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K: Hi everyone, thanks for joining us for this special report of the rehabINK podcast. rehabINK is a student-led online magazine focused on rehabilitation research and innovation. So if you haven't read it yet, go check it out. I promise it's worth it. I'm Kyla Alsbury, a second-year PhD student at the Rehabilitation Sciences Institute, also known as RSI.

A: And I'm Analyssa Cardenas, a second-year master's candidate at RSI. Today we have the great fortune to chat with one of our very own graduate students, Vahid Anwari. Not only is Vahid a graduate student here at the University of Toronto, he is also a practicing medical radiation technologist with the University Health Network or UHN. We were very excited to talk to Vahid about an innovative project which is helping combat COVID-19 and support our healthcare system. As the number of COVID-19 cases rapidly increased in Canada, hospitals and healthcare workers faced a shortage of personal protective equipment, or PPE. Led by Dr. Azad Mashari, Vahid and a team of dedicated individuals are leading an initiative to 3D print face shields for healthcare workers. On March 29th, 2020, they sent out their first one hundred 3D printed face shields to be shipped to healthcare workers. But, before we get too far into it, let's hear from Vahid himself.

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A: Okay, so Vahid can you tell us a little bit about what you're doing to help combat COVID?

V: Yeah, I can definitely talk about our work at the University Health Network. So what we've been doing for the past six weeks is to kind of develop two main things to combat the PPE shortage (personal protective equipment). So we are using 3D printers to print face shields. The reason why the face shields are so important now is because there's already a shortage of surgical masks, so the face shield kind of acts as a first barrier to the person, to the healthcare worker. So what we do is we print the frames of the face shield and then we buy the plastic, the clear plastic that goes in front, and then we just snap on the plastic to the frame that's 3D printed. And the last thing that goes in is a strap that holds everything together. So these face shields printed in the basement of Toronto General Hospital, so far we've distributed two thousand to the hospital alone and our other sites have distributed another two thousand as well. So that's why we are focused on using 3D printing. The second thing we're doing is we're testing stopgap solutions for N95 masks, and we've heard a lot about N95 masks being in a huge shortage. There are other filters that can be used as an alternative and what we're doing is testing silicone to help hold that filter on your face, basically, to make a really good seal. so that's right now in the clinical trial phase where we're testing it on people. So yeah, those are main two things that we're focused on right now.

K: That's amazing! That's really neat. I actually hadn't seen the face shields before all of this. Like I've seen obviously the surgical masks and the N95s, but the face shields were new to me and it seems like they've been really helpful and useful during this pandemic. That's really incredible.

V: Yeah, the face shield, before this pandemic, was not used a lot. I mean we've used-- I've used it very few times myself and they are thrown away usually when you finish your case. So, it would be

for a patient you think is kind of on a ventilator and there may be some splashes or aerosol-generating kind of procedure, but not used a lot. But now that surgical masks are becoming a shortage, face shields are becoming really important to kind of keep that mask clean.

K: Yeah that's amazing. Can you clean the face shields? Because I know initially, with N95 masks, you would just dispose of them once you were done using it, and now they're trying to look into whether or not you can re-use them, right, with sterilizing them or whatnot. Is it the same with the face shields? Or once they're used do you have to dispose of them?

V: So, it depends on what material it's made of. If the face shield has a foam which the non-reusable ones do, then it can't be reused because the foam cannot be washed or bleached properly. However, if the face shield is made of entirely plastic, which ours is, then it can be reused. So ours is a reusable face shield that you can reuse as many times as you want.

K: That's fantastic because you also have to think about the environmental impact of all of these PPE supplies that we're using, right, if you're having to dispose of them. That's so cool.

V: Yeah, for sure. I think after this pandemic there's going to be a lot of innovation towards reusable healthcare equipment. It was not a thought before but I definitely think there are going to be companies that are going to produce reusable N95s, reusable face shields, reusable everything.

K: Yeah, I feel like that only makes sense, right?

V: Yeah.

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K: So what inspired you to take on this project on top of working as a healthcare professional and also being a master's student?

V: I think one of my main inspirations was my colleagues. And when I was working with them initially at the very beginning, I anticipated that there is going to be a shortage of PPE and my colleagues knew that I was 3D printing and had knowledge of how to make them. So, they asked me, "can you make us these face shields?" So I started experimenting and that kind of took off. So, I got encouraged by the fact that there was a huge need in our department. So now, when I see people wearing the face shields that we made, it's kind of inspirational that it all started from us.

A: Well that's great, thanks so much for all of the work that you're doing. I can only imagine how busy you are on top of also doing research and working as a healthcare professional, you must be super busy.

V: Yeah, some things have definitely fallen behind, like my research—my-- I just had an interview with my supervisor and he said, "what have you done?" And I said, "I've been printing face shields," but that's not really my research for my master's, so I have to find a balance now.

A: Yeah, I think it's really great how you're already applying something that you're kind of an expert in and you have those skills already, and it's so needed right now too. I was wondering if you can speak to any challenges that you may have had in planning or implementing this initiative that you started?

- V:** Yeah, for sure. So, to get this initiative going I had a collaborator in anaesthesia—so Dr. Azad Mashari who's the Director of the 3D printing lab here. It's called APOL, so 'Advanced Perioperative Imaging Lab', and when I asked him if we could do this printing together, he actually had started doing his own prints and he knew that I was 3D printing so he was delighted to have me on board and then we also have another colleague that's also working and helping us. So, one of the main challenges that we found is that logistically, how we were going to distribute two thousand face shields. Like just that alone, emailing people and, you know, getting payments from them and finding enough plastic, like sourcing that from China, and then figuring out how it's going to come to us. And then making sure that we have enough filaments to put into the printer, to make the face shields. So, I think from a distribution point of view it was very challenging. Like, making one or two is super easy, but when you're trying to make a thousand and two thousand, now you're going into quality control and production. So, I definitely had challenges in that aspect; however, I'm lucky that I do have help, and I kind of understand where my weaknesses are and I try to get people to help me in those aspects.
- K:** Yeah, I think that's great. I think you touched on the teamwork, right? And that it's, you know, you need the help of your team members who have expertise in different areas. And I think, too, the-- you mentioned too, that there's all these different moving parts to having something like this actually come to fruition, right? It's not just about making the masks, it's where do you get the materials and who actually needs them? The logistics of actually getting them to the people who need them and the payment—there's so many different pieces and I think sometimes especially when we're reading the news we think, "Oh, well it's simple. Just make the PPE." But there's so many other steps that are involved too.
- V:** Yeah, that's right. Yeah, I think that's the key component is kind of understanding production and manufacturing and distribution. Like, that never comes to mind when you have a hundred, like when you try to make for one hospital-- it's challenges where you need more expertise in.
- K:** Yeah, you're definitely building lots of extra skills on top of what you already know, right?
- V:** Yeah.
- K:** You already touched on this a little bit, but what makes these 3D printed masks different from other masks?
- V:** So I think that the main piece that-- the main selling point is that it is reusable, so that you can dump it in bleach and Virox, or wipe it with any kind of cleaning agent that the hospitals have. The other main criteria is that it is cheap. We sell them for \$10 per piece all assembled, and if you look in the market there are companies that are trying to make money off of face shields and other equipment and they're selling them for \$25 or \$30 dollars to the general public. So our aim was to make it as cheap as possible but also cover our cost of how much product to buy and the labor. So, \$10 is the amount where we could cover all our costs but also not make profit off of it and just try to get it to as much people as possible. So, in that respect, we partnered with this not-for-profit company called Glia.org in London, Ontario. And this organization is mainly focused on making opensource medical equipment that's Health Canada validated, which this face shield is. So that partnership has really helped us get this to as many hospitals as possible. So, the \$10 apiece—the price point, is one of the other aspects that we focused on.

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K: Yeah, I think that's so important. I think you know, our healthcare system runs at a budget where we expect a certain amount of disease, or people to come into the hospital system, right? But something like this pandemic has just thrown all of the budgets completely out of whack, right? We couldn't really have predicted the impact of it, so it's great that you're making it affordable for people as well. And I haven't heard of that organization, I'll have to check them out too. I'm curious about the time it takes to make these masks. For example, how many can you make in an hour?

V: So, right now the frame takes an hour and half to print—just one individual. So, the printers we have, we can put two in one plate. And of those printers, we have ten of those, so in one hour we can make 20. If we're rotating the printers throughout the whole day, we can make 100–150 just with those printers. And we also have five larger printers that can print five at a time. So, in total, in our facility, we can make 150 in a day. We also have community members that have printers of their own—and they're also printing for us—and they can usually print 500 in a week. There are others that can print 1000 in a week. So, in total, adding all those what we call "printing farms", in a week we can make 2000.

K: Wow, that's incredible.

V: Yeah. I think the key was to just have as many people with printers print them so that we can get the numbers high.

K: How did you get the community partners engaged? The people that have printers.

V: Yeah, I think it was more of a plea for help and people kind of answered that call. So, Dr. Mashari, he made an announcement and asked for printers using the network that he had. So, Toronto Public Library answered that call, and they said, "We have 10–12 printers, do you guys want it?" So, then they made that announcement and then all these other people heard that, and then they said, they emailed us and said, "We also have printers." So, there was an art exhibit close by, and they donated three-- loaned three printers. And then U of T Computer Engineering lab heard that call on Twitter and they also loaned us. So, in a way, it kind of snowballed to us having 20 printers in the lab just from those community members.

K: Wow, that's so cool. I think I actually did read the call from the Toronto Public Library. I'm on their emailing list. I think I actually did see that, but it's neat to see how far-reaching it went.

V: Yeah.

A: So, if we don't have a 3D printer-- I guess my question is, how do you suggest that our listeners help you and your team combat COVID if we don't have a printer that we can donate?

V: Absolutely. I think we need the people that can kind of help us manage, like, production. So if people want to get involved, we need like a manager that can answer emails and make requests for materials on our behalf. And then we also need drivers that can drive and drop off face shields to other hospitals. And if there are-- let us know if there are people with printers and they want to print for us, they should have at least two printers if they want. If there are other people that want to donate printers, we would be happy to hear that. We're also looking for a good source of

elastic and like screens, like those plastic screens that we use. If there are local sources, we like to have backups in case our supply stops coming from China. So, I think in that aspect, people can help us reach out to those resources.

A: That's great, thank you. Yeah, I guess because, one, I'm not any sort of healthcare professional, but I'm still eager to help and I'm sure there are many people who also want to be doing their part to help if they can. So, thanks for providing that list of things that people can do.

V: Yeah, no problem.

K: Yeah, I don't have a car or any of the supplies that you need. I have a bike and I live downtown, so if that's helpful, let me know *[laughter]*. So, do you foresee that your workplace or your lab will continue to print these masks once the COVID pandemic hopefully starts to fade away into our memory?

V: If there is a need, yeah, I think we can definitely keep printing and making face shields; however, I don't see us doing this full time, 24/7, once the pandemic kind of disappears. So yeah, I would suggest definitely it would be better that the hospital has a proper resource for reusable face shields from a company that makes this their living. But if that's not the case, the lab itself at the hospital is a perfectly adequate resource-- alternative resource as well. So we will see. I'm not sure what exactly is going to happen in the next month or two, or even in six months. So we have to play it by ear and kind of determine what the needs are going to be. And I do also have to finish a master's degree, so--

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K: It's a small detail. Well it's really inspiring to hear everything that you and your team have been working on and I really appreciate you sharing all that with us. It's neat.

V: Yeah, no problem. I'm glad to talk about it to the community—to a wider community. I wish we could show people the lab and take videos but unfortunately we can't do that, so-- No, I think it's really cool to kind of walk in the lab and see 20 printers and people that can come and they look at them and they say-- they ask, "Is this all your printers?" We say, "No, these are all community printers that we got." So, we can point out to the library printers, and the U of T, and the art-based printers. And people kind of are happy to hear that the community kind of got together, and they gave away this expensive resource just for us without any kind of preconditions to print face shields. So, I think that in itself is an amazing act for people. So, I would say that's kind of cool as well. So yeah, other than that I think that's the main gist of what we are doing.

K: Yeah, I think it's a bit of a-- it's a ray of hope in this pandemic, I think, to see that people are volunteering their time and their resources to try to help everybody else. It's inspiring to see.

V: Definitely. Yeah, thank you for inviting me to talk about it. I think that—I take that as an honor, for sure.

A: Wow, that was so great. We really do have some really amazing peers here at RSI.

K: Yeah, we're definitely lucky. If you're interested in helping Vahid and his colleagues ensure that these 3D printed shields get into the hands of front line healthcare workers, you can email Vahid

at vahid.anwari@uhn.ca. That's V-A-H-I-D dot A-N-W-A-R-I at UHN dot C-A. If you also happen to have a 3D printer, their team has made a free design available online at glia.org. That's G-L-I-A dot org. You can download their design free of charge and print yourself, or others, these shields.

A: So, thanks for listening today and stay tuned for our next episode where we interview authors of articles from rehabINK's Issue 8 called *Technology: Adapting the Future of Rehabilitation*.

K: We'd love to hear your thoughts on this episode. How are you handling these unprecedented times? Are you also contributing to the fight against COVID-19? If you have any thoughts, stories, or insights, tweet us @rehabINK, at R-E-H-A-B-I-N-K, or visit our website at www.rehabinkmag.com.

A: Thanks, and until next time, stay healthy and curious.

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