BioSpine, a game changing QLD-led technology to help recover movement and sensation after paralysis.

Announcer:

This is a podcast by Lumina, the perfect space to innovate, collaborate, and grow in health, science and tech.

Host - Rebecca Griffin:

Claudio Pizzolato, welcome to HealthTech Talks.

Guest - Claudio Pizzolato:

Oh, thanks for having me here.

Host - Rebecca Griffin:

Claudio, you're an associate professor at Griffith University School of Health Sciences and Social Work and the Australian Centre for Precision Health and Technology. One of your key areas of interest and passion is Project BioSpine, which aims to restore movement and sensation in individuals with a spinal cord injury. This is such exciting work, Claudio. If the aim is to restore movement and sensation in people with spinal cord injury, does this mean they could potentially walk again?

Guest - Claudio Pizzolato:

Well, that is a fantastic question, and the potential is there. That's what we are aiming for, and you need to aim high and work your way there. You're going to learn a lot of things during the journey, but that's what we're aiming for. Absolutely.

Host - Rebecca Griffin:

Incredible aim. So tell me about the science behind your work. Can the human nervous system rewire itself after injury?

Guest - Claudio Pizzolato:

Well, I'll tell you a bit about spinal cord injury before and then that hopefully can explain a bit better, like how this reconnection could potentially happen. So after a spinal cord injury, what happens is that your spinal cord is damaged, your brain cannot communicate with the muscle, sending but also receiving signals from below the level of injury. The way we experience the world is through our senses, and you are used to the common senses, like the side taste and so on, but you have sensors embedded in all your body that allows you to understand your position in space and really have the perception of

yourself. So that's why if you close your eyes, you can understand the position you're in and that's because you have so much information coming back to your brain. So the spinal cord injury interrupts this. It disrupts it, but even though a person might have a complete injury, meaning that there is no ability to move or perceive sensation below the level of injury, it doesn't mean that the spinal cord is detached.

Often, in more than 50% of cases, what happens is that you have a bruise and that hinders the communication, but there are still neurons that remain intact across the level of injury. So the question is how can you leverage those existing neurons and reprogram them to re-enable this communication between brain and muscles? That's the principle we're going by. It's about training those existing neurons which have ability to remodel to a certain extent. And what I mean is that, for example, becoming... have stronger synoptic connections, but also have some level of re-branching by physically connecting with new neurons around it. So it's really about using this natural bridge, but putting the right things in place to make it usable.

Host - Rebecca Griffin:

That is absolutely amazing. So is this the basis of your work?

Guest - Claudio Pizzolato:

Yeah, that's exactly right. We started our work by first principle, this is the mechanism that we're targeting. And then we started saying, "Okay, what is the best set of technologies that we can combine to promote some level of plasticity of the spinal cord? How can we tap into this mechanism in a way that is non-invasive and it's acceptable by people?" And that's how we developed BioSpine. So it's about thinking first about what are we actually trying to tackle from a neural perspective and then around it, how do we best craft the technology to enable that to occur?

Host - Rebecca Griffin:

So how did you come to be part of the team?

Guest - Claudio Pizzolato:

That's a good story. I was at Griffith during other type of biomechanics research, still in the neuromusculoskeletal domain, but at that time, I was working mostly in rehabilitation after Achilles tendon injury. But it's at that time when I met Dinesh Palipana. Dinesh is a remarkable individual. He's a medical doctor, and he has a spinal cord injury. Well, you can read a bit about his story. Yeah. He published a book recently. Actually, I met him because he was my neighbor. We used to live on the same floor in the same apartment building. Met in the elevator a few times. And when you see a doctor in a wheelchair, you start asking questions. That's how the conversation and the friendship started. We first started to share elevator rides and then he gave me a lift to uni a few times because he was just

working at GCUH. And that's where it showed me some of the research that was ongoing in the US and overseas. Basically what I said is, "Well, we can do it better here." And that's how it started.

Host - Rebecca Griffin:

So you are the neighbor. I've heard about you-

Guest - Claudio Pizzolato:

Yeah. Okay.

Host - Rebecca Griffin:

... because I have interviewed Dinesh previously, and he's a remarkable human. And he told me about you. So there you go, small world. So talk us through the neuro assistive robots and how they're taking the scientific evidence and turning it into real time practical theory.

Guest - Claudio Pizzolato:

In BioSpine, our core technologies involve interacting with the person from a physical perspective. So what it means is that we use motorized equipment, and that could be exoskeletons, could be something simple like a cycling ergometer, which we're using a lot at the moment. But it's basically something with some motors that allows people to be mobilized. So you move the joints, right? So instead of doing it manually, use a robot of some sort. I'm using robot very liberally here, something with motors that you can control. The other key technology that we're using is electrical stimulation. So we are using electrical stimulation applied to the muscles, and what practically means is that we deliver an electric current to the muscles to generate a contraction and movement. And then we are also using electrical stimulation to the spinal cord. Now, the challenge here is how do you understand what's the best way to turn on and activate these rehabilitation devices?

What's the best way to do it for that person? And that's where all the work in biomechanics comes in. It's about simulating the interaction on a computer first, and that's what we call a digital twin. By simulating that interaction in real time, we can then control the devices at the same time. In that way, we can basically make everything automatic. I don't have to decide manually how much to move the leg, how much to stimulate the muscles. Everything is done automatically to promote, as much as possible, the plasticity of the spinal cord. So some of these technologies or the digital twin really can be extended and applied to many other cases. So right now, BioSpine relates to recovery of the spinal cord injury. But what we can do with the same type of technology, let's say for a person that has a post-stroke, so some level of impairment after a stroke, we can pick up the motor in tension, so the electrical activity that is available and some of the muscles of the person and use that to reconstruct the movement that they're trying to achieve.

So now you have the movement that the person is trying to achieve, ideally what they're actually able to achieve, which is probably limited due to the impairment. And then you take the difference, and you can control, let's say, an exoskeleton or a robot to provide that difference. So what you're doing, you are supporting the rehabilitation of the person. Well, the movement, but both from a rehabilitation perspective, but also being able to support daily living. The goal there is that the technology needs to be supportive. It can't take over. It needs to provide just the adequate level of support because you're still trying to put the effort in to actually get better and do the job. You can't be complacent and just being taken around by the robots. You need to put the effort in. These digital twins allow us to do this.

Host - Rebecca Griffin:

Now, we talked about Dinesh and there's obviously yourself, but you must have some other amazing minds on your team. Tell us about what kind of professionals make up the team.

Guest - Claudio Pizzolato:

The team is a fantastic blend of skills and individuals, really. That's also what makes me so happy to be working on this project. It's not just doing something that might help people that live with a spinal cord injury, but it's really that challenge and the excitement of working with the team that is comprised of such a diverse set of skills. So as you said, we have medical doctors, we have different flavors of engineers because even as doctors have specializations, engineers do as well. So electronic engineer, biomedical engineers, mechatronic engineers, software engineers and so on. Then we have lots of people with a clinical background besides doctors and physiotherapists, exercise physiologists. So those are very important because they are the people that deal with our participants, work with the people with spinal cord injury. But the very interesting thing and something that might be very different from other research teams, we also have industrial designers on board and that allows us to rapid prototyping different type of technologies, adapt them to the individual.

And I wouldn't be able to think about the project being at this stage without that massive input of creativity and design. Yeah. It's amazing. And we also have game designers as well.

Host - Rebecca Griffin:

Really?

Guest - Claudio Pizzolato:

Yeah, absolutely. I explained some of the technology, but the other part is that we use virtual reality to actually immerse the person in the therapy and have them to explore a virtual world. So that allows us to yes, further train the brain because the visual system is extremely powerful. But also, if we can make the rehabilitation more exciting, more pleasant, people would just want to do more independently, whether that is beneficial for them or not. And the more rehab you do, the better it is.

Announcer:

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So where's the project up to? Are you currently running clinical trials?

Guest - Claudio Pizzolato:

Yes, we are running a clinical trial. So we run a very early phase clinical trial a couple of years ago with four people with complete paralysis, and we are seeing some very promising results. So that allowed us to receive continuation funds for our research. Now, we expanded the evaluation of the technology on a larger number of individuals. So we have 12 people coming in the lab at the moment, twice a week, and at the same time, allowed us to improve on manual the technology that we're using, both from a technical perspective. So I mentioned earlier we included a stimulation of the spinal cord now, which is quite an exciting technology, but also from a clinical workflow because when you have coming in twice a week, you need to have something that works well and that people are happy to use and it's comfortable. So we had to develop some technologies in-house to enable that to occur because there was no commercial alternative there.

Host - Rebecca Griffin:

What have the key learnings been so far?

Guest - Claudio Pizzolato:

Well, there has been lots of learnings, I would say. I'll start from a clinical perspective. I'll tell you what we have seen in our previous cohort of participants. We have seen people regaining ability to contract muscles that were previously paralyzed, which was the goal initially that we set, and we were very happy to see that happening. So these people were initially classified as having a complete spinal cord injury, but by the end of the training, and that was one year of training, so probably 120 hours in a year, they were reclassified... Two of them were reclassified as incomplete. So-

Host - Rebecca Griffin:

Wow.

Guest - Claudio Pizzolato:

... that was very, very exciting for us. And that means, as I mentioned, improvements in contracting muscles that were previously paralyzed, improvement in sensory function, so ability to perceive some level of sensation. Again, importantly, something that we did not expect was ability to thermoregulate

again. People with spinal cord injury very, very often have trouble in thermoregulating. So what it means is that they cannot sweat. So they have a very bad time in different difficult weather, like whether it's too hot or too cold. That can lead to some life-threatening situations because if you are stuck in a hot car and you can't sweat, you can imagine. So we were very, very excited when some of our participants started to report this to us and telling us that they deal with hot and cold way better.

So that's something that we didn't think about at the beginning. Other things that we have seen was improvements in bone mineral density, so substantial improvement often for what I've seen in the literature. And other clinical trials that have used maybe some similar technologies, they've reported some level of slowing down the decrease, but we actually have seen an uptick in our participants, so it was very exciting. And then some other improvements in, let's say, bladder control as well. So-

Host - Rebecca Griffin:

That's remarkable, isn't it?

Guest - Claudio Pizzolato:

It's so good. Yes.

Host - Rebecca Griffin:

Can you tell us about a participant who is having life-changing success with the technology you're developing?

Guest - Claudio Pizzolato:

Listen, as I mentioned before, we had four participants that participated in our first study. Some of them moved remotely, and they couldn't attend the lab anymore, but they were really looking forward to have maybe an at-home system to keep working on it because they had changes that, for them, were important. They changed their quality of life. They changed their independence. Even if we're not talking about people walking again or being completely independent again, those small improvements still made a remarkable difference in their daily life. So unfortunately, we don't have at-home system yet, and they were not able to come back to the lab to continue training. So we still chat with them, and they're still very keen. So that's why we are working as part of our design and development to a system that could be used at home because people can get more time on the device as well. So that's as much as I can share, because some of our other participants are currently enrolled in a trial. So as I said, you can invite me back in a few... Maybe-

Host - Rebecca Griffin:

Definitely.

Guest - Claudio Pizzolato:

Maybe next year, I'll give you an update.

Host - Rebecca Griffin:

Now, project BioSpine took part in the 2024 LuminaX HealthTech Accelerator Program. How did you hope the program could help your project, because you seem to have already come so far?

Guest - Claudio Pizzolato:

First thing, we are academics. We are good at doing the research. We are less good in commercializing it. It's not truly our job commercializing. That's the university job, but being able to interface with the business side of things and truly understand the dynamics between creating a solid business and the research was so valuable and was an unexpected learning from the program. Because you can have the most amazing research, but if it's not cast in a way that can be translatable down the track, it becomes very difficult for it to make an impact. So interfacing through the LuminaX Program, interfacing with lots of people and the amazing mentors throughout the program and going throughout all the workshops, that allowed us to rethink the way we can shape the technology to make it more usable, but also align with some of the health requirements or funding pathways that are available for technology so that people could actually access this.

So that really helped us shape our thinking in how we can modify some of... not the core aspect of the technology, but what are some of the things that we need to include and consider, also from a co-design perspective, to enable this to be used within a health context so that it can work with the rest of the healthcare system. Being able to talk and discuss with many of the mentors and going through the program, that was amazing.

Host - Rebecca Griffin:

So the program has helped you to advance Project BioSpine?

Guest - Claudio Pizzolato:

Absolutely. The program helped us a lot. Actually, just recently, that was announced last week, we secured an Australia economic Accelerator grant for BioSpine, and that's in collaboration with industry partners. It's to advance towards scale manufacturing of one of our key components, which is a brain computer interface. So we read brain waves, and we understand what the person is trying to do. So through Lumina, we made the connections and we took the learnings of the program, and I used those to... Well, with the team, we basically leveraged those. We wrote the grant thinking about these business needs. So that helped a lot in terms of getting the narrative right to target the commercialization of the product. So that was extremely, extremely helpful.

Host - Rebecca Griffin:

Huge congratulations.

Guest - Claudio Pizzolato:

Thanks.

Host - Rebecca Griffin:

Now, project BioSpine is based at Griffith Uni, which is part of this terrific Gold Coast Health and Knowledge Precinct where we are doing our interview today. How did you think being part of this ecosystem has opened doors for the project?

Guest - Claudio Pizzolato:

Well, I'll start by saying that the ecosystem is fantastic. I don't know how many other places would've such a fantastic synergy between the precinct, the hospital, the university, and I feel very, very lucky to be here. I think, no, it probably adds to the serendipitousness, if it's a word, of the old project. Being, and meeting the right people, assembling the right team and having the right environment that allows you to grow allows you to dare and be brave and support you in that. The synergy between the precinct and the university, I don't think we could have had this project if it wasn't... There were many factors, of course, but having the precinct here, that definitely contributed to it.

Host - Rebecca Griffin:

It's a terrific environment. It really does put people in the right place at the right time-

Guest - Claudio Pizzolato:

Exactly.

Host - Rebecca Griffin:

... without even knowing, doesn't it?

Guest - Claudio Pizzolato:

Exactly. You get to know so many people and people that want to change... They want to change the world. They want to create new technology. They want to make an impact. And that environment drives you because if you were in an environment where people were just negative or just dismissive on what you're trying to do, you would lose the will to try to push all the time. But instead, you are immersed in this atmosphere that makes you feel that something big is going to happen.

Host - Rebecca Griffin:

Yeah, it's so positive and encouraging. You can just feel it. Now, the type of work that you are doing is the type of work that I imagine you live and breathe. So I just wonder how you go home and switch off from this project, because I imagine it would be something that you can't stop thinking about. It's so exciting.

Guest - Claudio Pizzolato:

You are correct. I don't think you stop thinking about it. You maybe think about variations of it, or you are concerned how you're going to fund the next year or how you're going to make the commercialization happen. Oh, you don't stop thinking about it. I think it's also part of being an academic, which I believe there are some similarities of working independently. Of course, you are more protected in academia. You can take some liberties, but practically thinking, if you are driven, you can achieve and get your research done. That means working on it and thinking about it. It's not something that you go home at 5:00 and you stop thinking about it. It's always in your mind, how you're going to make it better, how you're going to solve this problem. There's always some dramas. So yes, it's difficult to switch off. You just find some hobby and you switch off by doing other things.

Host - Rebecca Griffin:

And I guess it's just such a wonderful passion, isn't it? And once you find your passion-

Guest - Claudio Pizzolato:

Absolutely. As I said, I feel very fortunate to do a job that it's so exciting.

Host - Rebecca Griffin:

Claudio, it's been really wonderful talking with you today. All the best with this incredible project, and thank you for your time.

Guest - Claudio Pizzolato:

Thank you so much, Rebecca. It was a pleasure.

Host - Rebecca Griffin:

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