and wrists that are so common in long-term manual wheelchair users. Energy conservation is another big one. You know, energy conservation I believe is not just important for people who perhaps have a medical condition that leads to fatigue, that leads to a lack of endurance, who maybe have cardiopulmonary insufficiency. Energy conservation is for all of us. I go to the grocery store like many of you fairly often. I don't walk there. I could but it's a long walk and I'd buy a lot of stuff and it's too hard to carry back to my home. I drive there. I load up the back of my minivan and then I bring it all home. It's more efficient. I need to conserve my energy and my time for other activities that I have during the day.

All of us choose strategies to conserve energy throughout the day. We need to look at that and consider it for our clients as well. For some users, a PAPAW can increase the distance they can traverse each day. So for someone who's perhaps out in the community and has longer distances to go throughout their neighborhood, throughout a college campus, throughout a large high school, this might allow someone to go farther than they otherwise could, and finally PAPAWs increase access to slopes and varied terrain as well as more control, and that control means when I'm going up that ramp, I'm not going to start sliding back or rolling back, and when I'm going down the slope, I have more control of my speed without requiring a stronger grip on those handrims. The main drawbacks of PAPAWs is that we are increasing the weight of this little ultralight chair that they're often used on. We are increasing cost. Although these are typically less costly than a power chair, sometimes they are quite expensive, and we're adding them on to a manual chair and that's something we have to look at is cost as well as funding. It can reduce the ability of this person to perform certain wheelchair tasks such as wheelies.

So if somebody's a super-active ultralight user, they may be able to pop a wheelie and get up and over a curb or even manage going down a few steps. They most likely will not be able to do so with any style of PAPAW, particularly an externally-mounted one like this. And this may impact accessibility. So big question. If these increase efficiency so much, then why doesn't everyone use them? Why are we still using a design of a manual chair that at least in terms of the propulsion method, pushing forward on a wheel, has not changed pretty much since the wheelchair was invented? Well, research has shown that all of these strategies basically compensate for manual wheelchair design issues that lead to injury and pain that tend to worsen over time. We have research that shows that these non-powered and powered options increase efficiency, reduce pain, reduce repetitive stress injury, especially over time for long-term self-propellers.

So again, why aren't we using them? Well, I think that many wheelchair users are not even aware that these technologies are out there, and if they are aware of it, if a team member says, "Hey, by the way, "there's this great technology "that might make you more efficient," they may be resistant to more technology than they think they need. Many funding sources are also not aware of these technologies and as a result might be reluctant to pay for more than they believe is necessary. So even if we say, "Hey, it's logical to assume "if we intervene with this, "that this person will have less consequences "to typical manual wheelchair propulsion in their future," funding sources tend to be a little more concerned with the now than they are with the future. A good example of this is it's very difficult to get funding for a pressure-relieving cushion for many people until they develop a pressure injury. That is certainly not a logical situation, but there's little about our funding situations that are logical.

This is another area where unless someone has already torn up their shoulders, the funding sources may be very reluctant to reimburse this technology. In the future,

hopefully we'll have even more improved design on manual chairs and with these techniques to make manual wheelchair propulsion more efficient, and we can continue to build awareness through education of the clients, of team members, as well as funding sources. Now one of the things we're trying to do with this series is most of these courses include a case study, and much of your post test will be based on the case study. If you are preparing to take the SMS examination, a lot of the examination is comprised of more detailed case studies, which personally I like. You have a little more information to answer questions and so we're kind of building in some of that practice for you in these webinars. Now this involves a client that I saw some time ago, and I was working for a different location at the time, and so unfortunately I cannot share his photographs. But we're gonna talk about DeShawn.

DeShawn contracted transverse myelitis at a younger age. Some people recover completely from this condition, and other people have residual impact from it. At the time of this evaluation, excuse me, he was 13 years old and attending middle school. DeShawn was already using an ultralightweight manual wheelchair and he had customized seating to provide the postural support, stability, and pressure relief that he required. He was able to propel throughout his school. The school primarily had level smooth surfaces, but despite those surfaces it was still slow for him to move throughout the school, and it took a lot of energy especially if he had to transverse a longer distance. So moving from class to class was getting to be quite difficult for him, and it led to fatigue and that was impacting his school performance. Now one of my favorite sayings is what's the point? If we're analyzing a situation, I need to know what's the point. What's the point of DeShawn pushing his manual chair in middle school?

Well, the main point of DeShawn going to middle school is school! He's supposed to be learning something, he's supposed to be participating in class, and if his mobility is getting in the way of that, that's a problem. The purpose of school is not to build up

DeShawn's upper extremity strength or his cardiovascular endurance or to reverse the effects of his transverse myelitis as much as possible. Those are therapeutic tasks, not the main goal of school. DeShawn also is having difficulty on ramps. He didn't have enough strength to propel up the ramp and he couldn't slow himself down when he went down the ramp, which meant he flew down the ramp without a lot of control and was at risk of hurting himself or someone else. So as a result, he was dependent for those activities. So even though he could move himself around through the school, someone else had to push him up and down ramps and outdoors, as he also had difficulty with varied terrain. So we considered a powered chair. "Hey, if we put him in a power wheelchair "that would be great." He could get anywhere he wanted nice and fast, and the school was certainly accessible. But DeShawn didn't want that power chair, he was very reluctant to move to the power wheelchair at all, and the family did not have an accessible vehicle so they needed something that they could fold. It was very important, and with a power chair that would not have been possible. So we needed a different option.

So we arranged for a trial with some power assist, or power pushrim-activated power assist wheels. We could remove his current rear wheels from his ultralight chair so that he could try these on his own manual chair, which was ideal. It really makes assessment very very nice. We were able to get ahold of a pair of these that were the same size as his current wheels, so we weren't changing his configuration. He was in his own chair, his own seating. Ideal way to evaluate these. So we popped on some power wheels and he liked him, he liked them a lot. He was able to go a much further distance than he could before, faster, and he had control up and down those slopes. He was able to go up a ramp independently for the first time. Now we were concerned about funding. I'm always concerned about funding. I wish I didn't have to be, but we thought that there was a chance these could not be funded because they did cost quite a bit. So we thought it would be helpful to document as much as we could the difference these wheels were going to make to DeShawn.

So we measured how long did it take DeShawn to move between specific locations before and after this intervention. So for example, how long does it take DeShawn without the power assist wheels to get from his classroom to the next class or from his class to the cafeteria. And then we measured that same task with the PAPAWs, not just in terms of how long but also documenting effort, and that is a little more qualitative but we could look at how fatigued he was. We could check heart rate, we could check respiration rate, and some of that is certainly more objective. We also documented situations that he was completely unable to manage in the current manual wheelchair like going up a ramp and then documented tasks that although he was unable to perform independently in his manual chair, he could perform with the power assist wheels. Now there are some measures out there you can use. With DeShawn we simply wrote down and documented some of these findings and included that in our letter of medical necessity.

But there are some more objective pre-set measures out there if you were interested in those. Two that could be appropriate in a situation like this where we're trying to determine, "Hey, is this really making a difference, "this PAPAW intervention," would be the Wheelchair Propulsion Test or the Wheelchair Skills Test. Both of these are available online. You can look them up, and again I would encourage you to measure before and after the intervention. You might say, "Well, how in the world "do I get ahold of these wheels so I can try them out "with a client that I'm working with?" You can contact your local Complex Rehabilitation Technology supplier. Ask them, "Could I get ahold of these "to try with this client?" It's important to use the same size wheel if you can because otherwise it's going to change the configuration of the chair. So if your client is using a 24-inch wheel, you want a 24-inch power assist wheel. If the supplier says, "Hey, I don't have that "and I can't get ahold of it for you," you can contact the manufacturer and you've seen in a number of these pictures several of these manufacturers' names. You can contact your manufacturer. Ask for the local

representative in your area and say, "Hey, can you get ahold of this for me "to try with this client?"

Now we not only wanted DeShawn to try out these power wheels but we wanted his mom to also, so she tried to take the manual wheelchair apart with the PAPAWs on it and put this in her vehicle. It was heavier. With the motor and that little computer brain on each wheel, they certainly weigh more than his typical rear wheels but she was able to do it and she decided that his function was more important than the wheels weighing a little more and so she decided that it was okay to pursue these PAPAWs.

So what were the results, well DeShawn was independent in all of his mobility, and this included varied terrains such as those bumpy sidewalks or a rougher outdoor area at the school or in his community. He also could manage slopes, both propelling up a ramp which he was unable to do before and controlling his descent on that same ramp going down. He was no longer dependent on other people to help him in those situations even though he could push himself in his ultralight chair, someone had to be around for when he got stuck and needed some extra help. And he wasn't as worn out, so he was better able to participate in school. So when he got to math class, instead of being completely wiped out he was okay. He was able to participate and then still had enough energy to move on to his next class. So what is our take home message? Well, many people who use a manual chair are inefficient in their self-propulsion and again that can be for a variety of reasons. These various add-on options, whether they're mechanical or electric power options can provide that efficiency both in distance and in force to overcome certain obstacles.

Many people who self-propel develop injuries and pain. We did discuss this further again in our ultralights course, if you want more information. And by providing these alternative drive mechanisms, we can reduce that risk of injury, also reduce pain. There are options that exist which close the gap between those manual chairs and power

chairs, and again, some of them are mechanical, some of them are these PAPAWs. But we have a variety of options out there. This technology continues to improve and change, so remember when you're considering these options there could be newer ones available to you. In terms of references, there are a number of journal articles out there that talk about using particularly PAPAWs and the impact on that for manual wheelchair users who self-propel, and you can check those out online. A more recent resource is listed here in this newer text, "Seating and Wheeled Mobility: a clinical resource guide." There is a chapter in there on these alternate drive mechanisms, and it goes through a lot of this information including a summary of what our most recent research shows. If you have any questions about any of the material that we've covered here today, feel free to email me. I will show you a slide with my contact info in just a moment.

Again, if you have questions or comments about this material, I encourage you to reach out either to myself or to occupationaltherapy.com. I'd also encourage you to watch the rest of the series on this various seating and wheeled mobility topics as a part of our seating and mobility specialist series. Again, we're attempting to provide more in-depth information that can again not only prepare you for that certification examination, but hopefully also for the clients that you're working with, for meeting their needs as well as possible. I wanna thank you very much for your time today and joining us for this session, and make sure you again, you have that contact information. Now we have just a couple minutes left, so I'm gonna just address a few questions that often come up about this area of technology.

A big one always is funding. How in the world do I justify this? If the funding source thinks that my client can propel a manual chair, how can I convince them to pay for something that just makes it easier? Well, a lot of it has to do with our documentation and how we word things. We might be getting at the same meaning, but how we express it can make or break successful funding approval. So if I'm working with

DeShawn and say, "You know, when he uses this particular technology, "it sure makes it a lot easier for him to get to class. "He can get there even faster "than some of the other students!" That's probably not gonna result in successful funding. But instead, if I say, "DeShawn has a medical condition, "transverse myelitis, that results in decreased "motorability, strength, and endurance, "that it's taking him an unreasonable amount of effort "and he has a lack of efficiency in his self-propulsion." If I give specific examples about why this lack of efficiency or how this lack of efficiency is impacting his day, such as he's now too tired to participate adequately in class or he cannot independently manage certain situations, certain environments throughout his day, as well as, as a bonus, if I'm able to actually try the equipment out with him I can then also document, "This is how he did with the recommended equipment," and compare the two. If I can throw some numbers in there that is always helpful. It took Shawn X-amount of time to get between these two locations, and now it requires this much time or it takes this percentage-less time or I've noted a change in heart rate, respiration, any numbers we can put in are often very very helpful with funding as well. So again, I would encourage you to keep this in mind with the clients you're working with. I wish you well on the examination and again if you have any questions, just reach out to myself or occupationaltherapy.com. Thanks again, everyone.

- [Fawn] Thanks, Michelle, for another great talk in the SMS series. I hope everyone has a great rest of the day. You join us again on occupationaltherapy.com, and continued. Thanks, everyone!