S3, Ep 7: Technology to Make Walking Easier

**Dr. Marie McNeely** 00:01

Hello and welcome to Changing What's Possible: The Disability innovation podcast brought to you by Cerebral Palsy Alliance Research Foundation or CPARF. I'm your host, Dr Marie McNeely, and this season, we are excited to bring you cutting-edge stories and insights on research, technology, and innovation for people with CP and other disabilities. Before we introduce you to today's guest — listeners, we are excited to let you know about CPARF's upcoming STEPtember campaign, which runs for the whole month of September. Join thousands of people across the country to raise funds for life-changing cerebral palsy research and assistive technology that will positively reshape what it's like to live with a disability. And if you want to pair any physical activity with your fundraising, you can challenge yourself to get moving all September long. Make a team of up to four people and get your friends and family in on the fun. Sign up today for free at www.steptember.us. That's www, dot, S, T, E, P, T, E, M, B, E r.us, and now we'll get started with today's episode.

**Dr. Marie McNeely** 01:13

We have with us our guest, Dr Collin Bowersock. Listeners, Collin is a postdoctoral research fellow at Northern Arizona University, and today, we are going to talk more about the research that Collin is doing on at-home use of a wearable robotic exoskeleton device for gait assistance for people with cerebral palsy. If you want to hear more about the story behind the device, the Biomotum SPARK, check out Episode Five from season one of our show. But Collin, we are so excited to have you joining us today. So thank you so much for being here. How are you?

**Dr. Collin Bowersock** 01:46

I'm doing good. I'm enjoying some spring weather out here in northern Arizona. Finally, I think we're almost done for snow for the year, so it's always nice. I'm doing good. I'm happy to be here.

**Dr. Marie McNeely** 01:55

Well, we are thrilled to have you with us and looking forward to learning more about you and all the wonderful work that you're doing. So can you start by maybe giving us a little bit more background about yourself?

**Dr. Collin Bowersock** 01:59

Yeah, absolutely. I grew up in North Texas, in a town called Wichita Falls. I was pretty small town fun around there, but my parents did a good job of keeping me in sports, keeping me out of trouble. So I grew up playing all the sports all throughout until high school, and there you kind of have to pick. I ended up picking soccer, and that kind of led me to traveling around a bunch across the state of Texas through high school. So that was kind of my main hobby. Then I went to college, played soccer for a few years at a small university, and then moved out to Lubbock, Texas, which is West Texas, good time there. And then through my academic career, had the really like the privilege to be able to live in a bunch of different places. So I moved to North Carolina. That's where I met my wife, Jessica, who's also, in fact, a PhD in neuroscience. So it's pretty fun to have someone there to bounce ideas off of. From there, went to Virginia, Southern Virginia near the coast, near Virginia Beach, which is really nice. Then did some studying at the University of Louisville, jazz in Louisville. And now here I am in northern Arizona, at Northern Arizona University in Flagstaff, which is a really beautiful place. So I've been lucky. I've got to move around quite a bit doing all this academic work.

**Dr. Marie McNeely** 03:19

That's wonderful. It's great that you've been able to explore some different areas of the country, and I'm curious about where this scientific interest fits into the picture. So can you tell us, Collin, how did you originally get interested or involved in working on assistive devices and rehabilitative technology?

**Dr. Collin Bowersock** 03:35

As soon as I kind of started my graduate studies, I was always involved in rehabilitation. That was kind of like my main goal or main interest. So at East Carolina University, I was looking at simple running techniques that people could change that would reduce the amount of like joint loading in their knees. Specifically the population I worked with, there was individuals who had ACL reconstruction, so had an injury, then had the reconstruction, and then we work with them to try to change the running technique, to modify these joint loads. So that's kind of my first interest into rehabilitation. So it was nice to see people you're hoping you know you're going to change some lives. Did a little bit of that, and then as I did some more work, I moved on to Old Dominion University, and I moved a little bit away from the rehabilitation and really started studying and investigating why we move the way we move.

**Dr. Collin Bowersock** 04:30

So that sounds maybe a little far fetched, but it's, why do we walk in this manner? Why do we take steps? And each of us does have, like, some characteristics of how we walk, but it's all pretty similar. So I was studying there, I looked at and I was still focused on gait there, but I was looking at like, what influences how the way we walk. So kind of give an example here, when any of us walks, we have variability in our walking pattern. So sometimes we take really long steps and really slow steps. And then sometimes we take really short steps and really quick steps, so the way we walk is variable. Now this is inherent and kind of all of our movement patterns, but this variability is not random. It has pattern and it has structure to it, and we found that through different research. So as we take a small step, we're more likely to take another small step than a long step. So it's not just randomly switching throughout, but all of our movements have this underlying structure. Now, with different aging or frailty or disease or injury, we have a breakdown in this pattern of walking. So this natural, inherent variability that we did have changes. So I was kind of studying into that, like, what factors influence this, and is there a way that we could maybe reintroduce this variability into our gate pattern, but if we do so, does that even lead to, like, more stable and enhanced performance of gait pattern? So I did some research into that and focus my dissertation there. So there I was really interested in motor control is kind of that field of study.

**Dr. Collin Bowersock** 06:02

With that, I moved on to the University of Louisville, whereas at the Kentucky Spinal Cord Injury Research Center, and there, I was able to study how the spinal cord itself, without any input from the brain, is able to control these movements. So we get sensory information that the spinal cord is able to process, and then the spinal cord sends out its own kind of motor programs and how it's going to respond to this information. So there was my first introduction to kind of involving the robotic devices into rehabilitation. There we had a robotic device that would perturb, which just means, like a simple push or a pull individuals. But these perturbations were obviously very precise, and we could do it in a very systematic way. So as we perturb them, we could see if the muscles, like below the level of injury of the spinal cord, if they would respond, which, right away is incredible that it's already able to respond by itself, knowing from the brain, just from the spinal cord. But then with more and more training, could it respond more appropriately? So with stronger perturbations, could the muscles respond even stronger, and could they tell the difference between a perturbation to the left to the right, to the front to the back, and would the responses be different? So that's kind of how I ended up here with working on rehabilitation, and now I've kind of brought in this robotics and these assistive devices to enhance some of our rehabilitation techniques.

**Dr. Marie McNeely** 07:29

Very interesting. And you touched on how gait can be a little bit different from person to person, or you might see specific characteristics with age or with certain conditions or disease states or whatever the case may be. So can you talk about, Collin — what are some of the common walking patterns that you might see in people with cerebral palsy who you're working with in your research now?

**Dr. Collin Bowersock** 07:48

Yeah, cerebral palsy, which I'll probably end up abbreviating, CP, there's a number of characteristics, and not everyone with CP is going to walk the same way, but there are some commonalities, or some things you'll see more often in an individual with CP. One of the most common is drop foot. And what drop foot means, and you also see this in other people with like affected neuromotor control. But drop foot what it is, is when you're walking, an able-bodied individual pushes off with their toes, and as they switch from the toe being off the ground to in the air, we usually pick up our toes mostly, so we don't trip. Individuals with CP have a difficulty picking up that toe, so we call that drop foot, where the ankles are kind of relaxed and slack. And because of that, they typically have to have more hip and knee movement to control for that drop in the foot, so that they clear the ground. So drop foot's a pretty common one. Another one that's pretty common is crouched gait. So what crouch gate is, kind of the characteristics, or that is a lot of bend in the knee as you walk, it kind of looks like you're doing, almost like a bit of a squat for each step, instead of standing more erect and upright. And then some overall more common ones, there's always some balance issues. They often walk much slower, these individuals. Lower limb weakness, their spasms, lack of control. So walking is just not as simple as it is for an able-bodied adult. It's hard. Sometimes the biomechanics are a bit different, and it can be exhausting to do what an able-bodied individual may consider easier.

**Dr. Marie McNeely** 09:20

That makes sense. And then we'd mentioned that you've entered this wonderful world of robotics for your postdoctoral fellowship. I'd love to talk a little bit about kind of what this robotic assistance can do, and why. Specifically, is the robotic assistance that you're working on focused on this ankle joint. You did mention drop foot. Can you talk a little bit more about how this robotic assistance can maybe improve ankle movement as well as other aspects of gait. So

**Dr. Collin Bowersock** 09:44

like I said, drop the it's very common, and the gold standard of how it's being treated now is with an AFO or an ankle foot orthosis. And what that is is pretty much, if you've ever seen someone like sprain their ankle or have some sort of ankle surgery or injury, they wear those big old boots, and the boot pretty much just locks the foot in, like a neutral 90 degrees. So the AFO is pretty similar to that. It just locks the ankle at 90 degrees and stops the drop foot, so that the foot kind of raises up during swing. And it does allow for more stability, and allows individuals kind of rock from the heel to the toe, and it helps a little bit of walking. The problem with these AFOs, or kind of a critique, is, if you lock a joint out, you're going to have disuse of that muscle, and then it's kind of the use it or lose it principle. If you're locking the ankle joint, you're not engaging these muscles, you're not going to really progress in any kind of rehabilitation. But they do help increase people's mobility.

**Dr. Collin Bowersock** 10:43

So our idea here is to provide a device which can still help in this drop foot, but it doesn't lock the ankle out, and then it also helps individuals push off. So I'll describe that a little bit more. So the assistive device we have as an individual is walking, and your foot's on the ground, and you start to push off with your toes. The device itself will help you push off. So it'll kind of propel you forward, and then as it propels you forward and your foot leaves the ground, it will then help you pick up your toes. So then the device will rotate your ankle up so that it helps that drop foot. So that's a kind of idea behind the assistive device we have.

**Dr. Collin Bowersock** 11:22

Now there's some other things you can do, so I kind of described it as an assistive technology, where it helps you move the ankle, helps you push off, makes walking easier. You can go longer distances, but it can also be used as a training tool, so we can change it from assisted to resistance. So what that can do, it's almost like a bit of strength training. It makes it a little bit harder to walk with the idea there that with that little bit of resistance, we can increase, not exactly the strength more, say, but almost just the engagement of the muscles. As I said, some individuals have a little bit of lack of motor control, where the muscles maybe engage at the wrong time or not as well as we would like. So we can kind of increase that neural engagement, the muscular engagement, while maybe increasing a bit of strength, with the hope, again, that without the device or with the device and assistance, walking is easier. We can walk further. We can increase our mobility so we can explore much more of the things we want to do.

**Dr. Marie McNeely** 12:21

Phenomenal. And I really like that. This is a dual purpose device, as you described, with these two different assistive versus resistive modes. And maybe this helps give us a visual of what it might look like. But for listeners who aren't familiar with the Biomotum SPARK device yet, and perhaps missed season one, episode five, can you give us a quick description of what this device looks like and how it works?

**Dr. Collin Bowersock** 12:42

Absolutely I can. There is really good pictures on our lab website, which I'll give at the end of this podcast. But to give it an explanation, it's basically, I'll say three parts, and I'll describe each. The first is a waist belt. So that's kind of how the device is really attached to you. It's pretty much like a fanny pack. You just clip it around your waist so there's nothing upper body. And then from the waist, there's some foot plates that go inside your shoe. So just as you put like, maybe like that cushioning stuff or an orthotic in your shoe, you put these foot plates in your shoe. So we got the waist belt, we got the foot plates in each and then there is some motor some cables and some ankle pulleys that are involved.

**Dr. Collin Bowersock** 13:24

So I'll go back to the waist belt. In the waist belt, that's where all the power and all kind of the circuitry and the engineering stuff is in this device. So you buckle it in the front, there's nothing there. But towards the back is kind of a plastic pack about probably eight by eight inches and only about two inches deep, pretty small. Within those is that's where the motors are. And the motors are these sprockets, just like you'd have on a bicycle, with chains on each sprocket. So there's two in each control. You know, the left one controls the left leg. Right one controls the right leg. So as these chains move up and down and rotate the sprocket, that's what rotates the ankle pulley down at the bottom. And the way they're connected is through they're called Bowden tubes and steel cable. It's pretty much like a bicycle cable, how you would like hit the brakes on the handlebar or something like that. So those go all the way down, connect to these ankle pulleys. And the ankle pulleys, again, is what allowed the device to push your feet down, or push your toes down or pick your feet up, depending on whether your foot's on the ground or your foot's in the air. Now, the way the individual is able to kind of control the device is in that foot plate that goes in the shoe, there's a little bitty load cell or a force-sensing cell. What that does is it tells the device when the foot is on the ground and how hard you're pushing into the ground. So when the foot's on the ground, the device knows that, and it will help you push off when it's in the assistive mode. And then when it no longer senses load, it knows your foot's in the air, and then it'll help you pick your toes up during what we call the swing phase of walking. So that's the only real, like, component of how the user is able to control the device, but it stands out a bit from other devices, in that the user has to be walking for it to help. So it's not going to walk for you. The user does have to begin walking, and then with the walking, it'll provide assistance based on how fast you're walking, how long your steps are. So it's really nice that it's functional in that way.

**Dr. Marie McNeely** 15:22

Absolutely. And I think that ties in with my next question here, just this idea of having a sort of customized or personalized device that responds to how you as an individual are walking. So Collin, can you maybe go into a little bit more detail on how this device can be, maybe customized or personalized to meet the specific walking needs that different people may have who have different issues in their gait?

**Dr. Collin Bowersock** 15:43

Yes, so one the sizing, all of us are different sizes, so different components to make it fit each individual. So we work with children all the way up to adults, everyone's different size. That's all customizable. How it attaches to the calves. We have large, medium, small. It's almost just like you'd buy any pair of shoes, but along with like getting it customized to fit well, the customizing of how it's going to behave for each individual. So some people would like way more assistance when they walk, and that's programmable through an app. So the device is connected through a mobile app, and in the app you can set how much assistance you'd like, almost just kind of a dial, like, do you want very little assistance, or do you want max out assistance, where it's going to feel like you're walking without any effort at all? So that's customizable. And then also the different phases of walking. Do you want a lot of assistance when your foot's on the ground, but not so much when your foot's in the air, if the user doesn't struggle with drop foot, maybe they don't want any assistance when the foot's going into the air, or maybe they're really working on that in some sort of rehabilitation program, so they don't want any assistance at that point. And then, while it's as I described there, you can customize assistance for each phase of walking. You can also customize it for each limb. Often, individuals will have one side that's maybe a little more affected than the other, so you can have way more assistance on one side, not so much assistance on the other, and really make it customized to, as you said, the way each individual walks.

**Dr. Marie McNeely** 17:14

Very interesting. And I know you are doing some CPARF-funded research related to this device. Can you describe Colin, how your work with this Biomotum SPARK really influenced your current CPARF-funded fellowship research.

**Dr. Collin Bowersock** 17:27

Yes, I have been lucky enough to be funded through CPARF, which is great. I'm really excited about the project they're funding and allowing me to do. The SPARK device was the first device I was introduced to when I started working in this lab. So there had been previously many, many iterations and many different ways to try to design what we call an exoskeleton. We've tried some at the hip, we've tried some to help walking at the knee. Tried some that are knee and ankle, hip and ankle. So all these designs, and this is kind of what we say, we the group as a whole, got down to this device works well for a wide variety of people, and that's kind of once that was there. I took that device, it's like, okay, this is the technology I'm going to use, and now I'm going to explore it with the CPARF funding.

**Dr. Marie McNeely** 18:12

Very cool. And can you go into maybe some of the details of this project? What are the aims, Collin, of your fellowship? And can you give us an update, maybe, on its progress so far?

**Dr. Collin Bowersock** 18:21

Our device obviously isn't the only one. Many researchers have been working on creating an exoskeleton or gait deficiencies or abnormalities. So while many have been laboratory-tested, we've shown that it can increase and we have all these metrics that we throw out there. It increases push-off power. It decreases the plantar flexor activation. It increases range of motion. So we have all these laboratory studies that say these devices do have the potential to help. However, no one's really shown that they do help in the real world, and our device, too, has not been tested. So how these tests go — we have individuals come into a lab that they may or may not have been in before. We have them walk on a treadmill that's an instrumented treadmill so it's big, it's a little bit scary. Sometimes it's elevated off the ground. It's got handrails all over it. And then we have them walk at this set speed, so that both limbs kind of have to move at the same speed. So it's a very sterile environment. So what we're trying to do, and what I'm trying to do with the CPARF funding, is get these devices into the homes of those who can find benefit using them. We've tried and tried and showed that, yes, it can work, yes it can work. So now it's time to push and it's like these individuals need this, and let's see if it does work.

**Dr. Collin Bowersock** 19:41

So my main aims are, one, is this going to be feasible? Are individuals going to be able to use the device on their own, without help from the researcher telling them how to turn it on, how to change the settings? Is it feasible? Does anyone like using it? Do they find it helpful at all, or do they find it very burdensome and then also, we are testing a little bit of performance. Is it helping them walk faster, or things like that? And a little bit of an update. It's ongoing. But some main things is, individuals do like using it. We kind of scale them on an enjoyment level using a scale. And a lot of individuals do like using it. They find it fun, they find it engaging, and they not based on their performance, but just their rating. They do find it to be beneficial. They think it makes it way easier for them to walk, which is very exciting for us.

**Dr. Marie McNeely** 20:30

And do you have an update, maybe on the number of participants, or just kind of where you are in the timeline of the study?

**Dr. Collin Bowersock** 20:36

We are towards the end of the data collection part. We have right now finished, I think five or six participants, which seems a bit of a small number. We'd still like to increase it, but gotta kind of start somewhere. What these individuals look like. We've had children around 12 years old, all the way to adults. We have an individual who's in their 30s, so wide spectrum, and they all had different levels of severity of CP. They're graded on — there's a scale called the gross motor function classification system, which just kind of gives everyone an idea of how much the individual is affected. So we have people that are one, which means not very affected, and then three, which is individuals who typically need a walking aid to ambulate around the world, so get a good spread in the type of individual, and also ages. So it's gone pretty well.

**Dr. Marie McNeely** 21:31

Wonderful. And I'm really glad you mentioned this kind of diverse range of participants that you have in the research. And I think important to emphasize a point that you did mention earlier, that all of these people are able to, to some extent, walk independently, and I think that's an important note, just to emphasize for listeners out there that this device, you do need to be able to ambulate to be able to benefit from this assistive device.

**Dr. Collin Bowersock** 21:51

They don't have to be able to walk a ton. This device does help propel forward, but if they do need a wheelchair or one of those standing walkers, this device may not be the best for them.

**Dr. Marie McNeely** 22:02

Well, that makes sense, so let's maybe talk about the challenges. I think, Collin, you've made it sound easy. So far, you're doing this phenomenal study, working with this great device. But what have been, or what are some of the biggest challenges that you see with translating use of a device like this one from sort of the sterile environment of the lab to being used in the home by individuals.

**Dr. Collin Bowersock** 22:21

What we all as researchers struggle with this translation is, does anyone like using this? Is it reasonable that they're going to put this on and walk around with it? I think those are the biggest challenges. And there's a researcher, Karl Zelik, who has really invested a lot of his time, energy and resources into studying outside-of-the-lab exoskeleton use, as I mentioned, we have all these metrics that shows it's beneficial in our mind, but kind of an area that's lacking is like, what is the user? Like, if they find that it helps, if they find that it's great, they find it makes things easy, then good. Then all these metrics that we're kind of messing around with may not matter so much, but that goes both ways. If we find that it makes it easier to walk based on our metrics, but they don't think so — they think, I don't think this is helping at all, then we really need to go back to drawing board and say, what is it about it that you don't think it's helping you?

**Dr. Collin Bowersock** 23:16

A lot of it comes down to comfort. I don't find this comfortable to wear, it throws me off balance, things like that. Some can be just perception on how it makes them feel. With the children, we've had really good responses because they get to wear a robot, which is awesome.

**Dr. Marie McNeely** 23:31

Right.

**Dr. Collin Bowersock** 23:32

 So they're Iron Man walking around, taking big-o steps, running, moving fast and it feels awesome, but that may be less so as we get into adulthood, or kids in high school, or kids in college, you may not want to be having this robot that kind of like makes noise every time you walk. So it could be like perception, you know, how do I look? How do my friends thinks it looks? And then, obviously, ease of use. If it's taking people 40 minutes to put this thing on and start walking, then the technology just isn't quite feasible. We haven't found that with our device, we've found it's pretty comparable to putting on, as I mentioned those AFOs, it takes about the same amount of time, which was a big finding for us,

**Dr. Marie McNeely** 24:13

Absolutely. And you mentioned something that a lot of people may potentially get self conscious with, particularly once they're out of their cool childhood robot stage. But can you tell us a little bit more about that? What is the sound that it makes when you're moving around? Or How loud is it?

**Dr. Collin Bowersock** 24:27

It's not loud. You can definitely hear it. It sounds like any electric motor, which isn't really a great explanation. It's not a whine, and it's not quite a chirp, but it's somewhere in between. We hear a sprocket moving on a chain, but it's not grinding or anything like that. It sounds like you would almost imagine an exoskeleton would sound just kind of like zooming each step, but it's not like a constant humming or anything loud like that. If you're standing still, no sound at all. When you take a step, you hear like a little maybe a whir is maybe the sound, but —

**Dr. Marie McNeely** 25:01

We won't make you make the sound.

**Dr. Collin Bowersock** 25:03

Yeah, it's not too loud where you couldn't have a conversation or talk to anyone around you, or where it would disrupt. But that is a point, and there is a way to reduce this sound further that we have been able to do, but it sacrifices a bit of performance. So we're kind of in between that right now.

**Dr. Marie McNeely** 25:21

Absolutely, and I know this is a product that is sort of in development and continuing to be iterated with feedback from people and just advances in the technology and what you're able to sort of pack into the little box they're controlling it. So when you think about kind of moving it into everyday use and everyday life for average people out there, how do you envision the device being used?

**Dr. Collin Bowersock** 25:41

Right now, what I see kind of the future of the device is, as I mentioned, it can be used as a I'll call it a gate aid, where it can help individuals walk. And in that aspect, I see helping keep up with their siblings, friends, peers. They want to go on this hike that everyone's going on. They can wear the device for this high they are after school activities. You know, they've been in school for eight hours. They're exhausted. They can put it on after school to do this thing they really want to do, but may not be able to without.

**Dr. Collin Bowersock** 26:11

Right now, I don't see I think it could eventually be something you'd want to wear every day, all day. This device, it's different than some other assistive devices like the AFO, where the more you use it, it doesn't necessarily mean you're going to be reliant on it. So as I mentioned, with the AFOs, although they do help with mobility, for some individuals, they lock the ankle joint and cause less muscle activity, where this device can assist the SPARK as you're walking, but the assistant doesn't disengage the muscles. You have full ankle range of motion, so as you're walking, you're still engaging the muscles of the ankle, and you're still recruiting them to help you walk. So we're not too worried about individuals getting reliant on this device, and we hope that as they use the device, then their walking without it will also improve.

**Dr. Collin Bowersock** 27:03

Now with the resistive kind of aspect of the device, we're hoping that that'll kind of help with the like at-home rehabilitation, which has always been a struggle in all populations. So people have a hard time doing your rehab program when you're at the house. I mean, I have a hard time. I hurt my shoulder. I know what to do, I still won't do it. But this device, it's engaging, and it's a bit fun again, because you get to wear a robot and do this, so we're hoping it can be used as a rehabilitation tool as well at the home, and then increase mobility when you don't have to wear it anymore, or you don't have to wear it all the time. So that's another part of the research I'd really like to dig into is, if people engage with the device for months and months, how does their walking do without the device any longer?

**Dr. Marie McNeely** 27:49

Definitely. I think you brought up some really good points there, explaining that you would maybe strategically use it for certain activities, because I think you're absolutely right for maybe a kid who's in school just sitting for much of the day, that doesn't really makes sense to have this sort of clunky back fanny pack device on, but maybe they could put it on for recess and then take it off. Is that the sort of thing that you might be envisioning?

**Dr. Collin Bowersock** 28:07

Yeah, yeah, kind of like task dependent. Hopefully listeners who want to see will look up a picture of it, but it's not this huge, rigid device. It can be folded up into a backpack like it's all flexible. It's like I said, these little Bowden it's like bicycle cables. You can kind of fold that all and really the biggest part is, like the foot plate, so it can be as big as two shoes, but take up the room of probably four shoes with the waist pack. So I don't see them carrying it around, but you could maybe store it in a locker, or have it when you're going to recess, have it there when you're going to your after school activity, maybe I keep it there so it's not huge and clunky. where it'd be like impossible to remove it from the house.

**Dr. Marie McNeely** 28:47

That makes sense, and I think that's helpful for us to kind of envision the future of it. And we touched on how it can be tailored or individualized per person based on their needs. But I think there's maybe another dimension to this personalization that I'd love to touch on as well, and that is being able to change for one person over the course of time. And we've touched on this a little bit. But can you explain maybe, Collin, how the device can be adapted or adjusted to allow it to be tailored to maybe the variability of someone's needs throughout the course of a day? Maybe they have more energy in the morning, but need a little bit more help at the end of the day, or even just over time as they age.

**Dr. Collin Bowersock** 29:22

So as I mentioned, the assistance, like the level of how much it's going to help you can be changed, and that can also be changed for the amount of resistance. So if you're starting like a, let's say a rehabilitation program, and using this device, you may start at, and we rate it in Newton meters. Let's say you want to start at a resistance level of five, and then after a week, you want to jump up to seven, and then after that 10, to make it even harder and harder, which would be like a training program where you lift heavier and heavier weights. So could be used that kind of throughout the day. We envision, you know, the user could always change it, open the app say, like, I don't need so much resistance right now, or I don't need assistance. I'm just walking with my friends, but now we're running through a field. I need way more assistance. But then a problem with this gold standard I mentioned, the AFOs. These individuals, children, get them when they're young. They wear them for a little bit, they outgrow them, and they either get a new pair, and then another new pair, a new pair. They say, I'm tired of this, and I'm no longer going to wear these. They don't fit, and they're not adaptable. Where our devices, you get bigger feet, you get a new foot plate that's bigger, you know, you grow taller. We make the cables a little bit longer. The waist belt doesn't fit, it's easy to adapt. So it is, yeah, it's usable for children and adults, and they're not going to grow out of it. As far as the amount of assistance or resistance the device can provide, or literally the sizing, which can be a difficult spot for a lot of these families.

**Dr. Marie McNeely** 30:48

Absolutely, I like that. You kind of described it as this modular device where you could maybe just replace one piece of it as you grow out of it. And I think that's phenomenal. And we talked about some of the barriers to maybe translating this to in-home use. But I'm curious to talk a little bit more about this in depth. So historically, when you think about the big picture of these kinds of devices moving from the lab or the clinic into the home, what have been some of the barriers to compliance, for example, or maybe engagement with home use of these sorts of things, and how do you think that this Biomotum SPARK maybe overcomes or addresses some of these problems that have happened in the past?

**Dr. Collin Bowersock** 31:23

As you mentioned, some devices, I mean, even AFOs or other devices. You get them, you go to the house, and then you never use them. And that's an issue to address. And often, kind of, as I said, it comes down to it's not fun, or it's bulky, or it makes me feel weird. So with the SPARK, we're trying to address that in like, making it fun, making it cool. We make it different colors. We have purple cables. We can also make orange cables. I mean, just like when kids have braces or anything else, you want to customize it a bit so that can make it more fun. And then this isn't implemented yet, but we've had the idea of almost like a fitness tracker. It would give you, like, how many steps you did that day, how fast you walked that day, just anything to get a little more engaging. And then we also have a hope that that information could be sent to their physical therapist or occupational therapist, that the therapist could also know, oh, they have been engaging today or throughout the week. And if they haven't, maybe the therapist or whoever could send them a little reminder, like, don't forget to walk three times in the device today.

**Dr. Marie McNeely** 32:26

Definitely, and I really like some of the points you mentioned there, because I think with technology, the risk is you're really excited about this new shiny thing when you first get it, but maybe your enthusiasm wanes over time as it becomes more cumbersome, or you just aren't as interested in investing the time to put it on, et cetera. But I think the ways that you described of making it engaging, letting people kind of track their progress or their steps, or having that as a way that they can kind of have another touch point with a therapist or rehabilitation professional, I think can really overcome some of those issues that you might just have with new technology.

**Dr. Collin Bowersock** 33:05

Yeah. I mean, people, a lot of us, we wear the watches. We wear the trackers. It's really fun to, like, look at your own data. And, you know, we've kind of, everyone's kind of, like, hoarded the data that these individuals have. So, yeah, like, give it to them. Like, this is how fast you're walking. This how many steps you took today. Can you beat your record? Which is engaging and fun and yet useful.

**Dr. Marie McNeely** 33:24

Absolutely. I think it adds another dimension. And I'd love to talk about the feedback. You mentioned that you've worked with a number of individuals over quite some time with this study to get some feedback, to hear what they think about the device. And I'd love to get some insight into what people are saying about it.

**Dr. Collin Bowersock** 33:39

A lot of people, especially, I mean, they like wearing it. They think it's fun. I do the at home study. I go to the participants' houses, and typically, like, the siblings will be standing around, or the parents will ask if they can invite their friends over so that they can see it so they do like and use it. Everyone's smiling. It's fun to see. The parents, I get their feedback in a little post interview for the our younger participants, and they say they like walking, like they're looking forward to going outside and walking with the device. And I've kind of followed up with a few people, and they said, Yeah, we walked after the device left the house. We still did our, like, daily walks for a little bit, and then for a little bit, and then it kind of stops again. So it's another thing, hopefully, just can help people stay active, and the more active these individuals can be like you can increase their mobility, so it doesn't lead to a more progressive decline in mobility.

**Dr. Marie McNeely** 34:33

That makes sense. And I think when you're looking at in general, user reviews for a product, there's not a product out there that has sort of all five star-reviews. So have you received any maybe constructive feedback that you've had to think about or contemplate how you might be able to incorporate it into the device?

**Dr. Collin Bowersock** 34:47

Yeah, so some of the things I've mentioned that — these ideas have come from the participants. They want the data. They think that would be cool. So right now, the way the device works is it's connected to your phone, so you have the app, and that's how you control it. But for the kids, they've asked for what we would call a headless mode, where you would just turn the device on, and then you just have dials on the device that you could turn up and turn down, so you don't need to carry and lug around your phone. A few people have mentioned the noise. They just didn't like it. Found it irritating, so that's been some constructive and we've been working on not quite a muffler, but a way to reduce it. I think those are kind of the key things that we're working on. One other thing is, for our older and just taller individuals who weigh more, we're starting to create a device that has some big daddy motors in it that can produce a lot more power. And circling back to your question earlier, I think that's another way the device can be progressive as an individual gets stronger or gets older or whatever. So yeah, the bigger motors would help larger or taller individuals just help them assist even more.

**Dr. Marie McNeely** 35:51

Definitely. And I think this assistive mode has a lot of potential benefits in terms of helping people, as you mentioned, do the things they want to do in their everyday lives. But could you explain Collin, what is maybe the amount of energy? If there's a way to quantify it or estimate it, that people could potentially be saving in assistance mode? Is there a way to quantify or measure how much further people can walk or how much faster?

**Dr. Collin Bowersock** 36:13

So in the study I'm conducting right now through the C{ARF funding, some of the things I did would I had them walk around their community, usually is around their neighborhood. So they do a standardized lap each time, and I time how long it took them to do it with the device and how long it took them to do it without the device. And I did that before training and after training. So that was one way we did it. Typically, individuals did that lap much faster with the device with a fewer amount of steps, which then means they took longer steps. That's not exactly a direct measurement, but doing the same distance, they were able to do it much faster and with fewer steps. So you could see that as that saved some energy. You saved 400 steps with the device.

**Dr. Collin Bowersock** 36:56

Some other ways, but you get back into the laboratory, is measuring metabolic cost, and the way you do that is you have people wear a mask which measures their respiration, so how much oxygen they're consuming and when for our device and others. When we've done that in the lab, we have seen that while you're wearing the device, you reduce your metabolic cost, which then translated — they use less energy you burn to less calories. So that's a more direct way, but definitely not as fun and not as I said. We're trying to get this back into the real world. The one other way to measure it is muscle activity. So when you're wearing the device, do your muscles engage more? Do they engage less? But that can be a little not tricky, but I wouldn't want to promote people not using their muscles as much. But if they're using them in a more efficient way, then yes, all for it.

**Dr. Marie McNeely** 37:47

Absolutely. And you hinted that there's the option to potentially, in the future, increase the size of the motors, increase the amount of power that the device could potentially put out. Do you have parameters for maybe what the current maximum, whether it's height or weight or force or anything for people being eligible for these studies that you're doing right now.

**Dr. Collin Bowersock** 38:04

Yeah, our exclusion criteria is pretty widespread. The kind of max weight we've been working towards is with the spark device, the way it is now, is about 160 pounds, which is not light, you know, it's a pretty good spread. And then we can go all the way down to an individual that's, I think our shortest was right around four, six, something like that. When we get much smaller. I mean, we could build another device, but all the components just get smaller and smaller. So for the study I'm currently doing, that's kind of our range right there, for the height, we had an individual who's quite tall, over six foot. So we have a good range of height and weight.

**Dr. Marie McNeely** 38:42

And is there a minimum weight that it has to be to sort of trigger the sensors in the footplate?

**Dr. Collin Bowersock** 38:46

When you step on it, there's like a little calibration process. So when you put your weight, when you stand, the system knows how much you weigh based on, like, how much force you're putting on each so then it knows that's kind of its threshold, its trigger point. If it's less than that, you're just now starting to step on it. If it's more than that, that's when you're pushing off. But no, you can't be too light for it.

**Dr. Marie McNeely** 39:08

That makes sense. And it sounds like you're doing some fantastic research in this area, but I think thinking about the future is always exciting. So for you, specifically, Collin, beyond your fellowship, what are the next steps for your research in this area?

**Dr. Collin Bowersock** 39:21

I would like to, even with just this device, or this type of device, expand into other populations. For example, one I've kind of been starting to think about is individuals with Parkinson's disease. So people with Parkinson's, they have what's called freezing of gait, so they could walk, they walk, they walk, and then all of a sudden they'll be a bit stuck, and it's due to some things going on in the brain, but they can't initiate a step is the main problem. Some not-great methods to fix that is you can push them and they will take a step just based on their response when you're falling. You got to take a step. That's kind of a way to trigger it. Another way is like put targets on the ground. Around little lines or pieces of paper, anything that they can aim towards, and that clears this freezing of the gait. With our device, which it would need a little bit of maneuvering. But if we put then we've had a device that you can also assist the hips. But if it could kind of just initiate that one step, and then the individual could start walking again, I think our device and kind of our whole configuration is well suited to solve some problems like that the way it is now, it could also help individuals with stroke, which we've explored a little bit, individuals with motor, incomplete spinal cord injuries, to help them walk. So just kind of offer this device to more people, like we want to help more and more people. So I think expanding our population.

**Dr. Collin Bowersock** 40:41

Some other things, more technology wise. Right now, as I said, it's an ankle assistive device. We've been working on devices so we could pair hip assistance and ankle assistance. So it'll help you swing your leg forward and push off, and it'll help you swing your leg backwards. For individuals who need more assistance at different joints in the body. We've also, one of my colleagues has done an upper body exoskeleton, so it's kind of built on the same platform, which is really unique to our device. So it's the same motor, same microchips, kind of all the same technology, but just created a way that now it's helping joints at the shoulder and the elbow. So I think expanding that technology and also expanding our amount of people that we're able to help is the next thing I'm gonna go explore.

**Dr. Marie McNeely** 41:27

Ah, very cool. I think there are a lot of exciting directions this work can go. But if our listeners want to learn more about you, the lab and the work that you're doing there, what is the best way for them to do so?

**Dr. Collin Bowersock** 41:39

well, reaching out to me directly would be really cool. My email address is pretty simple. It's my first initial C and then D and then my last name, bowersock at gmail dot com be happy to talk to anyone who wants to reach out, email back and forth. For the direct work in our lab, you can see all of our publications and some really cool videos of the device and how it works on our lab website. The Lab website is bio, B, i, o, mec, as in mechanics, M, E, C, K, so bio, neck.nau.edu, and that's the University website. There you'll see some interviews with Zach Lerner, who's the head of the lab there. You'll meet all the people in the lab that help do all this amazing work.

**Dr. Marie McNeely** 42:22

Awesome. Well. Listeners, definitely get in touch with Collin if you have specific questions, and check out the lab website to learn more about the amazing work that they're doing there. And Collin, it's been such a pleasure to have you on the show today. Thank you so much for your time.

**Dr. Collin Bowersock** 42:36

Yeah, thank you guys for having me.

**Dr. Marie McNeely** 42:37

It's been wonderful to chat with you. And listeners, great to have you here with us as well. When you have a moment, please subscribe and leave us a rating or review on your favorite podcast platform to let us know what you think of the show, and we look forward to connecting with you again in our next episode of Changing What's Possible.